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

MINERAL COMMODITY SUMMARIES 2010

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 Ore
Iron and Steel
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
Sodium Sulfate
Stone
Strontium
Sulfur
Talc
Tantalum
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Vanadium
Vermiculite
Yttrium
Zinc
Zirconium

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MINERAL COMMODITY SUMMARIES 2010

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science for a changing world

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

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INSTANT INFORMATION

Information about the U.S. Geological Survey, its programs, staff, and products is available from the Internet at <http://www.usgs.gov> or by contacting the Earth Science Information Center at 1-888-ASK-USGS (1-888-275-8747).

This publication has been prepared by the Minerals Information Team. Information about the Team and its products is available from the Internet at <http://minerals.usgs.gov/minerals> or by writing to Chief Scientist, Minerals Information Team, 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 more than 80 mineral commodities during the past 100 years.

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 2010 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 2009 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.

National reserves information for most mineral commodities found in this report, including those for the United States, are 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 reserves 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 reserves information reported in the mineral commodity sections of this publication.

A national estimate may be assembled from the following: historically reported reserves 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 (USBM), before 1996, and estimates of identified resources by an international collaborative effort (the International Strategic Minerals Inventory) are the basis for some reserves 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.

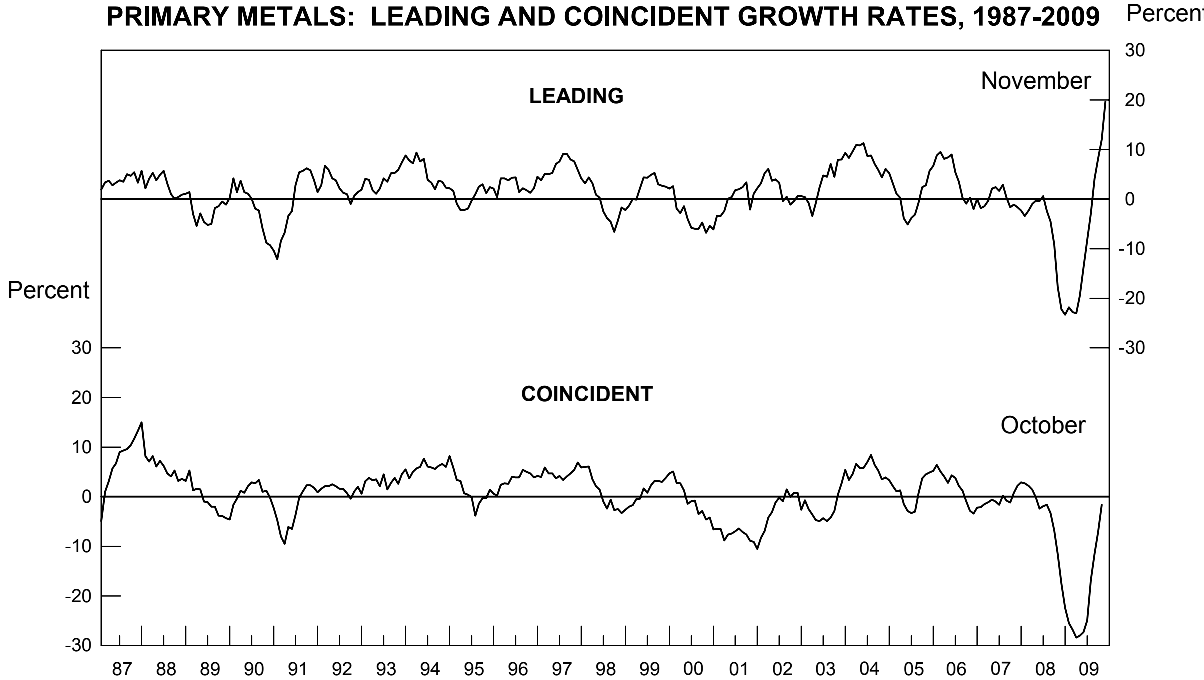
Throughout the history of Mineral Commodity Summaries and its predecessor prior to 1978, Commodity Data Summaries, the presentation of resource data has evolved. Although world resources have been discussed each year, presentation of reserves and reserve base data varied. From 1957 through 1979, only reserves information was published in the reports, but from 1980 through 1987, only estimates of reserve base, a concept introduced by the U.S. Bureau of Mines (USBM) and the USGS in 1980, were published. Beginning in 1988, both reserves and reserve base information were listed for each mineral commodity where applicable and available. Prior to 1996, the minerals availability studies conducted by the USBM and work with international collaborators were the basis for reserve base data reported in Mineral Commodity Summaries. When the USBM was closed in 1996, this function was discontinued. Since that time, reserve base estimates have been updated to be consistent with changes in reserves, but the nonreserves component of the information upon which the reserve base data were estimated is not current enough to support defensible reserve base estimates. For that reason, publication of reserve base estimates was discontinued for Mineral Commodity Summaries 2010.

Abbreviations and units of measure, and definitions of selected terms used in the report, are in Appendix A and Appendix B, respectively. A resource/reserve classification for minerals, based on USGS Circular 831 (published with the U.S. Bureau of Mines) is Appendix C, and a directory of USGS minerals information country specialists and their responsibilities is Appendix D.

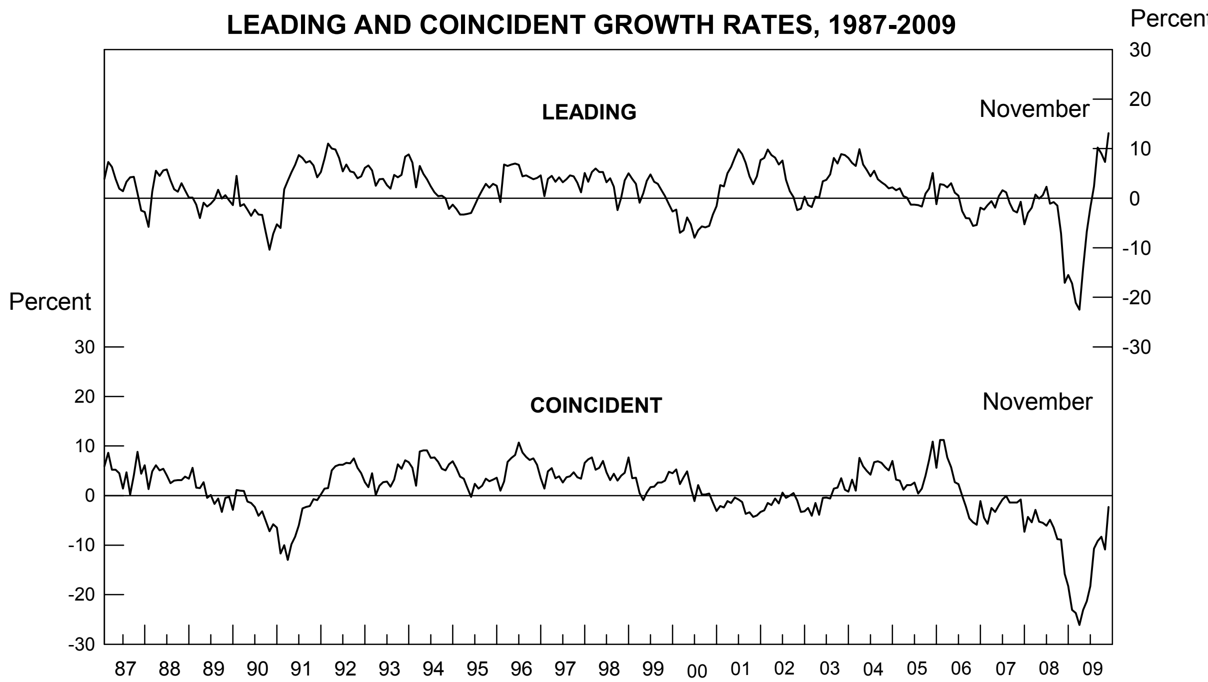
The USGS continually strives to improve the value of its publications to users. Constructive comments and suggestions by readers of the MCS 2010 are welcomed.

GROWTH RATES OF LEADING AND COINCIDENT INDEXES FOR MINERAL PRODUCTS

PRIMARY METALS: LEADING AND COINCIDENT GROWTH RATES, 1987-2009



NONMETALLIC MINERAL PRODUCTS:
LEADING AND COINCIDENT GROWTH RATES, 1987-2009



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 2009)

NET IMPORTS OF MINERAL RAW MATERIALS

GOLD, SODA ASH, ZINC CONCENTRATES, ETC.

Imports: $5.2 billion
Exports: $4.9 billion
Net imports: $0.3 billion

DOMESTIC MINERAL RAW MATERIALS FROM MINING

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

Value: $57.1 billion

METALS AND MINERAL PRODUCTS RECYCLED DOMESTICALLY

ALUMINUM, GLASS, STEEL, ETC.

Value of old scrap: $9.3 billion

NET EXPORTS OF OLD SCRAP

GOLD, STEEL, ETC.

Imports: $3.2 billion
Exports: $13.0 billion
Net exports: $9.8 billion

MINERAL MATERIALS PROCESSED DOMESTICALLY

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

Value of shipments: $454 billion

NET IMPORTS OF PROCESSED MINERAL MATERIALS

METALS, CHEMICALS, ETC.

Imports: $85.2 billion
Exports: $69.7 billion
Net imports: $15.5 billion

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

Value: $1,900 billion

U.S. ECONOMY

Gross Domestic Product: $14,200 billion

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

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

2009 U.S. NET IMPORT RELIANCE FOR SELECTED NONFUEL MINERAL MATERIALS

Commodity	Percent	Major Import Sources (2005-08)[1]
ARSENIC (trioxide)	100	China, Morocco, Belgium, Hong Kong
ASBESTOS	100	Canada
BAUXITE and ALUMINA	100	Jamaica, Brazil, Guinea, Australia
CESIUM	100	Canada
FLUORSPAR	100	China, Mexico, South Africa
GRAPHITE (natural)	100	China, Mexico, Canada, Brazil
INDIUM	100	China, Japan, Canada, Belgium
MANGANESE	100	South Africa, Gabon, China, Australia
MICA, sheet (natural)	100	China, Brazil, Belgium, India
NIOBIUM (columbium)	100	Brazil, Canada, Germany, Estonia
QUARTZ CRYSTAL (industrial)	100	China, Japan, Russia
RARE EARTHS	100	China, Japan, France, Russia
RUBIDIUM	100	Canada
STRONTIUM	100	Mexico, Germany
TANTALUM	100	Australia, China, Brazil, Japan
THALLIUM	100	Russia, Germany, Netherlands
THORIUM	100	United Kingdom, France, Canada
VANADIUM	100	Czech Republic, Rep. of Korea, Canada, Austria
YTTRIUM	100	China, Japan, France
GALLIUM	99	Germany, Canada, China, Ukraine
GEMSTONES	99	Israel, India, Belgium, South Africa
ANTIMONY	93	China, Mexico, Belgium
BISMUTH	90	Belgium, China, United Kingdom, Mexico
GERMANIUM	90	Belgium, China, Germany, Russia
PLATINUM	89	South Africa, Germany, United Kingdom, Canada
BARITE	80	China, India
TIN	80	Peru, Bolivia, China, Indonesia
RHENIUM	79	Chile, Netherlands
DIAMOND (natural industrial stone)	78	Botswana, South Africa, Namibia, India
STONE (dimension)	78	Brazil, Italy, China, Turkey
ZINC	76	Canada, Peru, Mexico, Ireland
COBALT	75	Norway, Russia, China, Canada
POTASH	73	Canada, Belarus, Germany, Russia
TITANIUM MINERAL CONCENTRATES	73	South Africa, Australia, Canada, Ukraine
TITANIUM (sponge)	67	Kazakhstan, Japan, China, Ukraine
SILVER	63	Mexico, Canada, Peru, Chile
TUNGSTEN	63	China, Germany, Canada, Bolivia
PEAT	60	Canada
PALLADIUM	47	Russia, South Africa, United Kingdom, Belgium
NITROGEN (fixed), AMMONIA	40	Trinidad and Tobago, Canada, Russia, Ukraine
CHROMIUM	39	South Africa, Kazakhstan, Russia
VERMICULITE	39	China, South Africa
GARNET (industrial)	37	India, Australia, China, Canada
DIAMOND (dust, grit and powder)	35	China, Ireland, Russia, Republic of Korea
MAGNESIUM METAL	35	Canada, Israel, Russia, China
MAGNESIUM COMPOUNDS	28	China, Austria, Canada, Australia
SILICON (ferrosilicon)	27	China, Russia, Venezuela, Canada
COPPER	24	Chile, Canada, Peru, Mexico
PERLITE	21	Greece
GYPSUM	19	Canada, Mexico, Spain
SALT	19	Canada, Chile, Mexico, Peru
ALUMINUM	18	Canada, Russia, Brazil, Venezuela
NICKEL	18	Canada, Russia, Australia, Norway
MICA, scrap and flake (natural)	11	Canada, China, India, Finland
CEMENT	8	China, Canada, Republic of Korea, Thailand
IRON and STEEL SLAG	8	Japan, Canada, Italy, France
IRON and STEEL	7	Canada, European Union, China, Mexico
SULFUR	4	Canada, Mexico, Venezuela
PUMICE	3	Greece, Turkey, Iceland, Mexico
BERYLLIUM	2	Kazakhstan, United Kingdom, Kenya, Ireland
LIME	2	Canada, Mexico
STONE (crushed)	2	Canada, Mexico, The Bahamas
PHOSPHATE ROCK	1	Morocco

[1]In descending order of import share.

SIGNIFICANT EVENTS, TRENDS, AND ISSUES[1]

The widespread effects of the struggling domestic economy were evident in the decreased performance of the U.S. minerals sector in 2009. Although 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, their contribution to the GDP was less than that in 2008. Trends in other sectors of the domestic economy were reflected in mineral production and consumption rates. For instance, continued declines in the U.S. housing market during 2009 were reflected in further reductions in the production and consumption of cement, clays, construction sand and gravel, crushed stone, and gypsum (commodities that are used almost exclusively in construction), and those associated with the related manufacture of goods, such as ceramic tile, paint, sanitaryware, roofing, and wallboard, used by the housing industry. Declines in automobile manufacturing resulted in reduced production and consumption of metals including, but not limited to, copper, iron and steel, lead, and platinum-group metals.

The figure on page 4 shows that the primary metals industry and the nonmetallic minerals products industry are intrinsically cyclical, and growth rates for leading and coincident indexes increased throughout 2009 after having fallen sharply in the second half of 2008. These growth rates are directly affected by the U.S. business cycle as well as by global economic conditions. The U.S. Geological Survey (USGS) generates composite indexes to measure economic activity in these industries. The coincident composite indexes describe the current situation using production, employment, and shipments data. The leading composite indexes forecast major changes in the industry's direction by such variables as stock prices, commodity prices, new product orders, and other indicators, which are combined into one gauge. For each of the indexes, a growth rate is calculated to measure its change relative to the previous 12 months. The U.S. primary metals industry appeared to be in recovery at yearend. The leading index indicated that an expansion in industry activity could occur in 2010.

As shown in the figure on page 5, the estimated value of mineral raw materials produced at mines in the United States in 2009 was $57 billion, a 20% decline from $72 billion in 2008. Net exports of mineral raw materials and old scrap contributed an additional $10 billion to the U.S. economy. The domestic raw materials, along with domestically recycled materials, were used to process mineral materials worth $454 billion. These mineral materials, including aluminum, brick, copper, fertilizers, and steel, and imported processed materials (worth about $16 billion) were, in turn, consumed by downstream industries with a value added of an estimated $1.9 trillion in 2009, representing about 13% of the U.S. GDP, compared with 14% in 2008. The total quantity of minerals produced in the United States in 2009 decreased by 19% from that of 2008, corresponding closely to the 20% decrease in value.

The estimated value of U.S. metal mine production in 2009 was $21.3 billion, about 22% less than that of 2008. Principal contributors to the total value of metal mine production in 2009 were gold (30%), copper (29%), molybdenum (17%), iron ore (9%), and zinc (6%). Although the quantity of metal production declined by 7% compared to that of 2008, the value of metal production declined by 22%. With few exceptions, metal prices fell significantly in 2009; some metal prices declined by more than 50% compared to those of 2008, when many hit record levels. One notable exception to this trend was gold, which reached an alltime high of $1,215.21 per troy ounce in early December 2009.

The estimated value of U.S. industrial minerals mine production in 2009 was $35.8 billion, 18% less than that of 2008. The value of industrial minerals mine production in 2009 was dominated by crushed stone (30%), cement (20%), and construction sand and gravel (17%). The value and quantity of industrial minerals mine production declined for nearly every mineral commodity. With the exception of fertilizer minerals, however, industrial minerals prices were relatively stable, with many showing slightly increased prices. Fertilizer minerals prices reached extremely high levels in 2008, but nitrogen, phosphate rock, and sulfur prices declined dramatically in 2009.

Mine production of 13 mineral commodities was worth more than $1 billion each in the United States in 2009. These were crushed stone, cement, gold, copper, construction sand and gravel, molybdenum concentrates, iron ore (shipped), salt, clays (all varieties), lime, soda ash, phosphate rock, and zinc, listed in decreasing order of value.

The figure on page 6 illustrates the reliance of the United States on foreign sources for raw and processed mineral materials. In 2009, the supply for more than one-half of U.S. apparent consumption of 38 mineral commodities came from imports, and the United States was 100% import reliant for 19 of those. U.S. import dependence has grown significantly during the past 30 years. In 1978, the United States was 100% import dependent for 7 mineral commodities, and more than 50% import dependent for 25 mineral commodities. In 2009, the United States was a net exporter of 20 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 2009, seven States each produced more than $2 billion worth of nonfuel mineral commodities. These States were, in descending order of value—Nevada, Arizona, Utah, California, Texas, Alaska, and Florida. The mineral production of these States accounted for 46% of the U.S. total output value (table 3).

In fiscal year 2009, the Defense Logistics Agency (DLA) sold $81 million of excess mineral materials from the

TABLE 1.—U.S. MINERAL INDUSTRY TRENDS

	2005	2006	2007	2008	2009[e]
Total mine production:[1]					
Metals	16,500	23,300	25,400	27,400	21,300
Industrial minerals	38,900	43,500	44,200	43,900	35,800
Coal	26,700	29,300	29,600	36,600	32,400
Employment:[2]					
Coal mining	61	67	68	71	70
Metal mining	22	25	28	32	28
Industrial minerals, except fuels	84	82	82	80	79
Chemicals and allied products	510	508	504	514	484
Stone, clay, and glass products	387	391	384	366	314
Primary metal industries	363	363	358	349	278
Average weekly earnings of production workers:[3]					
Coal mining	1,071	1,093	1,052	1,138	1,254
Metal mining	1,002	974	1,074	1,195	1,093
Industrial minerals, except fuels	827	861	870	839	808
Chemicals and allied products	832	834	820	809	839
Stone, clay, and glass products	700	712	716	711	706
Primary metal industries	816	844	843	850	820

[e]Estimated.

[1]Million dollars.

[2]Thousands of production workers.

[3]Dollars.

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

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

	2005	2006	2007	2008	2009[e]
Gross domestic product (billion dollars)	12,638	13,399	14,078	14,441	14,200
Industrial production (2002=100):					
Total index	107	110	111	109	98
Manufacturing:	108	111	113	109	97
Nonmetallic mineral products	108	110	107	101	84
Primary metals:	108	113	110	102	67
Iron and steel	110	119	116	105	60
Aluminum	103	105	102	100	78
Nonferrous metals (except aluminum)	103	100	102	99	85
Chemicals	109	113	114	109	104
Mining:	98	102	102	104	97
Coal	103	105	104	106	98
Oil and gas extraction	92	93	95	98	102
Metals	106	109	106	110	96
Nonmetallic minerals	111	114	106	92	77
Capacity utilization (percent):					
Total industry:	80	81	81	78	70
Mining:	89	90	89	90	84
Metals	82	81	79	81	69
Nonmetallic minerals	87	88	83	75	67
Housing starts (thousands)	2,073	1,812	1,342	900	546
Light vehicle sales (thousands)[1]	13,500	12,800	12,300	9,820	7,620
Highway construction, value, put in place (billion dollars)	64	72	77	81	84

[e]Estimated.

[1]Excludes imports.

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

National Defense Stockpile (NDS). Additional detailed information can be found in the “Government Stockpile” sections in the mineral commodity reports that follow. Under the authority of the Defense Production Act of 1950, the U.S. Geological Survey advises the DLA on acquisition and disposals of NDS mineral materials. At the end of the fiscal year, mineral materials valued at $1.23 billion remained in the stockpile.

In August 2008, the Defense National Stockpile Center had announced plans to suspend competitive commercial offerings of six commodities and reduce the sale quantities of nine additional commodities for the remainder of fiscal year 2008. During fiscal year 2009, sales of iridium, niobium metal ingot, platinum, tantalum carbide powder, tin, and zinc remained suspended.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2009[p, 1]

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$991,000	18	1.74	Cement (portland), stone (crushed), lime, sand and gravel (construction), cement (masonry).
Alaska	2,480,000	6	4.35	Zinc, gold, lead, silver, sand and gravel (construction).
Arizona	5,420,000	2	9.50	Copper, molybdenum concentrates, sand and gravel (construction), cement (portland), stone (crushed).
Arkansas	705,000	26	1.23	Bromine, stone (crushed), cement (portland), sand and gravel (construction), lime.
California	3,600,000	4	6.31	Sand and gravel (construction), cement (portland), boron minerals, stone (crushed), gold.
Colorado	1,960,000	8	3.42	Molybdenum concentrates, sand and gravel (construction), gold, cement (portland), stone (crushed).
Connecticut[2]	101,000	46	0.18	Stone (crushed), stone (dimension), sand and gravel (construction), clays (common), gemstones (natural).
Delaware[2]	13,600	50	0.02	Sand and gravel (construction), magnesium compounds, stone (crushed), gemstones (natural).
Florida	2,170,000	7	3.79	Phosphate rock, stone (crushed), cement (portland), sand and gravel (construction), zirconium concentrates.
Georgia	1,430,000	14	2.50	Clays (kaolin), stone (crushed), clays (fuller's earth), cement (portland), sand and gravel (construction).
Hawaii	134,000	42	0.23	Stone (crushed), sand and gravel (construction), gemstones (natural).
Idaho	917,000	22	1.61	Molybdenum (concentrates), phosphate rock, silver, sand and gravel (construction), lead.
Illinois	874,000	23	1.53	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), tripoli.
Indiana	776,000	25	1.36	Stone (crushed), cement (portland), sand and gravel (construction), lime, stone (dimension).
Iowa	518,000	31	0.91	Stone (crushed), cement (portland), sand and gravel (construction), lime, gypsum (crude).
Kansas	1,100,000	16	1.92	Helium (Grade–A), stone (crushed), cement (portland), salt, helium (crude).
Kentucky	638,000	29	1.12	Stone (crushed), lime, cement (portland), sand and gravel (construction), clays (common).
Louisiana[2]	494,000	34	0.86	Salt, sand and gravel (construction), stone (crushed), sand and gravel (industrial), clays (common).
Maine	120,000	43	0.21	Sand and gravel (construction), cement (portland), stone (crushed), cement (masonry), stone (dimension).
Maryland[2]	182,000	41	0.32	Cement (portland), stone (crushed), sand and gravel (construction), cement (masonry), stone (dimension).
Massachusetts	219,000	38	0.38	Stone (crushed), sand and gravel (construction), lime, stone (dimension), clays (common).
Michigan	1,610,000	12	2.82	Iron ore (usable shipped), cement (portland), salt, sand and gravel (construction), magnesium compounds, stone (crushed).
Minnesota	1,700,000	11	2.97	Iron ore (usable shipped), sand and gravel (construction), sand and gravel (industrial), stone (crushed), stone (dimension).
Mississippi	204,000	39	0.36	Sand and gravel (construction), stone (crushed), clays (fuller's earth), cement (portland), clays (ball).

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2009[p, 1]—Continued

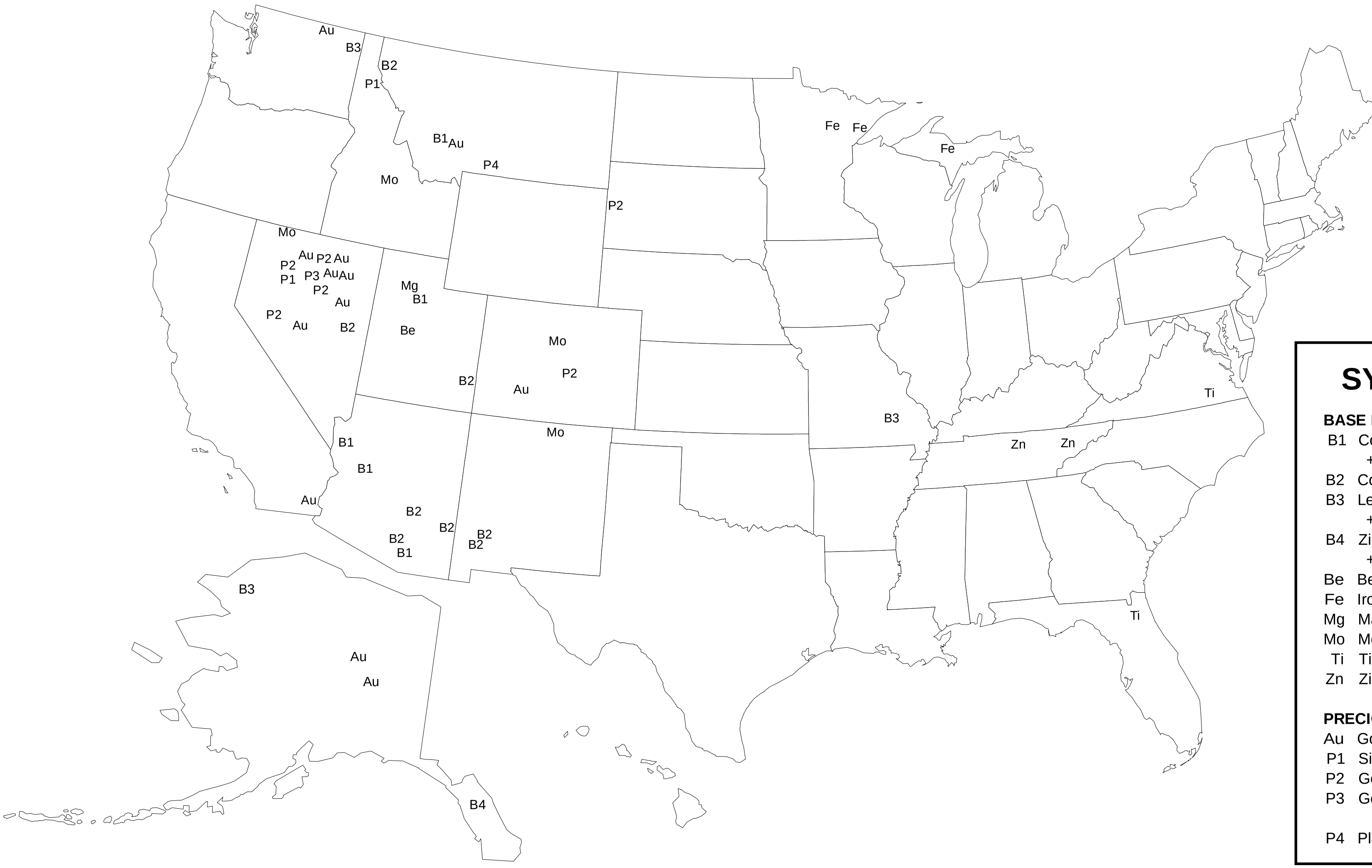
State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Missouri	$1,800,000	10	3.15	Stone (crushed), cement (portland), lead, lime, sand and gravel (construction).
Montana	1,060,000	17	1.86	Molybdenum concentrates, copper, platinum metal, palladium metal, sand and gravel (construction).
Nebraska[2]	118,000	44	0.21	Cement (portland), stone (crushed), sand and gravel (construction), lime, clays (common).
Nevada	5,510,000	1	9.64	Gold, copper, sand and gravel (construction), lime, stone (crushed).
New Hampshire	84,800	47	0.15	Stone (crushed), sand and gravel (construction), stone (dimension), gemstones (natural).
New Jersey	279,000	36	0.49	Sand and gravel (construction), stone (crushed), sand and gravel (industrial), greensand marl, peat.
New Mexico	974,000	20	1.71	Potash, copper, sand and gravel (construction), molybdenum concentrates, cement (portland).
New York	1,270,000	15	2.22	Salt, stone (crushed), cement (portland), sand and gravel (construction), wollastonite.
North Carolina	839,000	24	1.47	Stone (crushed), phosphate rock, sand and gravel (construction), sand and gravel (industrial), stone (dimension).
North Dakota[2]	33,100	49	0.06	Sand and gravel (construction), lime, clays (common), sand and gravel (industrial), stone (crushed).
Ohio	975,000	19	1.71	Stone (crushed), salt, sand and gravel (construction), lime, cement (portland).
Oklahoma	696,000	27	1.22	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), iodine.
Oregon	340,000	35	0.60	Stone (crushed), sand and gravel (construction), cement (portland), diatomite, perlite (crude).
Pennsylvania	1,570,000	13	2.74	Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry).
Rhode Island[2]	48,900	48	0.09	Sand and gravel (construction), stone (crushed), sand and gravel (industrial), gemstones (natural).
South Carolina	501,000	33	0.88	Cement (portland), stone (crushed), cement (masonry), sand and gravel (construction), vermiculite.
South Dakota	229,000	37	0.40	Gold, cement (portland), sand and gravel (construction), stone (crushed), stone (dimension).
Tennessee	641,000	28	1.12	Stone (crushed), cement (portland), sand and gravel (construction), clays (ball), lime.
Texas	2,900,000	5	5.07	Cement (portland), stone (crushed), sand and gravel (construction), salt, sand and gravel (industrial).
Utah	4,000,000	3	7.01	Copper, molybdenum concentrates, gold, magnesium metal, potash.
Vermont	111,000	45	0.19	Stone (crushed), stone (dimension), sand and gravel (construction), talc (crude), gemstones (natural).
Virginia	954,000	21	1.67	Stone (crushed), sand and gravel (construction), cement (portland), lime, zirconium concentrates.
Washington	586,000	30	1.03	Sand and gravel (construction), gold, stone (crushed), cement (portland), sand and gravel (industrial).
West Virginia	196,000	40	0.34	Stone (crushed), cement (portland), lime, sand and gravel (industrial), sand and gravel (construction).
Wisconsin[2]	505,000	32	0.88	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), lime, stone (dimension).
Wyoming	1,940,000	9	3.39	Soda ash, clays (bentonite), helium (Grade–A), sand and gravel (construction), cement (portland).
Undistributed	620,000	XX	1.09	
Total	57,100,000	XX	100.00	

[p]Preliminary. XX Not applicable.

[1]Data are rounded to 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



SYMBOLS

BASE METALS

B1 Copper and molybdenum +/- gold, silver
B2 Copper +/- gold, silver
B3 Lead, zinc +/- copper +/- gold +/- silver
B4 Zinc and silver + lead and gold
Be Beryllium
Fe Iron
Mg Magnesium
Mo Molybdenum
Ti Titanium minerals
Zn Zinc

PRECIOUS METALS

Au Gold
P1 Silver +/- base metals
P2 Gold and silver
P3 Gold and silver +/- base metals
P4 Platinum and palladium

MAJOR INDUSTRIAL MINERAL-PRODUCING AREAS—PART I

SYMBOLS

Ba	Barite	Mica	Mica
B	Borates	O	Olivine
Br	Bromine	Peat	Peat
Dia	Diatomite	P	Phosphate
Gar	Garnet	K	Potash
Gyp	Gypsum	Pyrp	Pyrophyllite
He	Helium	Salt	Salt
Irz	Ilmenite, rutile, and zircon	NaC	Soda ash
		NaS	Sodium sulfate
I	Iodine	S	Sulfur
Ky	Kyanite	Talc	Talc
MgCp	Magnesium compounds	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
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 $1.92 million, and production of high-purity fused aluminum oxide was estimated to have a value of more than $4.79 million. Silicon carbide was produced by two companies at two plants in the United States. Domestic production of crude silicon carbide had an estimated value of about $26.4 million. Bonded and coated abrasive products accounted for most abrasive uses of fused aluminum oxide and silicon carbide.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production,[1] United States and Canada (crude):					
Fused aluminum oxide, regular	10,000	10,000	10,000	10,000	10,000
Fused aluminum oxide, high-purity	5,000	5,000	5,000	5,000	5,000
Silicon carbide	35,000	35,000	35,000	35,000	35,000
Imports for consumption (U.S.):					
Fused aluminum oxide	244,000	209,000	237,000	285,000	49,200
Silicon carbide	201,000	186,000	164,000	127,000	55,900
Exports (U.S.):					
Fused aluminum oxide	13,900	15,300	18,200	21,900	11,900
Silicon carbide	15,600	20,300	19,300	17,000	18,300
Consumption, apparent (U.S.):					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	220,000	201,000	180,000	145,000	72,700
Price, value of imports, dollars per ton (U.S.):					
Fused aluminum oxide, regular	314	310	361	512	660
Fused aluminum oxide, high-purity	1,010	1,170	1,110	1,230	1,170
Silicon carbide	487	477	550	835	654
Net import reliance[2] as a percentage of apparent consumption (U.S.):					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	84	83	81	76	52

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

Import Sources (2005-08): Fused aluminum oxide, crude: China, 83%; Canada, 10%; Venezuela, 4%; Brazil, 1%; and other, 2%. Fused aluminum oxide, grain: Brazil, 27%; Germany, 25%; Austria, 16%; Italy, 8%; and other, 24%. Silicon carbide, crude: China, 83%; Venezuela, 6%; Romania, 4%; Netherlands, 3%; and other, 4%. Silicon carbide, grain: China, 39%; Brazil, 23%; Vietnam, 8%; Russia, 8%; and other, 22%.

Tariff:

Item	**Number**	**Normal Trade Relations 12-31-09**
Fused aluminum oxide, crude	2818.10.1000	Free.
Fused aluminum oxide, grain	2818.10.2000	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: National Defense Stockpile sales held during fiscal year 2007 depleted all remaining inventory of fused aluminum oxide abrasive grain.

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ABRASIVES (MANUFACTURED)

Events, Trends, and Issues: 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. Due to the negative impact of the economic recession on U.S. manufacturing sectors that utilize manufactured abrasives, there were large drops in the imports of aluminum oxide and silicon carbide. Global prices of abrasive aluminum oxide continued moving steadily higher in a price trend that began in 2007. Global prices of silicon carbide have also increased steadily since 2007, but they leveled out during the last half of 2009.

World Production Capacity:

	Fused aluminum oxide		Silicon carbide	
	2008	2009[e]	2008	2009[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 + adjustments for Government and industry stock changes.

ALUMINUM[1]

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

Domestic Production and Use: In 2009, 6 companies operated 13 primary aluminum smelters; 4 smelters were closed the entire year, and demolition of 1 smelter that had been idle since 2000 was completed in 2009. Of the operating smelters, three were temporarily idled and parts of four others were temporarily closed in 2009. Based on published market prices, the value of primary metal production was $2.96 billion. Aluminum consumption was centered in the East Central United States. Transportation accounted for an estimated 33% of domestic consumption; the remainder was used in packaging, 26%; building, 14%; electrical, 8%; machinery, 8%; consumer durables, 7%; and other, 4%.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production:					
Primary	2,481	2,284	2,554	2,658	1,710
Secondary (from old scrap)	1,080	1,260	1,600	1,340	1,260
Imports for consumption	5,330	5,180	4,490	4,200	4,130
Exports	2,370	2,820	2,840	3,280	2,570
Consumption, apparent[2]	5,990	5,980	5,110	3,790	3,610
Price, ingot, average U.S. market (spot), cents per pound	91.0	121.4	125.2	120.5	78.0
Stocks:					
Aluminum industry, yearend	1,430	1,410	1,400	1,220	920
LME, U.S. warehouses, yearend[3]	209	228	463	1,290	2,120
Employment, number[4]	58,400	57,300	56,600	53,900	45,000
Net import reliance[5] as a percentage of apparent consumption	41	31	19	E	18

Recycling: In 2009, aluminum recovered from purchased scrap was about 3.0 million tons, of which about 60% came from new (manufacturing) scrap and 40% from old scrap (discarded aluminum products). Aluminum recovered from old scrap was equivalent to about 35% of apparent consumption.

Import Sources (2005-08): Canada, 56%; Russia, 17%; Brazil, 4%; Venezuela, 4%; and other, 19%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Unwrought (in coils)	7601.10.3000	2.6% ad val.
Unwrought (other than aluminum alloys)	7601.10.6000	Free.
Waste and scrap	7602.00.0000	Free.

Depletion Allowance: Not applicable.[1]

Government Stockpile: None.

Events, Trends, and Issues: During the first half of 2009, several domestic primary aluminum smelters cut back production in response to significant price drops in the second half of 2008. Smelter closures took place in Alcoa, TN; Massena, NY; and Ravenswood, WV. Partial temporary shutdowns took place at smelters in Columbia Falls, MT; Hannibal, OH; Hawesville, KY; and New Madrid, MO. Demolition of a smelter in Vancouver, WA, that started in 2008 was completed in 2009. By the beginning of the fourth quarter of 2009, domestic smelters operated at about 49% of rated or engineered capacity.

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ALUMINUM

The United States again became reliant upon net imports as a percentage of apparent consumption in 2009 compared with that of 2008 when the Nation was a net exporter of aluminum, as domestic primary production and exports decreased significantly. Canada and Russia accounted for almost three-fourths of total imports. U.S. exports decreased by 22% in 2009 compared with the amount exported in 2008. China, Canada, and Mexico, in descending order, received approximately three-fourths of total United States exports.

The price of primary aluminum generally rose through August 2009 before declining in September. In January, the average monthly U.S. market price for primary ingot quoted by Platts Metals Week was $0.676 per pound; it reached a high of $0.921 per pound in August, but in September, the average monthly price was $0.883 per pound. Prices on the London Metal Exchange (LME) followed the trend of U.S. market prices. The monthly average LME cash price for August was $0.877 per pound, but in September the price was $0.832 per pound.

World primary aluminum production declined sharply in the first quarter of the year in response to price declines in the wake of the financial crises that started in late 2008 and continued in early 2009. World inventories of metal held by producers, as reported by the International Aluminium Institute, decreased through the end of August to about 2.3 million tons from 3.0 million tons at yearend 2008. Inventories of primary aluminum metal held by the LME worldwide increased during the year to 4.6 million tons at the end of September from 2.3 million tons at yearend 2008.

World Smelter Production and Capacity:

	Production		Yearend capacity	
	2008	2009[e]	2008	2009[e]
United States	2,658	1,710	3,620	3,500
Australia	1,970	1,970	1,970	1,970
Bahrain	865	870	880	880
Brazil	1,660	1,550	1,700	1,700
Canada	3,120	3,000	3,120	3,090
China	13,200	13,000	15,000	19,000
Germany	550	520	620	620
Iceland	787	790	790	790
India	1,310	1,600	1,800	2,000
Mozambique	536	500	570	570
Norway	1,360	1,200	1,360	1,230
Russia	3,800	3,300	4,400	5,150
South Africa	811	800	900	900
United Arab Emirates, Dubai	910	950	950	950
Venezuela	610	550	625	625
Other countries	4,850	4,600	6,260	6,920
World total (rounded)	39,000	36,900	44,600	49,900

World Resources: Domestic aluminum requirements cannot be met by domestic bauxite resources. Domestic nonbauxitic aluminum resources are abundant and could meet domestic aluminum demand. However, no processes for using these resources have been proven 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, titanium, and steel can substitute for aluminum in ground transportation and structural uses. Composites, steel, vinyl, and wood can substitute for aluminum in construction. Copper can replace aluminum in electrical applications.

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

ANTIMONY

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

Domestic Production and Use: There was no antimony mine production in the United States in 2009. Primary antimony metal and oxide was produced by one company in Montana, using foreign feedstock. The estimated distribution of antimony uses was as follows: flame retardants, 40%; transportation, including batteries, 22%; chemicals, 14%; ceramics and glass, 11%; and others, 13%.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009**[e]
Production:					
Mine (recoverable antimony)	—	—	W	—	—
Smelter:					
Primary	W	W	W	W	W
Secondary	3,030	3,520	3,480	3,080	2,900
Imports for consumption	22,700	23,200	21,900	21,900	23,000
Exports of metal, alloys, oxide, and waste and scrap[1]	2,140	2,140	1,950	2,200	2,000
Consumption, apparent[2]	31,400	24,300	23,700	21,500	22,400
Price, metal, average, cents per pound[3]	161	238	257	280	230
Stocks, yearend	2,110	2,120	1,900	1,620	1,750
Employment, plant, number[e]	10	10	10	10	10
Net import reliance[4] as a percentage of apparent consumption	88	86	85	93	93

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

Import Sources (2005-08): Metal: China, 67%; Mexico, 12%; Peru, 8%; and other, 13%. Ore and concentrate: China, 37%; Bolivia, 34%; and other, 29%. Oxide: China, 50%; Mexico, 37%; Belgium, 7%; and other, 6%. Total: China, 51%; Mexico, 34%; Belgium, 4%; and other, 11%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
Ore and concentrates	2617.10.0000	Free.
Antimony oxide	2825.80.0000	Free.
Antimony and articles thereof, including waste and scrap	8110.00.0000	Free.

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

Government Stockpile: None.

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ANTIMONY

Events, Trends, and Issues: In 2009, antimony production from domestic source materials 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. In recent years, the number of primary antimony smelters has been reduced, as smelters in New Jersey and Texas were closed in 2004. Only one domestic smelter, in Montana, continued to make antimony products. This domestic smelter, through its wholly owned Mexican subsidiary, received approval to build an ore-processing plant near its antimony-silver deposit in Mexico. The antimony materials produced here would provide feedstock for the Montana facility.

The price of antimony generally rose during 2009. The price started the year at about $1.93 per pound and finished August at about $2.67 per pound.

Several new antimony mine projects were being developed in Australia, Canada, and Laos.

World Mine Production and Reserves:

	Mine production		Reserves[5]
	2008	2009[e]	
United States	W	—	—
Bolivia	3,500	4,500	310,000
China	180,000	170,000	790,000
Russia (recoverable)	3,500	3,000	350,000
South Africa	2,800	3,000	44,000
Tajikistan	2,000	2,000	50,000
Thailand	—	—	420,000
Other countries	5,000	4,000	150,000
World total (rounded)	197,000	187,000	2,100,000

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, and South Africa. Additional antimony resources may occur in Mississippi Valley-type lead deposits in the Eastern United States.

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

[e]Estimated. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Gross weight, for metal, alloys, waste, and scrap.
[2]Domestic mine production + secondary production from old scrap + net import reliance.
[3]New York dealer price for 99.5% to 99.6% metal, c.i.f. U.S. ports.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

ARSENIC

(Data in metric tons of arsenic unless otherwise noted)

Domestic Production and Use: There has been no domestic production of arsenic trioxide or arsenic metal since 1985. Imports of arsenic trioxide averaged more than 20,000 tons annually during 2001-03. However, owing to environmental concerns and a voluntary ban on the use of arsenic trioxide for the production of chromated copper arsenate (CCA) wood preservatives at yearend 2003, imports of arsenic trioxide averaged 7,100 tons annually during 2004-08. Arsenic metal was used to strengthen the grids in lead-acid storage batteries and in small-arms ammunition, used by the United States military, was hardened by the addition of less than 1% arsenic metal. Arsenic metal was used as an antifriction additive for bearings, in 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 gallium-arsenide semiconductors that are used for solar cells, space research, and telecommunication. Arsenic may be 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 2009 was estimated to be about $7 million.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Imports for consumption:					
Metal	812	1,070	759	376	385
Trioxide	8,330	9,430	7,010	4,810	6,190
Exports, metal	3,270	3,060	2,490	1,050	2,980
Estimated consumption[1]	5,870	7,340	5,280	4,140	3,600
Value, cents per pound, average:[2]					
Metal (China)	95	160	81	98	92
Trioxide (China)	18	22	42	41	54
Trioxide (Mexico)	67	NA	NA	NA	NA
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: Electronic circuit boards, relays, and switches may contain arsenic. These scrap materials should be disposed of at sites that recycle arsenic-containing, end-of-service electronics or at hazardous waste sites. Arsenic contained in the process water at wood treatment plants where CCA was used was recycled. Arsenic was also recovered from gallium-arsenide scrap from semiconductor manufacturing. There was no recovery or recycling of arsenic from arsenic-containing residues and dusts at nonferrous smelters in the United States.

Import Sources (2005-08): Metal: China, 86%; Japan, 11%; and other, 3%. Trioxide: China, 47%; Morocco, 43%; Belgium, 4%; Hong Kong, 4%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Metal	2804.80.0000	Free.
Acid	2811.19.1000	2.3% ad val.
Trioxide	2811.29.1000	Free.
Sulfide	2813.90.1000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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ARSENIC

Events, Trends, and Issues: Since 2004, exports of arsenic metal have increased dramatically and arsenic-containing “e-waste” such as computers and other electronics, destined for reclamation and recycling, may be included in this export category. The exported arsenic metal may also have been used in electronics applications. In 2009, export destinations for arsenic metal were Honduras (76%), Guatemala (10%), and France (7%).

The U.S. Food and Drug Administration (FDA) urged caution with ayurvedic products and indicated that these products do not undergo FDA review. Ayurvedic medicine is a traditional healing system that originated in India and includes medicinal preparations that combine herbs with minerals and metals such as arsenic, lead, mercury, and zinc. High exposure to arsenic in drinking water has been linked to the development of diabetes. University researchers have found that the risk of diabetes for Americans with the highest arsenic content in their urine is more than three times the risk of those with the lowest arsenic levels.

In response to human health issues, the wood-preserving industry made a voluntary decision to stop using CCA to treat wood used for decks and outdoor residential use by yearend 2003. Because of known performance and lower cost, CCA may still be used to treat wood used for nonresidential applications. Human health concerns, regulation, use of alternative wood preservation material, and the substitution of concrete or plasticized wood products will affect the long-term demand for arsenic.

Arsenic contamination of the Mekong River in Southeast Asia reportedly is putting millions at risk of severe illness. Approximately 21% of the Vietnamese population was exposed to arsenic levels above the World Health Organization’s acceptable level of 10 parts per billion. Researchers in the United Kingdom indicated that one-third of baby-food rice for sale in the United Kingdom contained high levels of arsenic. There are no regulations regarding the amount of arsenic in food products; however, drinking water standards are in place in the European Union and in the United States. Arsenic may also be released from coal-burning powerplant emissions.

World Production and Reserves:

	Production (arsenic trioxide) 2008	Production (arsenic trioxide) 2009[e]	Reserves[4] (arsenic content)
Belgium	1,000	1,000	
Chile	10,000	11,500	World reserves are thought to be about 20 times annual world production.
China	25,000	25,000	
Kazakhstan	1,500	1,500	
Mexico	513	1,500	
Morocco	8,800	7,000	
Peru	4,000	4,000	
Russia	1,500	1,500	
Other countries	400	500	
World total (rounded)	52,700	53,500	

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

Substitutes: Wood-treatment substitutes include alkaline copper quaternary, ammoniacal copper quaternary, ammoniacal copper zinc arsenate, copper azole, and copper citrate. In humid areas, silver-containing biocides are being considered as an alternative wood preservative. Other CCA-treated wood substitutes include concrete, steel, plasticized wood scrap, or plastic composites.

[e]Estimated. NA Not available.
[1]Estimated to be the same as net imports.
[2]Calculated from U.S. Census Bureau import data.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

ASBESTOS

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Asbestos has not been mined in the United States since 2002, so the United States is dependent on imports to meet manufacturing needs. Asbestos consumption in the United States was estimated to be 715 tons, based on asbestos imports through July 2009. Roofing products were estimated to account for about 65% of U.S. consumption and other applications, 35%.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production (sales), mine	—	—	—	—	—
Imports for consumption	2,530	2,230	1,730	1,460	715
Exports[1]	1,510	3,410	815	368	55
Consumption, estimated	2,530	2,230	1,730	1,460	715
Price, average value, dollars per ton[2]	561	451	473	746	613
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: None.

Import Sources (2005-08): Canada, 89%; and other, 11%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Asbestos other than crocidolite	2524.90.0000	Free.
Crocidolite	2524.10.0000	Free.

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

Government Stockpile: None.

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ASBESTOS

Events, Trends, and Issues: There was no production of asbestos in the United States. U.S. exports decreased to an estimated 55 tons in 2009 from 368 tons in 2008. Exports are likely to include some nonasbestos materials and reexports, as U.S. production of asbestos ceased in 2002. Imports decreased to an estimated 715 tons in 2009 from 1,460 tons in 2008. Domestic consumption of asbestos decreased to 715 tons in 2009 from 1,460 tons in 2008. Much of the decline in imports and consumption probably can be attributed to reduced commercial building construction where asbestos-based roofing compounds are used. All the asbestos used in the United States was chrysotile. Canada remained the leading supplier of asbestos for domestic consumption.

Health research and asbestos cleanup continued in Libby, MT, where vermiculite contaminated with asbestos was mined and processed, and at several vermiculite processing plants across the country.

The Republic of Korea enacted the final stage of a ban on the use of asbestos in manufactured products, effective September 2009. Under the ban, asbestos may not be used to manufacture any children's products or products in which asbestos particles may come loose and contact skin. For all other manufactured products, the asbestos content must be less than 0.1%. Under the ban, talc used in the manufacture of paint and wallpaper must be certified to contain less than 1% asbestos.

World Mine Production and Reserves:

	Mine production		Reserves[4]
	2008	2009[e]	
United States	—	—	Small
Brazil	255,000	250,000	Moderate
Canada	180,000	180,000	Large
China	280,000	280,000	Large
Kazakhstan	230,000	210,000	Large
Russia	1,020,000	1,000,000	Large
Zimbabwe	50,000	25,000	Moderate
Other countries	75,000	75,000	Moderate
World total (rounded)	2,090,000	2,000,000	Large

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

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

[e]Estimated. — Zero.
[1]Probably includes nonasbestos materials and reexports.
[2]Average Customs value for U.S. chrysotile imports, all grades combined. Prices for individual commercial products are no longer published.
[3]Defined as imports – exports; however, imports account for all domestic consumption.
[4]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

BARITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Domestic producers of crude barite sold or used for grinding an estimated 380,000 tons in 2009 valued at about $20 million, a decrease in production of 41% from that of 2008. Most of the production came from four major mines in Nevada followed by a significantly smaller sales volume from a single mine in Georgia. In 2009, an estimated 1.9 million tons of barite (from domestic production and imports) was sold by crushers and grinders in eight States. Nearly 95% of the barite sold in the United States was used as a weighting agent in gas and oil-well drilling fluids. The majority of Nevada crude barite was ground in Nevada and then sold to gas-drilling customers in Colorado, Utah, and Wyoming. Crude barite was shipped to a Canadian grinding mill in Lethbridge, Alberta, which supplies the Western Canadian drilling mud market. The barite imports to Louisiana and Texas ports went primarily to offshore drilling operations in the Gulf of Mexico and to onshore operations in Louisiana, New Mexico, Oklahoma, and Texas. The Gulf of Mexico and these four States account for about 70% of natural gas production in the United States and represent the major regional market for barite.

Barite is also used as a filler, extender, or weighting agent in products such as paints, plastics, and rubber. Some specific applications include its use in automobile brake and clutch pads and automobile paint primer for metal protection and gloss, and to add weight to rubber mudflaps on trucks and to the cement jacket around petroleum pipelines under water. 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. It is the raw material for barium chemicals, such as barium carbonate, which is an ingredient in faceplate glass in the cathode-ray tubes of televisions and computer monitors.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Sold or used, mine	489	589	455	648	380
Imports for consumption	2,690	2,550	2,600	2,620	1,600
Exports	93	72	15	62	40
Consumption, apparent[1] (crude and ground)	3,080	3,070	3,040	3,210	1,940
Consumption[2] (ground and crushed)	2,720	3,040	2,980	2,840	1,900
Price, average value, dollars per ton, f.o.b. mine	35.90	40.00	45.30	47.60	52.00
Employment, mine and mill, number[e]	340	330	330	350	330
Net import reliance[3] as a percentage of apparent consumption	84	81	85	80	80

Recycling: None.

Import Sources (2005-08): China, 93%; India, 5%; and other, 2%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-09**
Crude barite	2511.10.5000	$1.25 per metric ton.
Ground barite	2511.10.1000	Free.
Oxide, hydroxide, and peroxide	2816.40.2000	2% ad val.
Other chlorides	2827.39.4500	4.2% ad val.
Other sulfates of barium	2833.27.0000	0.6% ad val.
Carbonate	2836.60.0000	2.3% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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BARITE

Events, Trends, and Issues: Kent Exploration Inc. announced that it had received mine plan approval from the U.S. Bureau of Land Management for the company's Flagstaff, WA, barite property. The approved mine plan permits the mining of a maximum of 100,000 short tons per year of barite from the historic open pit mine on the property. CE Minerals produced about 85,000 short tons of barite from the site in the early 1980s and reported a remaining resource of approximately 1.2 million short tons grading 4.2 specific gravity. During the first year of operation, Kent Exploration planned to test the economics of the project by crushing, separating, and upgrading to 4.1 specific gravity the estimated 30,000 short tons of existing stockpiled barite ore. The company has already signed a supply agreement with a customer for 20,000 short tons per year.[4]

In 2008, oil and gas prices rose dramatically through the first half of the year and peaked in July. The levels of exploration drilling in North America (measured by the count of operating drilling rigs) followed suit, but began to decrease when oil and gas prices started falling. The financial downturn that began in late 2008 and the concurrent global recession pushed oil and gas prices even lower, which resulted in a major decrease in drilling activity. The North American rig count hit its lowest point in early summer of 2009 when less than half the rigs were operating compared with operations in the same period the previous year. In the United States, approximately 80% of drill rigs are exploring for natural gas, and while oil prices recovered to some extent, natural gas prices remained low (under $3.50 per thousand cubic feet) in the latter part of 2009.

World Mine Production and Reserves: In 2009, the average monthly international rig count decreased by about 30% compared with that of 2008. An estimated 85% of all barite consumed worldwide is used in oil and gas drilling, so estimates for country production were made based on rig count data for lack of any other sources of data.

	Mine production		Reserves[5]
	2008	2009[e]	
United States	648	380	15,000
Algeria	60	40	9,000
Bulgaria	40	30	NA
China	4,600	3,000	62,000
Germany	77	60	1,000
India	1,100	800	34,000
Iran	240	180	NA
Kazakhstan	[6]95	[6]70	NA
Mexico	140	160	7,000
Morocco	[7]500	[7]350	10,000
Pakistan	43	35	1,000
Russia	63	50	2,000
Turkey	150	110	4,000
United Kingdom	50	40	100
Vietnam	80	60	NA
Other countries	160	110	24,000
World total (rounded)	8,050	5,500	170,000

World Resources: In the United States, identified resources of barite are estimated to be 150 million tons, and hypothetical resources include an additional 150 million tons. The world's barite resources[5] in all categories are about 2 billion tons, but only about 740 million tons is identified.

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]Kent Exploration Inc., 2009, Kent receives mine plan approval for Flagstaff, WA: Vancouver, British Columbia, Canada, Kent Exploration Inc. press release, May 5, 2 p.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[6]Estimated marketable barite; however, reported production figures are significantly higher.
[7]Estimated marketable production based on export data.

BAUXITE AND ALUMINA[1]

(Data in thousand metric dry tons unless otherwise noted)

Domestic Production and Use: Nearly all bauxite consumed in the United States was imported; of the total, more than 90% was converted to alumina. Of the total alumina used, about 90% went to primary aluminum smelters and the remainder went to nonmetallurgical uses. Annual alumina production capacity was 5.75 million tons, with three Bayer refineries operating throughout the year and one temporarily idled. Domestic bauxite was used in the production of nonmetallurgical products, such as abrasives, chemicals, and refractories.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production, bauxite, mine	NA	NA	NA	NA	NA
Imports of bauxite for consumption[2]	13,200	12,900	11,200	12,400	7,300
Imports of alumina[3]	1,860	1,860	2,440	2,530	1,800
Exports of bauxite[2]	62	43	30	31	29
Exports of alumina[3]	1,210	1,540	1,160	1,150	1,100
Shipments of bauxite from Government stockpile excesses[2]	—	—	—	—	—
Consumption, apparent, bauxite and alumina (in aluminum equivalents)[4]	3,540	3,290	3,630	3,410	2,100
Price, bauxite, average value U.S. imports (f.a.s.) dollars per ton	25	28	31	26	28
Stocks, bauxite, industry, yearend[2, 5]	W	W	W	W	W
Net import reliance,[6] bauxite and alumina, as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2005-08):[7] Bauxite: Jamaica, 32%; Guinea, 22%; Brazil, 18%; Guyana, 12%; and other, 16%. Alumina: Australia, 41%; Suriname, 18%; Jamaica, 16%; Brazil, 12%; and other, 13%. Total: Jamaica, 27%; Brazil, 16%; Guinea, 15%; Australia, 14%; and other, 28%.

Tariff: Import duties on bauxite and alumina were abolished in 1971 by Public Law 92-151. Duties can be levied only on such imports from nations with nonnormal trade relations. However, all countries that supplied commercial quantities of bauxite or alumina to the United States during the first 9 months of 2009 had normal-trade-relations status.

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

Government Stockpile:

Stockpile Status—9-30-09[8]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2009	Disposals FY 2009
Bauxite, metal grade Jamaica-type	—	—	2,030	—

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BAUXITE AND ALUMINA

Events, Trends, and Issues: The price range for metallurgical-grade alumina began the year at $210 to $240 per ton, as published by Metal Bulletin. By February, the price range had declined to $170 to $200 per ton, where it remained until mid-April. The price range increased to $200 to $230 per ton in April until the end of June, when it began to increase more rapidly. The price range was $300 to $310 per ton at the end of September.

World production of alumina decreased compared with that of 2008. Based on production data from the International Aluminium Institute, world alumina production during the first two quarters of 2009 decreased by 12% compared with that for the same period in 2008. Reduced output from bauxite mines in Guinea, Guyana, Jamaica, Russia, and Suriname was partially offset by increases in production from new and expanded mines in Australia, Brazil, China, and India and accounted for most of the slight decrease in worldwide production of bauxite in 2009 compared with that of 2008.

World Bauxite Mine Production and Reserves:

	Mine production		Reserves[9]
	2008	2009[e]	
United States	NA	NA	20,000
Australia	61,400	63,000	6,200,000
Brazil	22,000	28,000	1,900,000
China	35,000	37,000	750,000
Greece	2,220	2,200	600,000
Guinea	18,500	16,800	7,400,000
Guyana	2,100	1,200	700,000
India	21,200	22,300	770,000
Jamaica	14,000	8,000	2,000,000
Kazakhstan	4,900	4,900	360,000
Russia	6,300	3,300	200,000
Suriname	5,200	4,000	580,000
Venezuela	5,500	4,800	320,000
Vietnam	30	30	2,100,000
Other countries	6,550	5,410	3,200,000
World total (rounded)	205,000	201,000	27,000,000

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. Synthetic mullite, produced from kyanite and sillimanite, substitutes for bauxite-based refractories. Although more costly, silicon carbide and alumina-zirconia can substitute for bauxite-based abrasives.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[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]A company acquisition in 2007 resulted in the withholding of data, including revisions to data from 2005.
[6]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 percent of apparent consumption equaled 100% for bauxite and 20% for alumina in 2009. For the years 2005-08, the U.S. net import reliance as a percent of apparent consumption was 100% for bauxite and ranged from 5% to 31% for alumina.
[7]Based on aluminum equivalents.
[8]See Appendix B for definitions.
[9]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

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 and beryl from the National Defense Stockpile, 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 120 tons was valued at about $30 million, based on the estimated unit value for beryllium in imported beryllium-copper master alloy. Based on sales revenues, more than one-half of beryllium use was estimated to be in computer and telecommunications products, and the remainder was used in aerospace and defense applications, appliances, automotive electronics, industrial components, and other applications.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production, mine shipments[e]	110	155	152	176	120
Imports for consumption[1]	93	62	72	70	20
Exports[2]	201	135	101	112	30
Government stockpile releases[3]	79	158	27	39	11
Consumption:					
Apparent[4]	84	226	100	212	120
Reported, ore	160	180	190	220	140
Unit value, average annual, beryllium-copper master alloy, dollars per pound contained beryllium[5]	99	128	144	159	120
Stocks, ore, consumer, yearend	35	50	100	61	60
Net import reliance[6] as a percentage of apparent consumption	E	[7]31	E	17	2

Recycling: Beryllium was recycled mostly from new scrap generated during the manufacture of beryllium products. Detailed data on the quantities of beryllium recycled are not available, but may represent as much as 10% of apparent consumption.

Import Sources (2005-08):[1] Kazakhstan, 58%; United Kingdom, 11%; Kenya, 8%; Ireland, 6%; and other, 17%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-09**
Beryllium ores and concentrates	2617.90.0030	Free.
Beryllium oxide and hydroxide	2825.90.1000	3.7% ad val.
Beryllium-copper master alloy	7405.00.6030	Free.
Beryllium:		
Unwrought, including powders	8112.12.0000	8.5% ad val.
Waste and scrap	8112.13.0000	Free.
Other	8112.19.0000	5.5% ad val.

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

Government Stockpile: The Defense Logistics Agency, U.S. Department of Defense, had a goal of retaining 45 tons of hot-pressed beryllium powder in the National Defense Stockpile. Disposal limits for beryllium materials in the fiscal year 2010 Annual Materials Plan are as follows: beryl ore, 1 ton, and beryllium metal, 54 tons of contained beryllium.

Stockpile Status—9-30-09[8]

Material	**Uncommitted inventory**	**Authorized for disposal**	**Disposal plan FY 2009**	**Disposals FY 2009**
Beryl ore (11% BeO)	—	—	[9]36	—
Beryllium-copper master alloy	—	—	[9]11	—
Beryllium metal:				
Hot-pressed powder	132	87	—	1
Vacuum-cast	16	16	36	14

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BERYLLIUM

Events, Trends, and Issues: Market conditions deteriorated for beryllium-based products in 2009. During the first three quarters of 2009, the leading U.S. beryllium producer reported volume shipments of bulk and strip beryllium-copper alloy products to be 49% and 41% lower, respectively, than those during the first three quarters of 2008. Sales of beryllium products for key markets, including aerospace, automotive electronics, ceramics, computer and telecommunications, medical and industrial x-ray equipment, and oil and gas, were substantially lower than those during the first three quarters of 2008. Sales of beryllium products for defense-related applications were higher in the first half of 2009 compared with those of the first half of 2008. During the third quarter of 2009, however, Government-funding delays and postponed defense-related orders reduced sales considerably.

In an effort to ensure current and future availability of high-quality domestic beryllium to meet critical defense and commercial needs, the U.S. Department of Defense in 2005, under the Defense Production Act, Title III, invested in a public-private partnership with the leading U.S. beryllium producer to build a new $90.4 million primary beryllium facility in Ohio. In 2009, the Department of Defense increased its threshold of support to $85 million from $50 million. The leading U.S. beryllium producer continued construction of the new beryllium facility in 2009, and the facility was expected to be completed by the end of 2010. Primary beryllium facilities, the last of which closed in the United States in 2000, produce the feedstock used to make beryllium metal products.

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 must carefully control the quantity of beryllium dust, fumes, and mists in the workplace, which adds to the final cost of beryllium products.

World Mine Production and Reserves:

	Mine production[e]		Reserves[10]
	2008	2009	
United States	176	120	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 15,900 tons of contained beryllium. World beryllium reserves are not sufficiently well delineated to report consistent figures for all countries.
China	20	20	
Mozambique	1	1	
Other countries	([11])	([11])	
World total (rounded)	200	140	

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

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

[e]Estimated. E Net exporter. — 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]The sum of U.S. mine shipments and net import reliance.
[5]Calculated from gross weight and customs value of imports; beryllium content estimated to be 4%.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]Significant releases of beryl from the National Defense Stockpile resulted in a positive net import reliance as a percentage of apparent consumption in 2006.
[8]See Appendix B for definitions.
[9]Actual quantity will be limited to remaining inventory.
[10]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[11]Less than ½ unit.

BISMUTH

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

Domestic Production and Use: The United States ceased production of primary refined bismuth in 1997 and is thus highly import dependent for its supply. A small amount of bismuth is recycled by some domestic firms. Bismuth is contained in some lead ores mined domestically, but the bismuth-containing residues are not processed domestically and may be exported. The value of bismuth consumed was approximately $17 million. About 43% of the bismuth was used for metallurgical additives; 24% in fusible alloys, solders, and ammunition cartridges; 31% in pharmaceuticals and chemicals; and 2% in other uses.

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. Bismuth use in water meters and fixtures is one particular application that has increased in recent years. An application with major growth potential is the use of zinc-bismuth alloys to achieve thinner and more uniform galvanization. Bismuth was also used domestically in the manufacture of ceramic glazes, crystal ware, and pigments; as an additive to free-machining steels; and as an additive to malleable iron castings.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production:					
Refinery	—	—	—	—	—
Secondary (old scrap)	80	80	100	100	100
Imports for consumption, metal	2,530	2,300	3,070	1,925	1,200
Exports, metal, alloys, and scrap	142	311	421	375	290
Consumption:					
Reported	2,390	1,960	2,630	1,090	1,000
Apparent	2,460	2,120	2,740	1,560	1,020
Price, average, domestic dealer, dollars per pound	3.91	5.04	14.07	12.73	7.40
Stocks, yearend, consumer	175	125	138	228	220
Net import reliance[1] as a percentage of apparent consumption	97	96	96	94	90

Recycling: All types of bismuth-containing new and old alloy scrap were recycled and contributed about 20% of U.S. bismuth consumption, or 200 tons.

Import Sources (2005-08): Belgium, 34%; China, 26%; United Kingdom, 18%; Mexico, 14%; and other, 8%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
Bismuth and articles thereof, including waste and scrap	8106.00.0000	Free.

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

Government Stockpile: None.

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BISMUTH

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

The price of bismuth started 2009 at $9.00 per pound and declined throughout the year, ending August at $6.75 per pound. The estimated average price of bismuth for 2009 was about 42% below that for 2008. Industry analysts attributed the lower price to reduced world demand in view of a world economic slowdown.

In Canada, an exploration firm announced further progress with the analysis and development of its cobalt-gold-bismuth deposit in Northwest Territories. Another Canadian exploration company reported additional advancements to develop its bismuth-fluorspar-tungsten property in Vietnam. In Bolivia, the Government announced that a bismuth smelter that started up in late 2008 would commence shipments of bismuth ingots in 2009.

In Mexico, a major bismuth producer experienced a 66-day strike by employees seeking a wage increase, in February to April, causing a temporary shortfall in the world bismuth market.

World Mine Production and Reserves:

	Mine production		Reserves[2]
	2008	2009[e]	
United States	—	—	—
Bolivia	150	150	10,000
Canada	71	100	5,000
China	5,000	4,500	240,000
Kazakhstan	150	140	5,000
Mexico	1,170	1,200	10,000
Peru	960	960	11,000
Other countries	200	200	39,000
World total (rounded)	7,700	7,300	320,000

World Resources: Bismuth, at an estimated 8 parts per billion by weight, is the 69th element in order of abundance in the Earth's crust and is about twice as abundant as gold. World reserves of bismuth are usually based on bismuth content of lead resources because bismuth production is most often a byproduct of processing lead ores; in China, bismuth production is a byproduct of tungsten and other metal ore processing. Bismuth minerals rarely occur in sufficient quantities to be mined as principal products; the Tasna Mine in Bolivia and a mine in China are the only mines that produced bismuth from a bismuth ore. The Tasna Mine had been on standby status since the mid-1990s awaiting a significant and sustained rise in the metal price, and in late 2008 there were reports that it had reopened. Several bismuth-containing deposits are in varying stages of mining feasibility review. These polymetallic deposits include Bonfim in Brazil, NICO in Canada, and Nui Phao in Vietnam.

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

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

[e]Estimated. — Zero.
[1]Defined as imports – exports + adjustments for Government and industry stock changes.
[2]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

BORON

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

Domestic Production and Use: U.S. boron production and consumption in 2009 reported in boron oxide content were withheld to avoid disclosing company proprietary data. Boron minerals, primarily as sodium borates, were produced domestically by two companies in southern California. The leading producer mined borate ores containing tincal and kernite by open pit methods and operated associated compound plants. A second company produced borax and boric acid using saline brines as the raw material. A third company, which ceased all mining operations in 2003, became a trader of Turkish colemanite and ulexite. Boron minerals and chemicals were principally consumed in the North Central and the Eastern United States. The estimated distribution pattern for boron compounds consumed in the United States in 2009 was glass and ceramics, 76%; soaps, detergents, and bleaches, 5%; agriculture, 4%; enamels and glazes, 3%; and other, 12%.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production[1]	612	W	W	W	W
Imports for consumption, gross weight:					
Borax	1	2	1	1	1
Boric acid	52	85	67	50	46
Colemanite	31	25	26	30	25
Ulexite	103	131	92	75	62
Exports, gross weight:					
Boric acid	183	221	248	303	270
Refined sodium borates	308	393	446	519	480
Consumption:					
Apparent	439	W	W	W	W
Reported	W	W	W	W	W
Price, dollars per ton, granular pentahydrate borax[2]	587-685	587-685	599-699	437-509	430-500
Employment, number	1,360	1,320	1,350	1,420	1,200
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2005-08): Boric acid: Turkey, 59%; Chile, 22%; Bolivia, 8%; Peru, 5%; and other, 6%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Natural borates:		
Sodium	2528.10.0000	Free.
Calcium	2528.90.0010	Free.
Other	2528.90.0050	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: The United States was a major world producer of refined boron compounds during 2009; production data were withheld. Domestic production and consumption were expected to increase as in previous years, with end uses shifting slightly away from detergents and soaps towards glass and ceramics. The decline in glass consumption by the construction industry caused by the 2008 housing credit downturn was predicted to be offset by increased growth in the fiberglass and high-tech sectors. Consumption of borates used in high- technical applications was expected to increase by 10% in North America and 13% in Europe by 2012.

Borate consumption in China was projected to increase, driven in large part by demand from its domestic ceramic and glass industries. As a direct result, Chinese imports from Chile, Russia, Turkey, and the United States were expected to increase over the next several years. Europe and emerging markets are requiring higher building standards, which directly correlates to higher consumption of borates for insulation fiberglass. Continued investment in new refineries and technologies and the continued rise in demand should fuel growth in world production over the next several years.

World Production and Reserves:

	Production—All forms[4]		Reserves[5]
	2008	2009[e]	
United States	W	W	40,000
Argentina	785	790	2,000
Bolivia	56	50	NA
Chile	583	580	NA
China	140	140	25,000
Iran	2	2	1,000
Kazakhstan	30	30	NA
Peru	350	350	4,000
Russia	400	410	40,000
Turkey	2,000	2,100	60,000
World total (rounded)	[6]4,350	[6]4,500	170,000

World Resources: Large deposits of boron resources occur in southern California and in Turkey. U.S. deposits consist primarily of tincal and kernite together with borates contained in brines, and Turkish deposits are 70% colemanite. Small deposits are being mined in South America. At current levels of consumption, world resources are adequate for the foreseeable future.

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

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Minerals and compounds sold or used by producers; includes both actual mine production and marketable products.
[2]Source: Industrial Minerals, no. 459, December 2005, p. 70; no. 471, December 2006, p. 74; no. 483, December 2007, p. 76; no. 495, December 2008, p. 88. Mineral Commodity Summaries 2008 and earlier, used price of granulated pentahydrate borax in bulk, carload, and works.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]Gross weight of ore in thousand metric tons.
[5]Gross weight of boron-bearing mineral content. See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[6]Excludes U.S. production.

BROMINE

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

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

Primary uses of bromine compounds are in flame retardants, drilling fluids, brominated pesticides (mostly methyl bromide), and water treatment. Bromine is also used in the manufacture of dyes, insect repellents, perfumes, pharmaceuticals, and photographic chemicals. Other products containing bromine included intermediate chemicals for the manufacture of chemical products and bromide solutions used alone or in combination with other chemicals.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production[1]	226,000	243,000	W	W	W
Imports for consumption, elemental bromine and compounds[2]	60,000	44,000	30,000	41,000	43,000
Exports, elemental bromine and compounds	10,000	12,000	11,000	10,000	10,000
Consumption, apparent[3]	277,000	275,000	W	W	W
Price, cents per kilogram, bulk, purified bromine	74.0	139.2	NA	NA	NA
Employment, number	1,200	1,100	1,000	1,000	1,000
Net import reliance[4] as a percentage of apparent consumption	18	12	<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 (2005-08): Israel, 91%; China, 5%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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	2903.49.1000	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.

Events, Trends, and Issues: Although still the leading bromine producer in the world, the U.S. dominance has decreased as other countries, such as China, Israel, Japan, and Jordan, have strengthened their positions as world producers of elemental bromine.

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BROMINE

A company in Louisiana signed a memorandum of understanding with a specialty chemicals company to secure a domestic supply of activated carbon to assist in its use of bromine-based solutions for removing mercury emissions from coal-powered plants. Other companies intended to market bromine and brominated derivatives to be used in the removal of mercury from plant emissions.

The leading use of bromine is in flame retardants; however, this use is of concern because of the persistence of some bromine compounds in the environment and their potential health effects. Environment Canada has joined the European Union in prohibiting decabromodiphenyl ether (Deca-BDE), a widely used flame retardant, from being used in televisions, computers, and textiles. The Swedish Government is the only European country that would not pursue any national restrictions on Deca-BDE.

Bromine and bromine compound prices increased in 2009, reflecting the expanding markets of bromine and increases in the costs of energy, raw materials, regulatory compliance, and transportation.

World Mine Production and Reserves:

	Mine production		Reserves[5]
	2008	2009[e]	
United States[1]	W	W	11,000,000
Azerbaijan	3,500	3,500	300,000
China	135,000	139,000	130,000
Germany	1,000	1,000	([6])
India	1,500	1,500	([7])
Israel	164,000	165,000	([8])
Japan	20,000	20,000	([9])
Jordan	85,000	106,000	([8])
Spain	100	100	1,400,000
Turkmenistan	150	150	700,000
Ukraine	3,000	3,000	400,000
World total (rounded)	[10]413,000	[10]439,000	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]Sold or used by U.S. producers.
[2]Imports calculated from items shown in Tariff section.
[3]Includes recycled product.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[6]From waste bitterns associated with potash production.
[7]From waste bitterns associated with solar salt.
[8]From the Dead Sea.
[9]From seawater.
[10]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 were thought to have produced refined cadmium in 2009. One company, operating in Tennessee, recovered primary cadmium as a byproduct of zinc leaching from roasted sulfide concentrates. The other two companies, with facilities in Ohio and Pennsylvania, thermally recovered secondary cadmium metal from spent nickel-cadmium (NiCd) batteries and other cadmium-bearing scrap. Based on the average New York dealer price, U.S. cadmium metal consumption was valued at about $1.97 million in 2009.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production, refinery[1]	1,470	723	735	777	700
Imports for consumption, metal only	207	179	315	153	187
Imports for consumption, metal, alloys, scrap	288	180	316	197	194
Exports, metal only	([2])	18	270	295	305
Exports, metal, alloys, scrap	686	483	424	421	676
Consumption of metal, apparent	699	568	585	550	228
Price, metal, average annual:[3]					
Dollars per kilogram	3.31	2.98	7.61	5.93	2.69
Dollars per pound	1.50	1.35	3.45	2.69	1.22
Stocks, yearend, producer and distributor	1,540	1,400	1,440	1,460	1,450
Net import reliance[4] as a percentage of apparent consumption	E	E	E	E	E

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

Import Sources (2005-08): Metal:[5] Mexico, 30%; Australia, 25%; Canada, 18%; Peru, 8%; and other, 19%.

Tariff: Item	Number	Normal Trade Relations[6] 12-31-09
Cadmium oxide	2825.90.7500	Free.
Cadmium sulfide	2830.90.2000	3.1% ad val.
Pigments and preparations based on cadmium compounds	3206.49.6010	3.1% ad val.
Unwrought cadmium and powders	8107.20.0000	Free.
Cadmium waste and scrap	8107.30.0000	Free.
Wrought cadmium and other articles	8107.90.0000	4.4% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: Global refinery production of cadmium was estimated to decrease in 2009 as a result of production cutbacks at several zinc smelters that also recovered byproduct cadmium. Domestic apparent consumption of cadmium decreased in 2009 as a result of decreased refined production and a significant rise in cadmium exports during the year, possibly owing to an increase in the production of cadmium-containing products overseas. Global consumption of cadmium was expected to remain flat.

Most of the world's primary cadmium was produced in Asia and the Pacific—specifically China, Japan, and the Republic of Korea—followed by North America, Central Europe and Eurasia, and Western Europe. Secondary cadmium production takes place mainly at NiCd battery recycling facilities.

Cadmium use in batteries accounted for the majority of global consumption. The remainder was distributed as follows, in order of descending consumption: pigments, coatings and plating, stabilizers for plastics, nonferrous alloys, and other specialized uses (including photovoltaic devices). The percentage of cadmium consumed globally for NiCd battery production has been increasing, while the percentages for the other traditional end uses of cadmium—specifically coatings, pigments, and stabilizers—have gradually decreased, owing to environmental and health concerns. A large percentage of the global NiCd battery market was concentrated in Asia.

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CADMIUM

NiCd battery use in consumer electronics was thought to be declining owing partly to the preference for other rechargeable battery chemistries—particularly lithium ion (Li-ion) batteries, which have already replaced NiCd batteries to a large degree in laptops and cell phones. Li-ion batteries are used in lightweight electronic devices because of their greater energy density (power-to-weight ratio). However, demand for cadmium may increase owing to several new market opportunities for NiCd batteries, particularly in industrial applications. Industrial-sized NiCd batteries could also be used to store energy produced by certain on-grid photovoltaic systems. Peak energy produced during the midday would be stored in a NiCd battery and later dispatched during periods of high electricity demand.

Concern over cadmium's toxicity has spurred various recent legislative efforts, especially in the European Union, to restrict the use of cadmium in most of its end-use applications. The final effect of this legislation on global cadmium consumption has yet to be seen. If recent legislation involving cadmium dramatically reduces long-term demand, a situation could arise, such as has been recently seen with mercury, where an accumulating oversupply of byproduct cadmium will need to be permanently stockpiled.

World Refinery Production and Reserves: Cadmium reserves were calculated as a percentage of zinc reserves. Changes to cadmium reserves data from the prior year reflect a reevaluation of zinc reserves globally and by country.

	Refinery production		Reserves[7]
	2008	2009[e]	
United States	777	700	39,000
Australia	330	330	63,000
Canada	1,300	1,150	24,000
China	4,300	4,300	90,000
Germany	400	400	—
India	599	700	27,000
Japan	2,120	1,990	—
Kazakhstan	2,100	2,100	51,000
Korea, Republic of	2,900	2,300	—
Mexico	1,610	1,580	42,000
Netherlands	530	530	—
Peru	371	275	48,000
Poland	420	410	23,000
Russia	800	800	72,000
Other countries	1,040	1,240	110,000
World total (rounded)	19,600	18,800	590,000

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

Substitutes: Lithium-ion and nickel-metal hydride batteries are replacing NiCd batteries in some applications. However, the higher cost of these substitutes restricts their use in less-expensive products. Except where the surface characteristics of a coating are critical (e.g., 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. — Zero.
[1]Cadmium metal and oxide 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, and Mexico for items shown.
[7]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

CEMENT

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2009, about 70 million tons of portland cement and 2 million tons of masonry cement were produced at 107 plants in 37 States. Ongoing plant closures left the yearend plant count at 101. Cement also was produced at two plants in Puerto Rico. Sales volumes fell sharply, but prices fell only modestly; the overall value of sales was about $7.3 billion. Most of the cement was used to make concrete, worth at least $40 billion. About 72% of cement sales went to ready-mixed concrete producers, 13% to concrete product manufacturers, 7% to contractors (mainly road paving), 3% to building materials dealers, and 5% to other users. In descending order, Texas, California, Missouri, Pennsylvania, Alabama, and Michigan were the six leading cement-producing States and accounted for about 50% of U.S. production.

Salient Statistics—United States:[1]	2005	2006	2007	2008	2009[e]
Production:					
Portland and masonry cement[2]	99,319	98,167	95,464	86,310	71,800
Clinker	87,405	88,555	86,130	78,381	58,000
Shipments to final customers, includes exports	129,791	129,240	115,426	97,322	73,000
Imports of hydraulic cement for consumption	30,403	32,141	21,496	10,744	6,400
Imports of clinker for consumption	2,858	3,425	972	621	500
Exports of hydraulic cement and clinker	766	723	886	858	800
Consumption, apparent[3]	128,260	127,660	116,800	96,700	73,800
Price, average mill value, dollars per ton	91.00	101.50	104.00	103.00	100.00
Stocks, cement, yearend	7,450	9,380	8,890	8,360	12,000
Employment, mine and mill, number[e]	16,300	16,300	16,000	15,000	14,000
Net import reliance[4] as a percentage of apparent consumption	25	27	19	11	8

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. Certain secondary materials can be incorporated in blended cements and in the cement paste in concrete. Cement is not directly recycled, but there is significant recycling of concrete for use as aggregate.

Import Sources (2005-08):[5] China, 22%; Canada, 19%; Republic of Korea, 9%; Thailand, 7%; and other, 43%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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: The dominant issue in 2009 was the ongoing severe decline in construction spending and associated cement sales. The decline, which continued a trend begun in about mid-2006, was evident in all construction sectors (especially in housing), and affected all States. Unlike in 2007, where lower sales had been largely accommodated by reductions in imported cement, there was also a sharp decline in cement production in 2008-09, and a rash of plant closures. By yearend 2009, 14 plants had closed, and only 3 new plants had opened. A number of planned expansion projects at existing plants continued to be suspended, as were plans for at least two new plants. Toward yearend 2009, a large number of plants were idled temporarily, owing to full cement silos. A return to cement sales volumes more in line with the 2005-06 record years was expected to take about 5 years.

A number of environmental issues, especially carbon dioxide emissions, affect the cement industry. Plant-level reporting of carbon dioxide emissions was expected to become mandatory in 2010. Carbon dioxide reduction strategies by the cement industry largely aim at reducing emissions per ton of cement product rather than by plant. These strategies include installation of more fuel-efficient kiln technologies, partial substitution of noncarbonated 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

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CEMENT

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. Plant-level reporting of carbon dioxide emissions was expected to become mandatory in 2010. Recent revisions to the major portland cement standard ASTM-C150 and the similar AASHTO M85 allow for the incorporation of up to 5% ground limestone as an inert extender, but it was unclear how many plants would be able to adopt this practice. The C-150 standard was further revised in 2009 to allow for the addition of up to 5% of inorganic process additions. Research was ongoing toward developing cements that require less energy to manufacture than portland cement, and/or that utilize more benign raw materials.

A new emissions limitation protocol for cement plants was released in 2009 that would significantly lower the acceptable emissions levels of mercury and some other pollutants. It was unclear how many plants would be able to comply with the new limits; the mercury limits were further 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]	
	2008	**2009[e]**	**2008**	**2009**
United States (includes Puerto Rico)	87,600	72,800	108,000	111,000
Brazil	51,900	53,000	45,000	45,000
China	1,390,000	1,400,000	1,000,000	1,100,000
Egypt	40,000	40,000	38,000	38,000
France	21,700	21,000	22,000	22,000
Germany	33,600	33,000	31,000	31,000
India	[e]177,000	180,000	200,000	200,000
Indonesia	[e]37,000	37,000	42,000	42,000
Iran	44,400	45,000	36,000	40,000
Italy	43,000	43,000	46,000	46,000
Japan	62,800	60,000	70,000	70,000
Korea, Republic of	53,900	53,000	62,000	62,000
Mexico	47,600	45,000	42,000	42,000
Pakistan	[e]39,000	40,000	36,000	38,000
Russia	53,600	55,000	65,000	65,000
Saudi Arabia	31,800	32,000	29,000	30,000
Spain	42,100	42,000	42,000	42,000
Thailand	[e]35,600	35,000	50,000	50,000
Turkey	51,400	51,000	45,000	45,000
Vietnam	[e]37,000	37,000	35,000	35,000
Other countries (rounded)	[e]459,000	450,000	400,000	410,000
World total (rounded)	[e]2,840,000	2,800,000	2,400,000	2,600,000

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: Virtually all 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 (the ability to set and harden under water) by reacting with the lime released by the hydration of portland cement. 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: Pollucite, the ore mineral of cesium with the most commercial importance, may be found in zoned pegmatites worldwide, with the largest deposit at Bernic Lake in Canada. Canada is the leading producer and supplier of pollucite concentrate, which is imported for processing by one company in the United States. Occurrences of cesium-bearing pollucite in pegmatites have been discovered in Maine and South Dakota; however, these occurrences are not being mined. The most widespread end use of cesium is in cesium formate brines, a high-density, low-viscosity fluid used for high-pressure/high-temperature (HPHT) oil and gas drilling. Cesium formate possesses anti-oxidant and water-structuring properties that protect drilling polymers from thermal degradation and has the required density needed to maintain well control.

Cesium is used as an atomic resonance frequency standard in atomic clocks, playing a vital role in global positioning satellite, Internet, and cell phone transmissions and aircraft guidance systems. Owing to the high accuracy of the cesium atomic clock, which only loses or gains a second in 60 million years, 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.

Other applications of cesium include biomedical research, infrared detectors, night vision devices, photoelectric cells, and traffic controls. Cesium-131 and cesium-137, isotopes of cesium produced by the nuclear fission of uranium-235, are used primarily to treat cancer. Cesium-131 is used in the treatment of prostate cancer and cesium-137 is used in brachytherapy, where the radioactive source is placed within the cancerous area. Cesium-137 is also widely used in industrial gauges, in mining and geophysical instruments, and for sterilization of food, sewage, and surgical equipment. Radioactive cesium chloride is used in self-contained irradiators at hospitals and universities for blood irradiation and in biomedical and radiation research, as well as for industrial uses. Nonradioactive cesium chloride is used in electrically conductive glass.

Salient Statistics—United States: Mine production, consumption, import, and export data for cesium have not been available since the late 1980s. There is no trading of cesium, and therefore no market price is available. Consumption of cesium in the United States is estimated to only be a few thousand kilograms per year. In 2009, one company offered 1-gram ampoules of 99.8% (metals basis) cesium for $50.70 each and 99.98% (metals basis) cesium for $62.80, an increase of 14.2% and 7.5% from that of 2008, respectively. The price for 50 grams of 99.8% (metals basis) cesium was $629.00, and 100 grams of 99.98% (metals basis) cesium was priced at $1,725.00, an increase of 7.9% and 7.6% from that of 2008, respectively.

Recycling: Cesium formate brines are normally used by oil and gas exploration clients on a rental basis, and after completion of the well, the used cesium formate is returned and reprocessed for subsequent drilling operations. Approximately 15% of the cesium formate may be lost in the well. There are no data available on the amounts used or recovered.

Import Sources (2005-08): Canada is the chief source of pollucite concentrate imported by the United States, and the United States is 100% import reliant.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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

<u>Events, Trends, and Issues</u>: Domestic cesium occurrences will remain uneconomic unless market conditions change, such as the discovery of new end uses or increased consumption for existing end uses. Commercially useful quantities of inexpensive cesium are available as a byproduct of the production of lithium. There are no known human health issues associated with cesium, and its use has minimal environmental impact.

Cesium's cost and reactivity limit its viability in many applications; however, its use in cesium formate brines and nuclear medicine is showing steady growth. Cesium formate drilling operations are being undertaken in the Thar Desert in Pakistan, in the North Sea off the coast of Norway, and in Argentina. Aside from its use in drilling fluid, cesium formate brine is used as a fast-acting liquid pill for releasing drill pipes differentially stuck in oil-based mud (OBM) filter cakes. The pill of formate brine rapidly destroys the OBM filter cake and allows the pipe to be jarred free. In February 2009, the U.S. Food and Drug Administration expanded the clearance for cesium-131 brachytherapy seeds, allowing products to be commercially distributed to treat head, neck, and lung tumors.

The International Atomic Energy Agency has indicated that cesium-137 is one of several radioactive materials that may be used in radiological dispersion devices or "dirty bombs." As of February 2008, the National Research Council mandated that the U.S. Government take steps to promote the replacement of cesium-137 with lower risk alternatives. In April 2009, the U.S. Nuclear Regulatory Commission (NRC) agreed to encourage research into finding and implementing alternatives, but deemed that a near-term replacement was not practical and would be detrimental to current emergency medical capabilities. In August 2009, the NRC announced plans to monitor devices containing cesium-137, requiring material holders to obtain specific licenses for these devices. The new regulations are expected to take effect sometime in late 2010.

<u>World Mine Production and Reserves</u>: Pollucite, a hydrated aluminosilicate mineral, mainly formed in association with lithium-rich, lepidolite-bearing or petalite-bearing zoned granite pegmatites, is a significant cesium ore. Cesium reserves are therefore estimated based on the occurrence of pollucite, which is mined as a byproduct of the lithium mineral lepidolite. Concentrates of pollucite may contain about 20% cesium by weight. Data on cesium resources and mine production are either limited or not available. The deposit at Bernic Lake in Canada contains approximately 300,000 metric tons of pollucite with an average Cs_2O content of 24% and also contains lithium and tantalum. The next largest occurrence that may become economic is in Zimbabwe.

	Reserves[1]
Canada	70,000,000
Other countries	NA
World total (rounded)	70,000,000

<u>World Resources</u>: World resources of cesium have not been estimated. Cesium may be associated with lithium-bearing pegmatites worldwide, and cesium resources have been identified in Namibia and Zimbabwe. Cesium occurrences are also known in brines in Chile and China and in geothermal systems in Germany, India, and Tibet.

<u>Substitutes</u>: Because cesium and rubidium have similar physical properties and atomic radii, they may be used interchangeably in many applications.

NA Not available.
[1]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

CHROMIUM

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

Domestic Production and Use: In 2009, the United States was expected to consume about 7% 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. Imported chromite was consumed by one chemical firm to produce chromium chemicals. One company produced ferrochromium and chromium metal. Stainless- and heat-resisting-steel producers were the leading consumers of ferrochromium. Superalloys require chromium. The value of chromium material consumption in 2008 was $1,283 million as measured by the value of net imports, excluding stainless steel, and was expected to be about $320 million in 2009.

Salient Statistics—United States:[1]	**2005**	**2006**	**2007**	**2008**	**2009**[e]
Production:					
Mine	—	—	W	—	—
Recycling[2]	174	179	162	146	160
Imports for consumption	503	520	485	559	150
Exports	220	212	291	287	50
Government stockpile releases	91	103	137	11	1
Consumption:					
Reported (includes recycling)	431	437	442	404	330
Apparent[3] (includes recycling)	548	589	493	432	260
Unit value, average annual import (dollars per metric ton):					
Chromite ore (gross mass)	140	141	156	227	220
Ferrochromium (chromium content)	1,425	1,290	1,951	3,728	2,100
Chromium metal (gross mass)	8,007	8,181	8,331	11,078	10,000
Stocks, yearend, held by U.S consumers	9	10	10	7	5
Net import reliance[4] as a percentage of apparent consumption	68	70	67	66	39

Recycling: In 2009, recycled chromium (contained in reported stainless steel scrap receipts) accounted for 61% of apparent consumption.

Import Sources (2005-08): Chromium contained in chromite ore, chromium ferroalloys and metal, and stainless steel mill products and scrap: South Africa, 32%; Kazakhstan, 17%; Russia, 9%; and other, 42%.

Tariff:[5] **Item**	**Number**	**Normal Trade Relations 12-31-09**
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:[6] 22% (Domestic), 14% (Foreign).

Government Stockpile: In fiscal year (FY) 2009, which ended on September 30, 2009, the Defense Logistics Agency, Defense National Stockpile Center (DNSC), reported sales of 17,766 tons of high-carbon ferrochromium, 2,778 tons of low-carbon ferrochromium, and 120 tons of chromium metal. Disposals in the following table are estimated as the change in DNSC's reported current year minus previous year physical inventory. Metallurgical-grade chromite ore and ferrochromium silicon stocks were exhausted in FY 2002; chemical- and refractory-grade chromite ore stocks were exhausted in FY 2004. The DNSC announced maximum disposal limits for FY 2010 of about 90,700 tons of ferrochromium (high- and low-carbon combined) and 907 tons of chromium metal. At the current maximum disposal rate, ferrochromium stocks will be exhausted in FY 2011; chromium metal, in FY 2014.

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CHROMIUM

Stockpile Status—9-30-09[6]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2009	Disposals FY 2009	Average chromium content
Ferrochromium:					
High-carbon	115	139	[7]136	24.7	71.4%
Low-carbon	57.9	66.7	([7])	8.83	71.4%
Chromium metal	4.70	4.82	0.907	0.120	100%

Events, Trends, and Issues: The price of ferrochromium reached historically high levels in 2008, and then declined in 2009 with a weakening world economy. China's role as a chromium consumer grew along with its stainless steel production industry. China's importance as a consumer of raw materials used in stainless steel production increased owing to its strong economic growth and the expansion of its stainless steel production.

Ferrochromium production is an electrical energy-intensive process. South Africa, which accounts for about 40% of world chromite ore and ferrochromium production, experienced electrical power shortages that South Africa's electrical power utility dealt with by rationing. Indian ferrochromium producers, which accounted for about 15% of world ferrochromium production, dealt with limited electrical power supply by putting up dedicated electrical powerplants. Kazakhstan, which accounted for about 15% of world ferrochromium production, expected increasing electrical power demand and reduced production capacity owing to aging infrastructure. World financial problems relieved electrical power demand; however, with economic recovery, the electrical power supply constraint will return unless electrical power capacity is increased.

Much of the electrical power currently produced is coal-based, a carbon dioxide gas-producing process that is currently being considered for regulation because of its impact on global warming. These factors suggest that the electrical energy cost of ferrochromium production will rise in the future.

World Mine Production and Reserves: Reserves for South Africa were revised based on new information published by a mining company. Reserves for the United States were revised based on new information published by a mining company.

	Mine production[8]		Reserves[9]
	2008	2009[e]	(shipping grade)[10]
United States	—	—	620
India	3,900	3,900	44,000
Kazakhstan	3,630	3,600	180,000
South Africa	9,680	9,600	130,000
Other countries	6,540	6,300	NA
World total (rounded)	23,800	23,000	>350,000

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

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

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — 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 recycle) + 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 definitions. Reserve base estimates were discontinued in 2009; see Introduction. Proven reserves and probable reserves reported by mining companies previously reported as reserves and reserve base, respectively, have been combined into the reserves category.
[10]Reserves units are thousand metric tons of shipping-grade chromite ore, which is deposit quantity and grade normalized to 45% Cr_2O_3.

CLAYS

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2009, clay and shale production was reported in 41 States. About 190 companies operated approximately 830 clay pits or quarries. The leading 20 firms supplied about 50% of the tonnage and 80% of the value for all types of clay sold or used in the United States. In 2009, sales or use was estimated to be 25.3 million tons valued at $1.40 billion. Major uses for specific clays were estimated to be as follows: ball clay—38% floor and wall tile, 24% sanitaryware, and 38% other uses; bentonite—26% absorbents, 23% drilling mud, 17% foundry sand bond, 14% iron ore pelletizing, and 20% other uses; common clay—57% brick, 19% lightweight aggregate, 14% cement, and 10% other uses; fire clay—58% heavy clay products, 42% refractory products and other uses; fuller's earth—66% absorbent uses and 34% other uses; and kaolin—62% paper and 38% other uses.

Salient Statistics—United States:[1]	**2005**	**2006**	**2007**	**2008**	**2009**[e]
Production, mine:					
Ball clay	1,210	1,190	1,070	1,100	820
Bentonite	4,710	4,940	4,820	4,900	4,100
Common clay	24,300	24,200	20,600	15,400	12,500
Fire clay	353	848	565	420	360
Fuller's earth	2,730	2,540	2,660	2,510	2,360
Kaolin	7,800	7,470	7,110	6,280	5,200
Total[2]	41,200	41,200	36,800	30,600	25,300
Imports for consumption:					
Artificially activated clay and earth	17	21	23	25	19
Kaolin	262	303	194	211	180
Other	22	22	14	20	11
Total[2]	301	346	231	256	210
Exports:					
Ball clay	141	140	83	65	45
Bentonite	847	1,270	1,430	1,090	670
Fire clay[3]	368	348	425	393	320
Fuller's earth	55	69	134	127	86
Kaolin	3,580	3,540	3,300	2,960	2,150
Clays, not elsewhere classified	634	607	279	400	499
Total[2]	5,620	5,980	5,650	5,040	3,770
Consumption, apparent	35,900	35,600	31,400	25,800	21,700
Price, average, dollars per ton:					
Ball clay	44	44	46	47	48
Bentonite	46	48	52	53	55
Common clay	7	10	11	11	11
Fire clay	30	22	42	43	44
Fuller's earth	100	96	97	100	103
Kaolin	110	131	135	139	143
Employment, number:[e]					
Mine	990	1,250	1,150	1,060	875
Mill	4,940	5,130	5,080	5,020	4,540
Net import reliance[4] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2005-08): Brazil, 84%; United Kingdom, 4%; Mexico, 3%; Canada, 2%; and other, 7%.

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CLAYS

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
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: Declines in U.S. construction markets resulted in reduced demand for products manufactured using ball clay, common clay, and fire clay. Bentonite production decreased primarily because of a significant reduction in demand for domestic oil drilling and iron ore pelletizing. Sales of bentonite for pet litter and foundry applications declined slightly. Kaolin production declined because of lower demand in world paper markets and lower U.S. construction activity. Fuller's earth markets declined because of a drop in sales for fertilizer carrier and pet litter applications.

World Mine Production and Reserves:[5] Reserves are large in major producing countries, but data are not available.

	Mine production					
	Bentonite		Fuller's earth		Kaolin	
	2008	2009[e]	2008	2009[e]	2008	2009[e]
United States (sales)	4,900	4,100	2,510	2,360	6,280	5,200
Brazil (beneficiated)	32	28	—	—	2,500	2,130
Czech Republic (crude)	174	150	—	—	3,830	3,400
Germany (sales)	414	370	—	—	3,610	3,250
Greece (crude)	950	850	—	—	60	50
Italy (kaolinitic earth)	599	540	3	3	580	500
Korea, Republic of (crude)	—	—	—	—	955	900
Mexico	375	340	66	60	85	75
Spain	150	130	820	800	450	420
Turkey	900	810	—	—	620	400
Ukraine (crude)	300	240	—	—	2,400	2,000
United Kingdom	—	—	—	—	1,800	1,550
Uzbekistan (crude)	—	—	—	—	5,500	4,600
Other countries	2,900	2,400	280	277	7,230	6,150
World total (rounded)	11,700	10,000	3,680	3,500	35,900	30,600

World Resources: Resources of all clays are extremely large.

Substitutes: Alternatives, such as calcium carbonate and talc, are available for filler and extender applications.

[e]Estimated. E Net exporter. — Zero.
[1]Excludes Puerto Rico.
[2]Data may not add to totals shown because of independent rounding.
[3]Also includes some refractory-grade kaolin.
[4]Defined as imports – exports.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

COBALT

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

Domestic Production and Use: The United States did not mine or refine cobalt in 2009; however, negligible amounts of byproduct cobalt were produced as intermediate products from some mining operations. U.S. supply comprised imports, stock releases, and secondary materials, such as cemented carbide scrap, spent catalysts, and superalloy scrap. 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. In 2009, a cobalt plant in North Carolina ceased operations, and one plant in Ohio was placed on care-and-maintenance status. More than 60 industrial consumers were surveyed on a monthly or annual basis. Data reported by these consumers indicate that 49% 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; 15% in various other metallic applications; and 27% in a variety of chemical applications. The total estimated value of cobalt consumed in 2009 was $270 million.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production:					
Mine	—	—	—	—	—
Secondary	2,030	2,010	1,930	1,930	1,700
Imports for consumption	11,100	11,600	10,300	10,700	7,300
Exports	2,440	2,850	3,100	2,850	2,500
Shipments from Government stockpile excesses	1,110	260	617	203	200
Consumption:					
Reported (includes secondary)	9,150	9,280	9,320	8,810	7,000
Apparent[1] (includes secondary)	11,800	11,000	9,630	10,100	6,700
Price, average annual spot for cathodes, dollars per pound	15.96	17.22	30.55	39.01	18.00
Stocks, industry, yearend	1,190	1,180	1,310	1,160	1,160
Net import reliance[2] as a percentage of apparent consumption	83	82	80	81	75

Recycling: In 2009, cobalt contained in purchased scrap represented an estimated 24% of cobalt reported consumption.

Import Sources (2005-08): Cobalt contained in metal, oxide, and salts: Norway, 19%; Russia, 17%; China, 12%; Canada, 10%; and other, 42%.

Tariff: Item	Number	Normal Trade Relations[3] 12-31-09
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: The disposal limit for cobalt for fiscal year 2010 was reduced to 454 tons.

Stockpile Status—9-30-09[4]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2009	Disposals FY 2009
Cobalt	304	304	1,360	187

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COBALT

Events, Trends, and Issues: The global economic downturn that began in late 2008 resulted in reduced demand for and supply of cobalt. During the first half of 2009, the world availability of refined cobalt (as measured by production and U.S. Government shipments) was 13% lower than that of the first half of 2008. The decrease was primarily because of a decline in 2009 production from China and the closure of a Zambian refinery in late 2008. During the second half of 2009, a labor strike at a company in Canada resulted in reduced production of refined cobalt from that country. Beginning in late 2008, production of cobalt-bearing concentrates and intermediates was impacted by cutbacks at numerous nickel operations and at some copper-cobalt operations in Congo (Kinshasa). Financing, construction, and startup of some proposed brownfield and greenfield projects that would add to future world cobalt supply were delayed by various factors, including global economic conditions and low cobalt, copper, and nickel prices.

The London Metal Exchange planned to launch a cobalt contract in February 2010. The global contract would trade in 1-metric-ton lots of minimum 99.3% cobalt with delivery to warehouses in Baltimore, Rotterdam, and Singapore.

China was the world's leading producer of refined cobalt, and much of its production was from cobalt-rich ore and partially refined cobalt imported from Congo (Kinshasa). In 2008, China became the leading supplier of cobalt imports to the United States.

World Mine Production and Reserves: Reserves for Cuba were revised downward based on resource information for various nickel operations published by industry sources.

	Mine production		Reserves[5]
	2008	2009[e]	
United States	—	—	33,000
Australia	6,100	6,300	1,500,000
Brazil	1,200	1,000	29,000
Canada	8,600	5,000	120,000
China	6,000	6,200	72,000
Congo (Kinshasa)	31,000	25,000	3,400,000
Cuba	3,200	3,500	500,000
Morocco	1,700	1,600	20,000
New Caledonia[6]	1,600	1,300	230,000
Russia	6,200	6,200	250,000
Zambia	6,900	2,500	270,000
Other countries	3,400	3,200	180,000
World total (rounded)	75,900	62,000	6,600,000

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

Substitutes: In some applications, substitution of 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; 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. — Zero.
[1]The sum of U.S. net import reliance and secondary production, as estimated from consumption of purchased scrap.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]No tariff for Canada or Mexico. Tariffs for other countries for some items may be eliminated under special trade agreements.
[4]See Appendix B for definitions.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[6]Overseas territory of France.

COPPER

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

Domestic Production and Use: Domestic mine production in 2009 declined by about 9% to 1.2 million tons and its value fell to about $6.2 billion. The principal mining States, in descending order of production—Arizona, Utah, New Mexico, Nevada, and Montana—accounted for more than 99% of domestic production; copper also was recovered at mines in Idaho and Missouri. Although copper was recovered at 29 mines operating in the United States, 20 mines accounted for about 99% of production. Three primary smelters, 4 electrolytic and 3 fire refineries, and 15 solvent extraction-electrowinning facilities operated during the year. Refined copper and direct-melt scrap were consumed at about 30 brass mills; 15 rod mills; and 500 foundries, chemical plants, and miscellaneous consumers. Copper and copper alloy products were used in building construction, 50%; electric and electronic products, 21%; transportation equipment, 11%; consumer and general products, 10%; and industrial machinery and equipment, 8%.[1]

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production:					
Mine	1,140	1,200	1,170	1,310	1,190
Refinery:					
Primary	1,210	1,210	1,280	1,230	1,100
Secondary	47	45	46	53	55
Copper from all old scrap	183	150	157	166	160
Imports for consumption:					
Ores and concentrates	([2])	([2])	1	1	1
Refined	1,000	1,070	829	724	650
Unmanufactured	1,230	1,320	1,100	934	730
General imports, refined	977	1,070	832	721	650
Exports:					
Ores and concentrates	137	108	134	301	170
Refined	40	106	51	37	90
Unmanufactured	815	990	884	1,090	880
Consumption:					
Reported, refined	2,270	2,110	2,140	2,020	1,660
Apparent, unmanufactured[3]	2,400	2,190	2,270	2,020	1,660
Price, average, cents per pound:					
Domestic producer, cathode	173.5	314.8	328.0	319.2	237
London Metal Exchange, high-grade	166.8	304.9	322.8	315.0	230
Stocks, yearend, refined, held by U.S. producers, consumers, and metal exchanges	66	196	133	190	350
Employment, mine and mill, thousands	7.0	8.4	9.7	11.9	9.1
Net import reliance[4] as a percentage of apparent consumption	42	38	37	31	24

Recycling: Old scrap, converted to refined metal and alloys, provided 160,000 tons of copper, equivalent to 10% of apparent consumption. Purchased new scrap, derived from fabricating operations, yielded 650,000 tons of contained copper; about 85% of the copper contained in new scrap was consumed at brass or wire-rod mills. Of the total copper recovered from scrap (including aluminum- and nickel-based scrap), brass mills recovered 70%; miscellaneous manufacturers, foundries, and chemical plants, 13%; ingot makers, 11%; and copper smelters and refiners, 6%. Copper in all old and new, refined or remelted scrap contributed about 35% of the U.S. copper supply.

Import Sources (2005-08): Unmanufactured: Chile, 40%; Canada, 34%; Peru, 13%; Mexico, 6%; and other, 7%. Refined copper accounted for 81% of unwrought copper imports.

Tariff: Item	Number	Normal Trade Relations[5] 12-31-09
Copper ores and concentrates	2603.00.0000	1.7¢/kg on lead content.
Unrefined copper; anodes	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: The stockpiles of refined copper and brass were liquidated in 1993 and 1994, respectively. Details on inventories of beryllium-copper master alloys (4% beryllium) can be found in the section on beryllium.

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COPPER

Events, Trends, and Issues: With the onset of the economic crisis, the London Metal Exchange Ltd. (LME) price, which had averaged $3.65 per pound of copper during the first 9 months of 2008, fell sharply to an average of only $1.45 per pound in December 2008. Prices during the first 9 months of 2009, however, trended upward, the LME price averaging $2.82 per pound of copper in September, as supplies remained tight and there was renewed interest in commodity markets. Global production of refined copper was essentially unchanged owing to limited growth in mine production that resulted from cutbacks in response to the global economic crisis and to operational constraints that reduced output in Australia, Chile, and Indonesia, and because lower scrap availability led to a decline in secondary refined copper. Refined copper consumption declined slightly, as double digit declines in the European Union, Japan, and the United States were mostly offset by growth in China's apparent consumption of more than 25%. China's year-on-year imports of refined copper rose by 1.1 million tons during the first 6 months of 2009, much of which was believed to have entered unreported government and industry inventories. The International Copper Study Group forecast a small refined copper production surplus to develop by yearend 2009 and a slightly larger surplus in 2010.[6]

U.S. copper mine production, which had been expected to rise by more than 200,000 tons, declined by about 120,000 tons in 2009 following significant revisions to mine plans by several producers, including the closure of a mine opened during 2008. Domestic consumption of refined copper trended lower owing to weaker housing and automotive demand, and several brass mills closed during the year. U.S. mine and refinery production were expected to fall slightly in 2010, while consumption was projected to increase modestly in response to anticipated economic recovery.

World Mine Production and Reserves: Official reserves reported by China may include deposits not currently economic to develop. Revisions to reserves for Canada, Indonesia, Peru, and Poland are based on company reports.

	Mine production		Reserves[7]
	2008	2009[e]	
United States	1,310	1,190	35,000
Australia	886	900	24,000
Canada	607	520	8,000
Chile	5,330	5,320	160,000
China	950	960	30,000
Indonesia	651	950	31,000
Kazakhstan	420	410	18,000
Mexico	247	250	38,000
Peru	1,270	1,260	63,000
Poland	430	440	26,000
Russia	750	750	20,000
Zambia	546	655	19,000
Other countries	2,030	2,180	70,000
World total (rounded)	15,400	15,800	540,000

World Resources: Recent assessments of copper resources indicated 550 million tons of copper remaining in identified and undiscovered resources in the United States[8] and 1.3 billion tons of copper in discovered, mined, and undiscovered resources in the Andes Mountains of South America.[9] A preliminary assessment indicates that global land-based resources exceed 3 billion tons. Deep-sea nodules were estimated to contain 700 million tons of copper.

Substitutes: Aluminum substitutes for copper in power cables, 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 2008 by the Copper Development Association, Inc., 2009.
[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 and Mexico for items shown. Tariffs for other countries for some items may be eliminated under special trade agreements.
[6]International Copper Study Group, 2009, Forecast 2009-2010: Lisbon, Portugal, International Copper Study Group press release, October 8, 1 p.
[7]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[8]U.S. Geological Survey National Mineral Resource Assessment Team, 2000, 1998 assessment of undiscovered deposits of gold, silver, copper, lead, and zinc in the United States: U.S. Geological Survey Circular 1178, 21 p.
[9]Cunningham, C.G., et al., 2008, Quantitative mineral resource assessment of copper, molybdenum, gold, and silver in undiscovered porphyry copper deposits in the Andes Mountains of South America: U.S. Geological Survey Open-file Report 2008-1253, 282 p.

DIAMOND (INDUSTRIAL)

(Data in million carats unless otherwise noted)

Domestic Production and Use: In 2009, domestic production of industrial diamond was estimated to be approximately 260 million carats, and the United States was one of the world's leading markets. All domestic output was synthetic grit and powder. 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. The following industry sectors were the major consumers of industrial diamond: computer chip production, construction, machinery manufacturing, mining services (drilling for mineral, oil, and gas exploration), stone cutting and polishing, and transportation systems (infrastructure and vehicles). Stone cutting and highway building and repair consumed most of the industrial stone. About 98% 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:	2005	2006	2007	2008	2009[e]
Bort, grit, and dust and powder; natural and synthetic:					
Production:					
Manufactured diamond[e]	256	258	260	261	260
Secondary	4.6	34.2	34.4	33.9	33.9
Imports for consumption	284	371	411	492	229
Exports[1]	92	90	107	116	73.8
Sales from Government stockpile excesses	—	—	—	—	—
Consumption, apparent	453	573	598	670	449
Price, value of imports, dollars per carat	0.27	0.22	0.19	0.15	0.16
Net import reliance[2] as a percentage of apparent consumption	42	49	51	56	35
Stones, natural:					
Production:					
Mine	—	—	—	—	—
Secondary	0.53	0.56	0.38	0.36	0.36
Imports for consumption[3]	2.1	2.2	3.1	3.22	1.3
Exports[1]	([4])	([4])	—	([4])	—
Sales from Government stockpile excesses	—	([4])	([4])	0.47	—
Consumption, apparent	2.2	2.8	3.5	4.05	1.7
Price, value of imports, dollars per carat	13.91	12.61	11.54	12.89	12.18
Net import reliance[2] as a percentage of apparent consumption	77	80	89	91	78

Recycling: In 2009, the amount of diamond bort, grit, and dust and powder recycled was estimated to be 33.9 million carats. Lower prices of newly produced industrial diamond appear to be reducing the number and scale of diamond stone recycling operations. In 2009, it was estimated that 359,000 carats of diamond stone was recycled.

Import Sources (2005-08): Bort, grit, and dust and powder; natural and synthetic: China, 57%; Ireland, 24%; Russia, 6%; Republic of Korea, 5%; and other, 8%. Stones, primarily natural: Botswana, 39%; South Africa, 23%; Namibia, 12%; India, 7%; and other, 19%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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: National Defense Stockpile sales held during fiscal year 2008 depleted all remaining inventory of industrial diamond stone.

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DIAMOND (INDUSTRIAL)

Events, Trends, and Issues: China is 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. Owing to the negative impact of the economic recession on U.S. manufacturing sectors that utilize industrial diamond, imports in 2009 declined significantly compared with those of 2008. U.S. demand for industrial diamond is likely to continue in the construction sector as the United States continues building 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.

During 2009, work to further develop and improve the chemical vapor deposition (CVD) method of growing nearly 100%-pure diamond using microwave plasma technology continued and made this method of diamond synthesis more economical.

Demand for synthetic diamond grit and powder is expected to remain greater than 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:[5]

	Mine production		Reserves[6]
	2008	2009[e]	
United States	—	—	NA
Australia	15	14	95
Botswana	8	8	130
China	1	1	10
Congo (Kinshasa)	22	22	150
Russia	15	15	40
South Africa	8	8	70
Other countries	3	3	85
World total (rounded)	72	71	580

World Resources: Natural diamond resources have been discovered in more than 35 countries. Natural diamond accounts for about 12% of all industrial diamond used, while synthetic diamond accounts for the remainder. At least 15 countries have the technology to produce synthetic diamond.

Substitutes: Materials that can compete with industrial diamond in some applications include manufactured abrasives, such as cubic boron nitride, fused aluminum oxide, and silicon carbide. Synthetic diamond rather than natural diamond is used for about 88% 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]Less than ½ unit.
[5]Natural industrial diamond only. Note that synthetic diamond production far exceeds natural industrial diamond output. Worldwide production of manufactured industrial diamond totaled at least 4.55 billion carats in 2009; the leading producers included China, Ireland, Japan, Russia, South Africa, and the United States.
[6]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

DIATOMITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2009, domestic production of diatomite was estimated at 790,000 tons with an estimated processed value of $179 million, f.o.b. plant. Production took place at 7 diatomite-producing companies with 12 mining areas and 9 processing facilities in California, Nevada, Oregon, and Washington. Diatomite is frequently used in filter aids, 48%; cement additives, 33%; absorbents, 9%; fillers, 8%; insulation, 2%; and less than 1% for other applications, including specialized pharmaceutical and biomedical uses. The unit value of diatomite varied widely in 2009, from less than $9.00 per ton for cement manufacture to more than $3,500 per ton for limited specialty markets, including art supplies, cosmetics, and DNA extraction. The average unit value for filter-grade diatomite was $380 per ton.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production[1]	653	799	687	764	790
Imports for consumption	4	7	4	3	3
Exports	142	150	143	151	98
Consumption, apparent	515	656	548	616	692
Price, average value, dollars per ton, f.o.b. plant	274	220	237	224	228
Stocks, producer, yearend[e]	40	40	40	40	40
Employment, mine and plant, number[e]	1,000	1,020	1,020	1,020	1,020
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: None.

Import Sources (2005-08): Spain, 26%; Mexico, 23%; Italy, 19%; France, 16%; and other, 16%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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 in 2009 increased by about 3% compared with that of 2008. 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 ingredient in portland cement increased. 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: The reserves estimate for Czech Republic was revised based on information from the Czech Government.

	Mine production		Reserves[3]
	2008	2009[e]	
United States[1]	764	790	250,000
Chile	25	25	NA
China	440	450	110,000
Commonwealth of Independent States	80	80	NA
Costa Rica	26	26	NA
Czech Republic	20	20	4,100
Denmark[4] (processed)	230	240	NA
France	75	75	NA
Germany	54	54	NA
Iceland	28	28	NA
Italy	25	25	NA
Japan	115	120	NA
Mexico	83	87	NA
Peru	35	35	2,000
Spain	34	34	NA
Other countries	132	135	550,000
World total (rounded)	2,200	2,200	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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[4]Includes sales of moler production.

FELDSPAR

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: U.S. feldspar production in 2009 was valued at about $36 million. The three leading producers accounted for about 57% of the production, with five other companies supplying the remainder. Producing states were North Carolina, Virginia, California, Oklahoma, Idaho, Georgia, and South Dakota, in descending order of estimated tonnage. Feldspar processors reported coproduct recovery of mica and silica sand.

Feldspar is ground to about 20 mesh for glassmaking and to 200 mesh or finer for most ceramic and filler applications. It was estimated that feldspar shipments went to at least 30 States and to foreign destinations, including Canada and Mexico. In pottery and glass, feldspar functions as a flux. The estimated 2009 end-use distribution of domestic feldspar was glass, 70%, and pottery and other uses, 30%.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production, marketable[e]	750	760	730	680	530
Imports for consumption	26	5	4	2	2
Exports	15	10	10	15	4
Consumption, apparent[e]	761	755	724	667	528
Price, average value, marketable production, dollars per ton	57	59	59	60	65
Stocks, producer, yearend[1]	NA	NA	NA	NA	NA
Employment, mine, preparation plant, and office, number[e]	400	400	400	700	570
Net import reliance[2] as a percentage of apparent consumption	1	E	E	E	E

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

Import Sources (2005-08): Turkey, 54%; Mexico, 42%; and other, 4%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
Feldspar	2529.10.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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FELDSPAR

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. Residential and automotive flat glass have seen heavy recent declines as a result of declines in housing starts, a decrease in demand from commercial construction, and a slowdown in automobile sales. Fiberglass demand is forecast to expand steadily at 3.3% per year in the United States through 2013. Domestic feldspar consumption is moving away from ceramics toward glass markets, as indicated by a 5% increase of feldspars sold into the glass markets at the expense of ceramic feldspars sold.

Feldspar use in tile and porcelain pottery bodies used in sanitaryware declined concurrent with declines in the housing construction market. In September 2009, the adjusted annual rate for privately owned housing starts was 2.8% below the September 2008 rate, and U.S Census Bureau data also showed that housing completions were 39.6% below the September 2008 seasonally adjusted annual rate. Although this continued decrease in housing starts is significant, the large decrease in the percentage of finished houses may be an indication of shortages in capital for building materials and/or an explanation for the decreased demand of building supplies.

World Mine Production and Reserves: Estimates of reserves were revised for Czech Republic based on October 2008 Mineral Commodity Summaries of the Czech Republic; revisions for India were based on the Indian Minerals Yearbook.

	Mine production		Reserves[3]
	2008	2009[e]	
United States[e]	680	530	NA
Argentina	292	250	NA
Brazil	170	150	NA
China	2,000	2,000	NA
Czech Republic	510	420	30,000
Egypt	360	140	NA
France	650	550	NA
Germany	170	140	NA
India	400	340	38,000
Iran	300	250	NA
Italy	4,700	4,700	NA
Japan	700	600	NA
Korea, Republic of	400	340	NA
Malaysia	300	260	NA
Mexico	433	370	NA
Poland	440	370	NA
Portugal	372	320	11,000
Spain	675	580	NA
Thailand	678	580	NA
Turkey	6,500	5,000	NA
Venezuela	200	170	NA
Other countries	927	790	NA
World total (rounded)	21,900	18,900	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. There is ample geologic evidence that resources are large, although not always conveniently accessible to the principal centers of consumption.

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

[e]Estimated. E Net exporter. NA Not available.
[1]Change in stocks assumed to be zero for apparent consumption and net import reliance calculations.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

FLUORSPAR

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In Illinois, fluorspar was processed and 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, about 85% of reported fluorspar consumption went into the production of hydrofluoric acid (HF) in Louisiana and Texas. 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. The remaining 15% of the reported fluorspar consumption was 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. An estimated 55,000 tons of fluorosilicic acid (equivalent to about 97,000 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:	2005	2006	2007	2008	2009[e]
Production:					
Finished, all grades	—	—	—	NA	NA
Fluorspar equivalent from phosphate rock	86	70	94	111	97
Imports for consumption:					
Acid grade	586	490	577	496	420
Metallurgical grade	43	62	43	76	40
Total fluorspar imports	629	553	620	572	460
Fluorspar equivalent from hydrofluoric acid plus cryolite	209	233	233	209	160
Exports	36	13	14	19	12
Shipments from Government stockpile	28	66	17	—	—
Consumption:					
Apparent[1]	616	608	613	528	460
Reported	582	523	539	506	410
Price, average value, dollars per ton, c.i.f. U.S. port					
Acid grade	202	217	NA	NA	NA
Metallurgical grade	93	101	111	107	110
Stocks, yearend, consumer and dealer[2]	131	90	90	115	100
Employment, mine and mill, number	—	—	—	—	—
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 (2005-08): China, 52%; Mexico, 34%; South Africa, 9%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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: In September 2009, after a year's delay, Hastie Mining Co. and Moodie Mineral Co. received the long-awaited final permit that allowed them to begin work on the Klondike II fluorspar mine in Livingston County, KY. Development of the mine was expected to take 12 to 18 months before production could begin.[4]

By the middle of 2009, effects of the worldwide recession had negatively affected several fluorspar producers in Africa, which is one of the leading fluorspar exporting regions. Three fluorspar mining companies in Kenya, Namibia, and South Africa were forced to curtail mining operations and mothball their facilities because of the plummeting demand for their products. In recent years, these three companies accounted for about 330,000 tons per year of fluorspar export sales.

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FLUORSPAR

In June, the U.S. Trade Representative announced that the United States had requested World Trade Organization (WTO) dispute settlement consultations with China regarding China's export restraints on numerous important raw materials. The dispute concerned China's policy that provides substantial competitive advantages for the Chinese industries using these raw material inputs, including fluorspar. China is a leading global producer of fluorspar, which is an important mineral used in making numerous downstream products in the global aluminum, chemical, and steel industries. The European Union also requested formal WTO consultations with China on this matter.

Severely reduced demand for fluorspar resulted in a sharp decrease in Chinese acid-grade fluorspar prices of more than 30% compared with those of the fourth quarter of 2008. In September 2009, the published price (delivered to the United States) was in the range of $350 to $380 per metric ton.[5] Prices for low-arsenic acid-grade fluorspar from Mexico also decreased significantly. Prices for Mexican high-arsenic fluorspar were more stable owing to increased substitution for Chinese material. South African acid-grade prices stabilized because of better quality and reduced alternative supplies, as other African producers shut down.

As a result of accidental releases of HF at three U.S. petroleum refineries in Illinois, Pennsylvania, and Texas, the largest industrial union in North America called for the phaseout of HF used in petroleum alkylation units at refineries. The union planned to discuss alternatives to HF with the petroleum refining industry, and, if necessary, would work through the regulatory agencies and Congress to get the issue resolved. One-third of U.S. petroleum refineries use HF as an alkylation catalyst, while the other two-thirds use sulfuric acid, which is less dangerous because of its much lower vapor pressure. Petroleum alkylation accounts for about 15% of HF consumption in the United States.

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.

	Mine production		Reserves[6, 7]
	2008	2009[e]	
United States	NA	NA	NA
China	3,250	3,000	21,000
Kenya	98	45	2,000
Mexico	1,060	925	32,000
Mongolia	380	280	12,000
Morocco	61	40	NA
Namibia	[8]109	60	3,000
Russia	269	210	NA
South Africa	316	180	41,000
Spain	149	110	6,000
Other countries	350	250	110,000
World total (rounded)	6,040	5,100	230,000

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 1.0 billion tons, which at 3.5% fluorine would contain 35 million tons of fluorine, equivalent to about 72 million tons of fluorspar. World reserves of phosphate rock are estimated to be 18 billion tons, equivalent to 630 million tons of fluorine and 1.29 billion tons of fluorspar.

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. — Zero.
[1]Excludes 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]B. Moodie, Moodie Mineral Co., oral commun., August 31, 2009.
[5]Industrial Minerals, 2009, Prices: Industrial Minerals, no. 505, October, p. 84.
[6]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[7]Measured as 100% calcium fluoride.
[8]In previous years, data were in wet tons, but this quantity has been converted to dry tons to agree with other country data.

GALLIUM

(Data in kilograms of gallium content unless otherwise noted)

Domestic Production and Use: No domestic primary gallium recovery was reported in 2009. One company in Utah recovered and refined gallium from scrap and impure gallium metal, and one company in Oklahoma refined gallium from impure metal. Imports of gallium, which supplied most of U.S. gallium consumption, were valued at about $14 million. Gallium arsenide (GaAs) and gallium nitride (GaN) electronic components represented about 98% of domestic gallium consumption. About 67% of the gallium consumed was used in integrated circuits (ICs). Optoelectronic devices, which include laser diodes, light-emitting diodes (LEDs), photodetectors, and solar cells, represented 31% of gallium demand. The remaining 2% was used in research and development, specialty alloys, and other applications. Optoelectronic devices were used in areas such as aerospace, consumer goods, industrial equipment, medical equipment, and telecommunications. ICs were used in defense applications, high-performance computers, and telecommunications.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production, primary	—	—	—	—	—
Imports for consumption	15,800	26,900	37,100	41,100	29,000
Exports	NA	NA	NA	NA	NA
Consumption, apparent[1]	18,700	20,300	25,100	28,700	20,000
Price, yearend, dollars per kilogram, 99.99999%-pure[2]	538	443	530	579	480
Stocks, consumer, yearend	1,800	1,890	6,010	3,820	4,000
Employment, refinery, number	20	20	20	20	20
Net import reliance[3] as a percentage of reported consumption	99	99	99	99	99

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

Import Sources (2005-08): Germany, 24%; Canada, 20%; China, 16%; Ukraine, 12%; and other, 28%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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. The global economic slowdown weakened demand for gallium in 2009 and allowed existing stocks of unsold gallium to exert downward pressure on prices. Prices for low-grade (99.99%-pure) gallium decreased in Asia and Europe in the first half of 2009, from between $520 and $580 per kilogram at the beginning of the year to between $360 and $450 per kilogram by midyear. Prices in the United States decreased to between $450 and $500 per kilogram.

Several records for solar cell efficiency were achieved in 2009. One company set a world record for terrestrial concentrator solar cell efficiency with a photovoltaic device that converts greater than 41% of the light that hits it into electricity. The solar cell incorporated improvements in wafer processing that raised the cell's overall efficiency. Additionally, another company achieved a record 15.45% efficiency for its copper indium gallium diselenide (CIGS) thin film solar cell. The company's CIGS material utilizes a flexible substrate that allows it to be lightweight, flexible, and durable, unlike traditional solar panels which tend to be heavy, rigid, and fragile. Both solar cell efficiency records were verified by the U.S. Department of Energy's National Renewable Energy Laboratory.

Scientists at Massachusetts Institute of Technology (MIT) successfully integrated GaN with silicon to create a hybrid microchip that is expected to be smaller, faster, and more efficient than current silicon-based microprocessors. The MIT scientists anticipate the new integration process will enable circuit and system designers to uncompromisingly choose the best semiconductor material for each device in the microchip.

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GALLIUM

A Canadian-based firm that previously had completed an independent gallium resource estimate on a property in Humboldt County, NV, announced at the end of 2008 that it had suspended preparation of a preliminary feasibility study owing to turmoil in the global economy and the uncertainty of near-term gallium prices.

Market conditions deteriorated for GaAs-based products in 2009. GaAs demand, while still being driven mainly by high-speed, feature-rich, third-generation, cellular handsets and other high-speed wireless applications, was expected to decrease by 5% in 2009. Analysts estimated that the GaAs market will generate revenues of $3.5 billion in 2009.

Analysts estimated that the high-brightness LED market would decrease by 3.7% in 2009 as a result of the global economic downturn that began late in 2008. However, not all LED markets were being affected equally. Mature LED market segments including automotive lighting, mobile phones, and outdoor video screens were decreasing, while emerging LED market segments, such as backlights for liquid crystal displays in televisions and notebook computers, were still showing growth. The market for high-brightness LEDs reached $5.1 billion in 2008 and was expected to decrease to $4.9 billion in 2009.

World Production and Reserves:[4] In 2009, world primary production was estimated to be 78 metric tons, 30% lower than the revised 2008 world primary production of 111 tons. China, Germany, Kazakhstan, and Ukraine were the leading producers; countries with smaller output were Hungary, Japan, Russia, and Slovakia. Refined gallium production was estimated to be about 118 tons; this figure includes some scrap refining. China, Japan, and the United States were the principal producers of refined gallium. Gallium was recycled from new scrap in Germany, Japan, the United Kingdom, and the United States. World primary gallium production capacity in 2009 was estimated to be 184 tons; refinery capacity, 167 tons; and recycling capacity, 78 tons.

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

World Resources: Assuming that the average content of gallium in bauxite is 50 parts per million (ppm), U.S. bauxite resources, which are mainly subeconomic deposits, contain approximately 15 million kilograms of gallium. About 2 million kilograms of this metal is present in the bauxite deposits in Arkansas. Some domestic zinc ores contain as much as 50 ppm gallium and, as such, could be a significant resource. World resources of gallium in bauxite are estimated to exceed 1 billion kilograms, and a considerable quantity could be present in world zinc reserves. The foregoing estimates apply to total gallium content; only a small percentage of this metal in bauxite and zinc ores is economically recoverable.

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

[e]Estimated. NA Not available. — Zero.
[1]Reported consumption was utilized for apparent consumption for the years 1970 to the most recent.
[2]Estimated based on the average values of U.S. imports for 99.9999%- and 99.99999%-pure gallium.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

GARNET (INDUSTRIAL)[1]

(Data in metric tons of garnet unless otherwise noted)

Domestic Production and Use: Garnet for industrial use was mined in 2009 by four firms—one in Idaho, one in Montana, and two in New York. The estimated value of crude garnet production was about $8.85 million, while refined material sold or used had an estimated value of $7.96 million. Major end uses for garnet were waterjet cutting, 35%; abrasive blasting media, 30%; water filtration, 15%; abrasive powders, 10%; and other end uses, 10%.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production (crude)	40,100	34,100	61,400	62,900	56,500
Sold by producers	23,100	16,800	20,700	49,800	28,000
Imports for consumption[e]	41,800	50,800	52,300	49,200	41,100
Exports[e]	13,400	13,300	12,000	12,500	8,140
Consumption, apparent[e, 2]	68,600	71,600	102,000	99,700	89,500
Price, range of value, dollars per ton[3]	50-2,000	50-2,000	50-2,000	50-2,000	50-2,000
Stocks, producer	NA	NA	NA	NA	NA
Employment, mine and mill, number[e]	160	160	160	160	160
Net import reliance[4] as a percentage of apparent consumption	41	52	40	37	37

Recycling: Small amounts of garnet reportedly are recycled.

Import Sources (2005-08):[e] India, 35%; Australia, 35%; China, 19%; Canada, 10%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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 2009, domestic U.S. production of crude garnet concentrates decreased by about 10% compared with the production of 2008. U.S. garnet consumption also decreased by 10% compared with that of 2008. In 2009, imports were estimated to have decreased 16% compared with those of 2008, and exports were estimated to have decreased 35% from those of 2008. The 2009 estimated domestic sales of garnet decreased about 44% compared with sales of 2008. In 2009, the United States remained a net importer. Garnet imports have supplemented U.S. production in the domestic market, with Australia, Canada, China, and India being major garnet suppliers.

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

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

	Mine production		Reserves[5]
	2008	2009[e]	
United States	62,900	56,500	5,000,000
Australia	160,000	160,000	1,000,000
China	400,000	450,000	Moderate to Large
India	650,000	700,000	6,500,000
Other countries	35,500	36,000	6,500,000
World total (rounded)	1,310,000	1,400,000	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 as 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, 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 Canada, Chile, Czech Republic, Pakistan, South Africa, Spain, Thailand, and Ukraine; small mining operations have been reported in most of these countries.

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

[e]Estimated. NA Not available.
[1]Excludes gem and synthetic garnet.
[2]Defined as crude production – exports + imports.
[3]Includes both crude and refined garnet; most crude concentrate is $50 to $120 per ton, and most refined material is $150 to $450 per ton.
[4]Defined as imports – exports.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

GEMSTONES[1]

(Data in million dollars unless otherwise noted)

Domestic Production and Use: The combined value of U.S. natural and synthetic gemstone output decreased by 11% in 2009 from that of 2008. The natural gemstone production value decreased slightly from that of 2008, while synthetic gemstone production decreased 33% over the same period. Domestic gemstone production included agate, beryl, coral, garnet, jade, jasper, opal, pearl, quartz, sapphire, shell, topaz, tourmaline, turquoise, and many other gem materials. In decreasing order, Tennessee, Oregon, Arizona, Utah, California, North Carolina, Idaho, Arkansas, Colorado, Alabama, and Montana produced 86% of U.S. natural gemstones. The production value of laboratory-created (synthetic) gemstones decreased 33% from that of the previous year. This drop in production resulted from a large decrease in Moissanite production value. Laboratory-created gemstones were manufactured by five firms in Florida, New York, North Carolina, Massachusetts, and Arizona, in decreasing order of production. Major gemstone uses were carvings, gem and mineral collections, and jewelry.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production:[2]					
Natural[3]	13.4	11.3	11.9	11.5	11.2
Laboratory-created (synthetic)	51.1	52.1	73.5	51.4	34.3
Imports for consumption	17,200	18,300	20,100	20,900	14,500
Exports, including reexports[4]	8,850	9,930	12,300	15,300	9,950
Consumption, apparent	8,410	8,430	7,880	5,670	4,610
Price	Variable, depending on size, type, and quality				
Employment, mine, number[e]	1,200	1,200	1,200	1,200	1,200
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 (2005-08 by value): Israel, 48%; India, 20%; Belgium, 15%; South Africa, 5%; and other, 12%. Diamond imports accounted for 95% of the total value of gem imports.

Tariff:

Item	Number	Normal Trade Relations 12-31-09
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: The National Defense Stockpile (NDS) does not contain an inventory of gemstones. However, a very small portion of the industrial diamond stone inventory is of near-gem quality. Additionally, the beryl and quartz crystal inventories contain some gem-quality material that could be used by the gem industry. The U.S. Department of Defense is currently selling some NDS materials that may be near-gem quality.

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GEMSTONES

Events, Trends, and Issues: In 2009, the U.S. market for unset gem-quality diamonds was estimated to have exceeded $13.7 billion, accounting for more than an estimated 35% of world demand. This was a decrease of about 30% compared with that of 2008. The domestic market for natural, unset nondiamond gemstones was estimated to be about $787 million, which was a decrease of 32% from that of 2008. These decreases in the U.S. gemstone markets are a reflection of the impact of the global recession on luxury spending. The United States is expected to continue dominating global gemstone consumption.

Canadian diamond production decreased in 2009 to about 12 million carats. Diamond exploration also continued in Canada, and many new deposits have been found. Canada produced more than 13% of the world's natural gemstone diamonds in 2009. The success of the Canadian gem diamond industry has stimulated interest in domestic exploration for commercial diamond deposits; however, at present, there are no operating commercial diamond mines in the United States.

World Gem Diamond Mine Production[6] and Reserves:

	Mine production 2008	Mine production 2009[e]
Angola	8,100	8,000
Australia	273	260
Botswana	25,000	32,000
Brazil	200	200
Canada	14,800	12,000
Central African Republic	400	350
China	100	100
Congo (Kinshasa)	5,400	5,400
Côte d'Ivoire	210	—
Ghana	520	500
Guinea	2,500	2,000
Guyana	269	269
Namibia	1,500	2,000
Russia	21,900	21,900
Sierra Leone	220	300
South Africa	5,200	5,200
Tanzania	190	190
Other countries[9]	218	218
World total (rounded)	87,000	90,900

Reserves[7]

World reserves of diamond-bearing deposits are substantial. No reserves data are available for other gemstones.

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. — Zero.
[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 about 78% of the totals.
[5]Defined as imports – exports and reexports + adjustments for Government and industry stock changes.
[6]Data in thousands of carats of gem diamond.
[7]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[8]In addition to countries listed, Gabon, India, Indonesia, Liberia, and Venezuela are known to produce gem diamonds.

GERMANIUM

(Data in kilograms of germanium content unless otherwise noted)

Domestic Production and Use: Germanium production in the United States comes from either the refining of imported germanium compounds or industry-generated scrap. Germanium for domestic consumption also was obtained from materials imported in chemical form and either directly consumed or consumed in the production of other germanium compounds. Germanium was recovered from zinc concentrates produced at two domestic zinc mines, one in Alaska and the other in Washington. These concentrates were exported to Canada for processing. The mine in Washington was placed on temporary care-and-maintenance status in February. Another mine complex, in Tennessee, which had begun producing germanium-rich zinc concentrates in early 2008, was closed in October 2008 owing to declining market conditions. No germanium was recovered from these concentrates before the complex was shuttered. The latter complex was subsequently acquired by a leading zinc producer in May 2009.

A germanium refinery in Utica, NY, produced germanium tetrachloride for optical fiber production. Another refinery in Oklahoma produced refined germanium compounds for the production of fiber optics, infrared devices, and substrates for electronic devices. The major end uses for germanium, worldwide, were estimated to be fiber-optic systems, 30%; infrared optics, 25%; polymerization catalysts, 25%; electronics and solar electric applications, 15%; and other (phosphors, metallurgy, and chemotherapy), 5%. Domestically, these end uses varied and were estimated to be infrared optics, 50%; fiber-optic systems, 30%; electronics and solar electric applications, 15%; and other (phosphors, metallurgy, and chemotherapy), 5%. Germanium is not used in polymerization catalysts in the United States. The estimated value of germanium metal consumed in 2009, based upon the annual average U.S. producer price, was about $52.7 million.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production, refinery[e]	4,500	4,600	4,600	4,600	4,600
Total imports[1]	23,500	50,000	52,400	67,600	55,000
Total exports[1]	10,100	12,400	11,700	17,900	13,900
Shipments from Government stockpile excesses	4,510	4,580	6,900	102	100
Consumption, estimated	27,000	55,000	60,000	54,000	46,000
Price, producer, yearend, dollars per kilogram:					
Zone refined	660	950	1,240	1,490	950
Dioxide, electronic grade	405	660	800	960	580
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant[2] number[e]	65	65	65	70	70
Net import reliance[3] as a percentage of estimated consumption	65	85	80	90	90

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

Import Sources (2005-08):[4] Belgium, 46%; China, 24%; Germany, 13%; Russia, 13%; and other, 4%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
Germanium oxides	2825.60.0000	3.7% ad val.
Metal, unwrought	8112.92.6000	2.6% ad val.
Metal, powder	8112.92.6500	4.4% ad val.
Metal, wrought	8112.99.1000	4.4% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: The Defense National Stockpile Center (DNSC) continued the Basic Ordering Agreement sales program for germanium using monthly postings on the DNSC Web site. The disposal limit in the fiscal year 2009 Annual Materials Plan was unchanged from that of fiscal year 2008.

Stockpile Status—9-30-09[5]

Material	**Uncommitted inventory**	**Authorized for disposal**	**Disposal plan FY 2009**	**Disposals FY 2009**
Germanium	16,365	16,365	8,000	170

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GERMANIUM

Events, Trends, and Issues: The global market for germanium metal and germanium dioxide generally weakened through the first 10 months of the year. The estimated market price of germanium metal (99.99%) in late September was $950 per kilogram, a 33% decline from that of January, when it was about $1,425 per kilogram. Germanium dioxide prices also declined during the year and as of late September, germanium dioxide was selling for about $580 per kilogram. Slumping demand for germanium appeared to be a product of the overall downturn in the global economy in 2009. Throughout much of the year, many Chinese suppliers, accounting for the majority of the germanium produced globally, held an excess supply of material as the market continued to decline, in anticipation of an eventual turnaround, instead of selling at reduced prices. As a result of the falling prices, some consumers became hesitant to place large orders, expecting that cheaper material would be available in the future. Demand for germanium dioxide from polyethylene terephthalate manufacturers, used primarily to make plastic beverage containers in Asia, declined from that of the previous year. Consumption of germanium tetrachloride through the first half of the year declined as well when compared with the same time period in 2008 owing to reduced demand for fiber-optic cable. In May, the Yunnan Province in China announced that it would attempt to reinvigorate the Chinese germanium market by stockpiling 8 metric tons of germanium ingots. Domestically, demand for germanium was fairly stable owing to the continued use of germanium lenses and window blanks by the military for various infrared applications. Ongoing military engagements have led to increased spending on thermal weapon sights and related thermal imaging technology over the past several years.

In most satellite applications, germanium substrates continued to be favored for use in photovoltaic solar cells, and the development of terrestrial-based applications was ongoing. In August, a leading manufacturer of solar cells announced that it had manufactured a multijunction solar cell with a germanium substrate that set a new world record for terrestrial concentrator solar cell efficiency, converting 41.6% of sunlight into electricity. A high-efficiency solar cell such as this would potentially allow energy producers to generate more electrical power from typical industrial solar panels and pass on lower costs to consumers. Another producer reported that sales of germanium substrates through the first half of 2009 were greater than those in the corresponding period of 2008 owing to their increased use in high-brightness, light-emitting diodes for backlighting liquid crystal display screens and in vehicle headlights.

A company from the United Kingdom that developed a tarnish-resistant silver alloy containing germanium in the early 1990s called Argentium continued to market the material to jewelry manufacturers. Several jewelry manufacturers in Asia and Europe began incorporating Argentium silver into their collections during the past 2 years.

World Refinery Production and Reserves:

	Refinery production[e]		Reserves[6]
	2008	2009	
United States	4,600	4,600	450,000
China	100,000	100,000	NA
Russia	5,000	5,000	NA
Other countries	30,000	30,000	NA
World total	140,000	140,000	NA

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

Substitutes: Silicon can be a less-expensive substitute for germanium in certain electronic applications. Although some metallic compounds that contain gallium, indium, selenium, and tellurium can be substituted for germanium, germanium is more reliable than these materials in many high-frequency electronics applications and is a more economical substrate for 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 for germanium as a polymerization catalyst.

[e]Estimated. NA Not available.
[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 dioxide metal content. 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; metal content but does not include germanium tetrachloride and other germanium compounds for which data are not available.
[5]See Appendix B for definitions.
[6]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

GOLD

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

Domestic Production and Use: Gold was produced at about 50 lode mines, a few large placer mines (all in Alaska), and numerous smaller placer mines (mostly in Alaska and in the Western States). In addition, a small amount of domestic gold was recovered as a byproduct of processing base metals, chiefly copper. Thirty operations yielded more than 99% of the gold produced in the United States. In 2009, the value of mine production was about $6.4 billion. Commercial-grade refined gold came from about 2 dozen producers. A few dozen companies, out of several thousand companies and artisans, dominated the fabrication of gold into commercial products. U.S. jewelry manufacturing was heavily concentrated in New York, NY, and Providence, RI; areas with lesser concentrations include California, Florida, and Texas. Estimated uses were jewelry and arts, 72%; electrical and electronics, 7%; dental and other, 21%.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production:					
Mine	256	252	238	233	210
Refinery:					
Primary	195	181	176	168	170
Secondary (new and old scrap)	81	89	135	181	190
Imports[2]	341	263	170	231	340
Exports[2]	324	389	519	568	385
Consumption, reported	183	185	180	176	170
Stocks, yearend, Treasury[3]	8,140	8,140	8,140	8,140	8,140
Price, dollars per ounce[4]	446	606	699	*874	950
Employment, mine and mill, number[5]	7,910	8,350	9,130	9,560	9,600
Net import reliance[6] as a percentage of apparent consumption	E	E	E	E	E

Recycling: In 2009, 190 tons of new and old scrap was recycled, more than the reported consumption.

Import Sources (2005-08):[2] Canada, 30%; Peru, 29%; Mexico, 16%; Chile, 9%; and other, 16%.

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

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

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

Events, Trends, and Issues: Domestic gold mine production in 2009 was estimated to be 10% less than the level of 2008. Reduced production from several mines in Nevada, and the closure of one mine in Montana and one in Nevada, accounted for much of the decrease. These decreases were partially offset by increases in production from one new mine in Washington and increases from several mines Nevada. Because of the decrease in production, the United States fell to the fourth leading gold-producing nation; however, the United States was still a net exporter of gold.

Continued power generation problems, coupled with continuing labor problems in South Africa, caused several mines to continue to produce at reduced production levels. Australian gold producers have increased production because of new operations and increased production from several older mines. Production in Indonesia recovered from the low level in 2008 owing to increased ore grade. China has increased gold production again and remained the leading gold-producing nation, followed by Australia, South Africa, and the United States.

Jewelry consumption continued to drop as the price of gold continued to increase. The estimated price in 2009 was 24% higher than the price in 2008. In 2009, Engelhard Corp.'s daily price of gold ranged from a low of $812.30 per troy ounce on January 15 to an alltime high of $1,215.21 per troy ounce in early December.

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GOLD

With the increase in price of gold and the worldwide economic slowdown, investment in gold has increased, with investors seeking safe haven investments. Gold Exchange-Traded Funds (ETFs) have gained popularity with investors. According to some industry analysts, investing in gold in the traditional manner is not as accessible and carries higher costs owing to insurance, storage, and higher markups. The claimed advantage of the ETF is that the investor can purchase gold ETF shares through a stockbroker without being concerned about these problems. Each share represents one-tenth of an ounce of allocated gold. Demand for physical gold was also very high. There were local shortages of gold coins weighing 1 ounce or less.

World Mine Production and Reserves: Reserves estimates for Australia, Canada, China, and Papua New Guinea were revised based on new information derived from government and industry reports.

	Mine production		Reserves[7]
	2008	2009[e]	
United States	233	210	3,000
Australia	215	220	5,800
Brazil	50	50	2,000
Canada	95	100	1,000
Chile	39	40	2,000
China	285	300	1,900
Ghana	75	85	1,600
Indonesia	60	100	3,000
Mexico	50	55	1,400
Papua New Guinea	62	65	1,200
Peru	180	180	1,400
Russia	176	185	5,000
South Africa	213	210	6,000
Uzbekistan	85	85	1,700
Other countries	446	460	10,000
World total (rounded)	2,260	2,350	47,000

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

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

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

a. Waste and scrap.
b. Official monetary gold.
c. Gold in fabricated items.
d. Gold in coins. In 1991, the last year for which estimates are available, net imports amounted to 3.5 tons.
e. Net bullion flow (in tons) to market from foreign stocks at the New York Federal Reserve Bank: 0 (2005), 0 (2006), 189 (2007), 220 (2008), and 300 (2009 estimate).

[3]Includes gold in Exchange Stabilization Fund. Stocks were valued at the official price of $42.22 per troy ounce.
[4]Engelhard Corporation's average gold price quotation for the year. In 2009, price was estimated by the USGS based on the first 9 months of data.
[5]Data from Mine Safety and Health Administration.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[8]U.S. Geological Survey National Mineral Resource Assessment Team, 2000, 1998 assessment of undiscovered deposits of gold, silver, copper, lead, and zinc in the United States: U.S. Geological Survey Circular 1178, 21 p.
*Correction posted on June 30, 2010.

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 2009, approximately 100 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 2009 were refractory applications, 24%; foundry operations, 8%; brake linings, 7%; lubricants, 3%; and other applications, 58%.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production, mine	—	—	—	—	—
Imports for consumption	65	53	59	58	21
Exports	22	22	16	8	8
Consumption, apparent[1]	43	30	43	50	13
Price, imports (average dollars per ton at foreign ports):					
Flake	512	528	499	753	866
Lump and chip (Sri Lankan)	2,550	2,320	2,219	2,550	2,580
Amorphous	170	188	150	203	256
Stocks, yearend	NA	NA	NA	NA	NA
Net import reliance[2] as a percentage of apparent consumption	100	100	100	100	100

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

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

Import Sources (2005-08): China, 47%; Mexico, 24%; Canada, 19%; Brazil, 5%; and other, 5%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
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 was very weak during the last quarter of 2008 and in 2009, owing to the global recession's impact on the industrial sectors that use it. Leading sources for graphite imports were: flake graphite from China, Brazil, Madagascar, Canada, Germany, and Japan (in descending order of tonnage), graphite lump and chip from Sri Lanka; and amorphous graphite from Mexico. China produced the majority of the world's graphite from deposits clustered in the Shandong and Heilongjiang producing regions, and China's graphite production is expected to continue growing as producers there collaborate with western graphite producers. In the past few years, Canada has had a number of new graphite mines begin production, and this trend is expected to continue through the next few years. 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), probably will be the fastest growing market. Large-scale fuel-cell applications are being developed that could consume as much graphite as all other uses combined.

World Mine Production and Reserves:

	Mine production		Reserves[3]
	2008	2009[e]	
United States	—	—	—
Brazil	77	77	360
Canada	27	27	([4])
China	810	800	55,000
Czech Republic	3	3	1,300
India	140	140	5,200
Korea, North	30	30	([4])
Madagascar	5	5	940
Mexico	10	10	3,100
Norway	2	15	([4])
Sri Lanka	3	7	([4])
Ukraine	8	8	([4])
Other countries	5	5	5,100
World total (rounded)	1,120	1,130	71,000

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.

eEstimated. NA Not available. — Zero.
[1]Defined as imports – exports.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[4]Included with "Other countries."

GYPSUM

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2009, domestic production of crude gypsum was estimated to be 9.4 million tons with a value of about $79.9 million. The leading crude gypsum-producing States were, in descending order, Nevada, Iowa, California, Oklahoma, Texas, Arkansas, New Mexico, Indiana, and Michigan, which together accounted for 79% of total output. Overall, 46 companies produced gypsum in the United States at 55 mines in 18 States, and 9 companies calcined gypsum at 57 plants in 29 States. Approximately 88% of domestic consumption, which totaled approximately 21 million tons, was accounted for by manufacturers of wallboard and plaster products. Approximately 2 million tons for cement production, 1 million tons for agricultural applications, and small amounts of high-purity gypsum for a wide range of industrial processes accounted for the remaining tonnage. At the beginning of 2009, the production capacity of operating wallboard plants in the United States was about 26.8 billion square feet[1] per year.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production:					
Crude	21,100	21,100	17,900	14,400	9,400
Synthetic[2]	8,690	9,290	8,500	7,740	7,700
Calcined[3]	21,000	26,100	16,700	18,000	14,000
Wallboard products sold (million square feet[1])	28,700	35,000	27,800	20,700	18,500
Imports, crude, including anhydrite	11,200	11,400	9,400	7,300	4,200
Exports, crude, not ground or calcined	148	143	147	149	120
Consumption, apparent[4]	40,800	41,600	35,700	29,300	21,000
Price:					
Average crude, f.o.b. mine, dollars per metric ton	7.48	8.83	7.50	8.70	8.50
Average calcined, f.o.b. plant, dollars per metric ton	37.18	41.79	38.30	42.64	40.00
Employment, mine and calcining plant, number[e]	5,900	5,900	6,000	5,400	4,500
Net import reliance[5] as a percentage of apparent consumption	27	27	26	24	19

Recycling: Some of the more than 4 million tons of gypsum waste 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 (2005-08): Canada, 67%; Mexico, 25%; Spain, 7%; and other, 1%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
Gypsum; anhydrite	2520.10.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: U.S. gypsum production declined as the housing and construction markets continued to falter, with apparent consumption decreasing by about 28%. China produced more than three times the annual amount of the United States, the world's second ranked producer. Iran ranks third in world production and supplies much of the gypsum needed for construction in the Middle East. Spain, the leading European producer, ranked fourth in the world, and supplies both crude gypsum and gypsum products to much of Western Europe. An increased use of wallboard in Asia, coupled with new gypsum product plants, heightened production in that region. As more cultures recognize the economics and efficiency of wallboard, 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 the gypsum consumed is used for building plasters, the manufacture of portland cement, and wallboard products. The construction of wallboard plants designed to use synthetic gypsum as feedstock will result in less use of natural gypsum as these new plants become operational. Imports decreased by approximately 42%. Exports, although very low compared with imports, decreased by 19%.

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GYPSUM

In 2009, more than 2,000 homeowner complaints were filed with the U.S. Consumer Product Safety Commission regarding reports of corrosive drywall. The problematic drywall, which is suspected of causing health ailments and the corrosion of metal components within an affected home, is thought to have been imported from China in 2006 and 2007. According to the U.S. International Trade Commission, more than 600 metric tons of Chinese drywall was imported into the United States in 2009, which represented less than 1% of total 2009 imports.

World Mine Production and Reserves:

	Mine production		Reserves[6]
	2008	2009[e]	
United States	14,400	9,400	700,000
Algeria	1,670	1,700	
Argentina	1,200	1,200	
Australia	4,000	4,000	
Austria	1,000	1,000	
Brazil	2,100	2,100	1,300,000
Canada	5,740	5,500	450,000
China	46,000	42,000	
Egypt	2,000	2,000	
France	4,800	4,800	
Germany	1,900	1,900	
India	2,550	2,600	
Iran	12,000	12,000	
Italy	5,400	5,400	Reserves are large in major producing countries, but data for most are not available.
Japan	5,800	5,800	
Mexico	5,140	4,500	
Poland	1,580	1,300	
Russia	2,300	2,300	
Saudi Arabia	2,300	2,300	
Spain	11,500	11,500	
Thailand	8,000	8,000	
Turkey	3,000	3,000	
United Kingdom	1,700	1,700	
Other countries	12,700	16,000	
World total (rounded)	159,000	152,000	Large

World Resources: 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; 86 countries produce gypsum.

Substitutes: In such applications as stucco and plaster, cement and lime may be substituted; 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 2009, synthetic gypsum accounted for 57% of the total domestic gypsum supply.

[e]Estimated.

[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.

[2]Data refer to the amount sold or used, not produced.

[3]From domestic crude.

[4]Defined as crude + total synthetic reported used + imports – exports.

[5]Defined as imports – exports.

[6]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

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 2009 by private industry was about $640 million. Ten plants (six in Kansas and four in Texas) extracted helium from natural gas and produced only a crude helium product that varied from 50% to 80% helium. Ten plants (four in Kansas, and one each in Colorado, New Mexico, Oklahoma, Texas, Utah, and Wyoming) extracted helium from natural gas and produced an intermediate process stream of crude helium (about 70% helium and 30% nitrogen) and continued processing the stream to produce a Grade-A helium product. Of these 10 plants, 6 (4 in Kansas, 1 in Oklahoma, and 1 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 2009 domestic consumption of 52.1 million cubic meters (1.88 billion cubic feet) was used for cryogenic applications, 32%; for pressurizing and purging, 18%; for welding cover gas, 13%; for controlled atmospheres, 18%; leak detection, 4%; breathing mixtures, 2%; and other, 13%.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Helium extracted from natural gas[2]	76	79	77	80	80
Withdrawn from storage[3]	57	58	61	50	42
Grade-A helium sales	133	137	138	130	122
Imports for consumption	—	—	—	—	—
Exports[4]	51.4	61.9	64.2	69.9	69.4
Consumption, apparent[4]	81.6	75.1	73.8	60.1	52.6
Net import reliance[5] as a percentage of apparent consumption	E	E	E	E	E

Price: The Government price for crude helium was $2.25 per cubic meter ($62.25 per thousand cubic feet) in fiscal year (FY) 2009. 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 $4.51 to $5.23 per cubic meter ($125 to $145 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 (2005-08): None.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
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 2009, privately owned companies purchased about 4.9 million cubic meters (176 million cubic feet) of in-kind crude helium. In addition to this, privately owned companies also purchased 26.1 million cubic meters (940 million cubic feet) of open market sales helium. During FY 2009, the BLM's Amarillo Field Office, Helium Operations (AMFO), accepted about 17.3 million cubic meters (625 million cubic feet) of private helium for storage and redelivered nearly 59.4 million cubic meters (2,140 million cubic feet). As of September 30, 2009, about 18.6 million cubic meters (670 million cubic feet) of privately owned helium remained in storage at Cliffside Field.

Stockpile Status—9-30-09[6]

Material	**Uncommitted inventory**	**Authorized for disposal**	**Disposal plan FY 2009**	**Disposals FY 2009**
Helium	510.8	510.8	63.8	31.0

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HELIUM

Events, Trends, and Issues: During 2009, most helium suppliers announced price increases of 20% to 30% in response to continued increased raw material, energy, and distribution costs. Some companies increased high-pressure cylinder rental charges, and others continued cost-recovery efforts through various charges and surcharges. The price of pure helium is expected to continue to increase as production costs, including the price of crude helium, increase and helium reserves are depleted. Owing to continued depressed economic conditions, helium consumption declined in 2009 by about 6% compared with that of 2008 and was expected to decline again in 2010. During FY 2009, the AMFO conducted four open market helium offerings, selling a total of 26.1 million cubic meters (940 million cubic feet). The Skikda, Algeria, helium plant experienced some of the same operational problems that hindered production from 2006 through 2008. The Qatar helium plant produced helium without major operational problems and was thought to produce at higher rates in 2009 than 2008. During the year, one new crude helium plant was brought online in the Otis, KS, area. Worldwide, nine new helium plant projects are scheduled for startup sometime between 2009 and 2015. Two projects are scheduled for startup in the United States during 2011-12 near Riley Ridge, WY, and St. Johns, AZ. The other plants are planned for Algeria, Australia, China, India, Indonesia, Qatar, and Russia.

World Production and Reserves: Reserves data were revised based on estimated production for 2009 and new information available from the Government of Poland.

	Production		Reserves[9]
	2008	2009[e]	
United States (extracted from natural gas)	80	80	4,000
United States (from Cliffside Field)	50	42	([10])
Algeria	22.3	24	1,800
Canada	NA	NA	NA
China	NA	NA	NA
Poland	2.6	2.5	34
Qatar	12.7	15	NA
Russia	6.9	7.0	1,700
Other countries	NA	NA	NA
World total (rounded)	175	170	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, and Cliffside Fields are the depleting fields from which most U.S.-produced helium is extracted. These fields contain an estimated 2.7 billion cubic meters (96 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, 2009, 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]Helium from both Grade-A and crude helium.
[3]Extracted from natural gas in prior years.
[4]Grade-A helium.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]See Appendix B for definitions.
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[9]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[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 2009. Indium-containing zinc concentrates produced in Alaska were exported to Canada for processing. Two companies, one in New York and the other in Rhode Island, produced indium metal and indium products by upgrading lower grade imported indium metal. High-purity indium shapes, alloys, and compounds were also produced from imported indium by several additional firms. Production of indium tin oxide (ITO) continued to be the leading end use of indium and accounted for most global indium consumption. ITO thin-film coatings were primarily used for electrically conductive purposes in a variety of flat-panel devices—most commonly liquid crystal displays (LCDs). Other end uses included solders and alloys, compounds, electrical components and semiconductors, and research. The estimated value of primary indium metal consumed in 2009, based upon the annual average U.S. producer price, was about $60 million.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production, refinery	—	—	—	—	—
Imports for consumption[1]	142	100	147	144	95
Exports	NA	NA	NA	NA	NA
Consumption, estimated	115	125	125	130	120
Price, average annual, dollars per kilogram					
U.S. producer[2]	946	918	795	685	500
New York dealer[3]	961	815	637	519	390
Stocks, producer, yearend	NA	NA	NA	NA	NA
Net import reliance[4] as a percentage of estimated consumption	100	100	100	100	100

Recycling: Data on the quantity of secondary indium recovered from scrap were not available. Indium is most commonly recovered from ITO. Sputtering, the process in which ITO is deposited as a thin-film coating onto a substrate, is highly inefficient; approximately 30% of an ITO target material is deposited onto the substrate. The remaining 70% consists of the spent ITO target material, the grinding sludge, and the after-processing residue left on the walls of the sputtering chamber. It was estimated that 60% to 65% of the indium in new ITO target material will be recovered, and research was underway to improve this rate further. ITO recycling is concentrated in China, Japan, and the Republic of Korea—the countries where ITO production and sputtering take place.

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

Import Sources (2005-08):[1] China, 40%; Japan, 19%; Canada, 18%; Belgium, 7%; and other, 16%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Unwrought indium, including powders	8112.92.3000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: The U.S. producer price for indium remained at $500 per kilogram from the start of 2009 through mid-October. The New York dealer price range for indium began the year at $350 to $400 per kilogram, decreased steadily until mid-July, reaching a low of $290 to $340 per kilogram, and then rose until at least mid-October to $495 to $510 per kilogram.

The flat-panel and ITO industry reportedly was supported by a surge in flat-panel shipments to North America during the first quarter of 2009. However, spot prices for indium remained low during this time as leading Japanese ITO producers continued to work off of their indium inventories, which were built up from purchases made in 2008. ITO demand began to pick up pace around midyear, particularly in the Republic of Korea where exports of flat panels rose significantly owing to China's household appliance subsidy program and the weaker won. In December 2008, China began a 4-year, 13% subsidy program in certain agricultural regions to encourage farmers to purchase home appliances, mobile phones, and televisions. The program was initiated to bolster rural consumer spending and may significantly increase China's demand for flat-panel televisions in the long term.

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INDIUM

In mid-2009, the Japanese Government announced plans to include indium and gallium in its national stockpile of rare metals, which was initially created to support stable economic conditions for domestic industries that consume these raw materials. For each rare metal, the Government stockpiles a quantity equivalent to 42 days of standard Japanese consumption. Reportedly, the Government initially was seeking to purchase at least 1 metric ton of indium, but the exact quantity was not specified.

World Refinery Production and Reserves:

	Refinery production 2008	Refinery production 2009[e]	Reserves[5]
United States	—	—	Quantitative estimates of reserves are not available.
Belgium	30	30	
Brazil	5	10	
Canada	45	50	
China	310	300	
Japan	65	60	
Korea, Republic of	75	85	
Peru	6	20	
Russia	12	12	
Other countries	25	30	
World total (rounded)	570	600	

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

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

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

[e]Estimated. NA Not available. — Zero.
[1]Imports for consumption of unwrought indium and indium powders (Tariff no. 8112.92.3000).
[2]Indium Corp.'s price for 99.97% purity metal; 1-kilogram bar in lots of 10,000 troy ounces. Source: Platts Metals Week.
[3]Price is based on 99.99% minimum purity indium at warehouse (Rotterdam); cost, insurance, and freight (in minimum lots of 50 kilograms). Source: Platts Metals Week.
[4]Defined as imports – exports + adjustments for Government and industry stock changes; exports were assumed to be no greater than the difference between imports and consumption.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

IODINE

(Data in metric tons elemental iodine unless otherwise noted)

Domestic Production and Use: A slight increase in production of iodine was expected in 2009 compared with that of 2008. Iodine was produced in 2009 by three companies operating in Oklahoma, with a fourth company anticipating initial iodine production in Montana by late 2009. 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 c.i.f. value of iodine imports in 2009 was estimated to be $21.10 per kilogram.

Domestic and imported iodine were used to produce many intermediate iodine compounds by downstream manufactures, making it difficult to establish an accurate end-use pattern. Of the consumers that participate in an annual U.S. Geological Survey canvass, 19 plants reported consumption of iodine in 2008. Iodine and iodine compounds reported used were unspecified organic compounds, including ethyl and methyl iodide, 45%; crude iodine, 15%; povidine-iodine (iodophors), 10%; potassium iodide, 9%; ethylenediamine dihydroiodide, 5%; sodium iodide, 2%; and other, 14%.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production	1,570	W	W	W	W
Imports for consumption, crude content	6,250	5,640	6,060	6,300	5,600
Exports[1]	2,430	1,580	1,060	950	1,200
Shipments from Government stockpile excesses	444	467	93	—	—
Consumption:					
Apparent	5,600	W	W	W	W
Reported	4,680	4,570	4,470	4,590	4,400
Price, average c.i.f. value, dollars per kilogram, crude	16.75	19.34	21.01	21.52	21.10
Employment, number[e]	30	30	30	30	30
Net import reliance[2] as a percentage of apparent consumption	72	W	W	W	W

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

Import Sources (2005-08): Chile, 80%; Japan, 19%; and other, 1%.

Tariff:

Item	**Number**	**Normal Trade Relations 12-31-09**
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: Chile was the leading iodine-producing country, followed by Japan and the United States. Chile accounted for more than 50% of world production, with two of the leading iodine producers in the world in Chile. A large portion of Chilean iodine was produced as a byproduct or coproduct of nitrates. Japanese iodine was extracted from underground natural gas brines.

A leading Chilean iodine producer announced a $1 billion capital expansion plan to be executed from 2008 to 2010, which includes increasing capacity of its iodine and nitrate facilities by 25% by 2012. Another Chilean iodine producer completed construction of a new agitated leach plant to replace a heap leaching system. The new plant was expected to increase iodine recovery by over 25% and cut leaching time from 1 month to 24 hours. As a result, iodine production was expected to increase by 50%.

The Turkmenistan Government continued to invest significantly in repairing and upgrading production facilities to achieve its anticipated goal of 1,800 tons of iodine per year by 2010. A company in Azerbaijan continued expansion of its iodine plant supported by a $15 million loan from the European Bank of Reconstruction. The expansion, including the purchase of new equipment, addition of a new product line, and repair of extraction wells, would result in an expected production rate increase to 10,000 tons of iodine per year.

Demand for iodine in applications such as biocides, iodine salts, liquid crystal displays (LCD), synthetic fabric treatments, and x-ray contrast media are expected to increase at a rate of 3.5% to 4% per year over the next decade. The use of methyl iodide as a soil fumigant, although currently undergoing a trial period, may become a viable alternative to methyl bromide, which has proven to cause irreparable environmental damage. Global shipments of LCD televisions were expected to double by 2012, resulting in an anticipated increase in consumption of iodine by LCD producers. As more countries implement legislation mandating salt iodization to combat iodine deficiency, the global demand for iodized salt would be expected to increase. China's Ministry of Health, on the other hand, announced the reduction of iodine content in salt for specific provinces owing to fears iodized salt may be causing a rise in thyroid diseases in those provinces. The implementation of this program was expected to take place by the first half of 2010.

World Mine Production and Reserves:

	Mine production		Reserves[3]
	2008	2009[e]	
United States	W	W	250,000
Azerbaijan	300	300	170,000
Chile	15,500	16,000	9,000,000
China	570	580	4,000
Indonesia	75	75	100,000
Japan	9,500	9,300	4,900,000
Russia	300	300	120,000
Turkmenistan	270	300	170,000
Uzbekistan	2	2	NA
World total (rounded)	[4]26,500	[4]27,000	15,000,000

World Resources: In addition to the reserves shown above, seawater contains 0.05 parts per million iodine, or approximately 34 million 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: Bromine and chlorine could be substituted for most of the biocide, colorant, and ink uses of iodine, although they are usually considered less desirable than iodine. Antibiotics and boron are also substitutes for iodine as biocides. Salt crystals and finely divided carbon may be used for cloud seeding. There are no substitutes for iodine in some animal feed, catalytic, nutritional, pharmaceutical, and photographic uses.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Export data for the years 2005-06 were revised by the U.S. Census Bureau.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[4]Excludes U.S. production.

IRON ORE[1]

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

Domestic Production and Use: In 2009, mines in Michigan and Minnesota shipped 99% of the usable ore produced in the United States, with an estimated value of $2.0 billion. Twelve iron ore mines (11 open pits and 1 dredging operation), 8 concentration plants, and 8 pelletizing plants operated during the year. Almost all ore was concentrated before shipment. Eight of the mines operated by three companies accounted for virtually all of the production. The United States was estimated to have produced and consumed 1% of the world's iron ore output.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production, usable	54.3	52.7	52.5	53.6	26
Shipments	53.2	52.7	50.9	53.6	28
Imports for consumption	13.0	11.5	9.4	9.2	4
Exports	11.8	8.3	9.3	11.1	5
Consumption:					
Reported (ore and total agglomerate)[3]	60.1	58.2	54.8	51.9	28
Apparent[e]	56.6	57.1	51.3	49.7	26
Price,[4] U.S. dollars per metric ton	44.50	53.88	59.64	70.43	70.00
Stocks, mine, dock, and consuming plant, yearend, excluding byproduct ore[e, 5]	16.5	15.3	15.8	17.7	18.1
Employment, mine, concentrating and pelletizing plant, quarterly average, number	4,450	4,470	4,450	4,770	3,200
Net import reliance[6] as a percentage of apparent consumption (iron in ore)	4	8	E	E	E

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

Import Sources (2005-08): Canada, 58%; Brazil, 34%; Chile, 2%; Trinidad and Tobago, 2%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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.

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

Government Stockpile: None.

Events, Trends, and Issues: Following an almost 10% increase in worldwide price for lump and fines and a 5% increase in price for pellets in 2007, the 2008 iron ore price showed an even steeper increase of greater than 65% for lump and fines and almost 87% for pellets from the Americas. In 2008, Australian producers received an additional premium for shorter transport distances into the Asian market with an almost 80% increase in price for fines and an increase of greater than 96% for lump ores. In 2009, prices corrected following several years of continued increase. Lump and fines decreased in price by 28% and the price of pellets was almost halved.

Major iron-ore-mining companies continue to reinvest profits in mine development, but increases in capacity may outstrip expected consumption within the next few years, as growth dominated by China slows. In 2008, it was estimated that China increased production of mostly lower grade ores by 17% from that of the previous year—significantly lower than the 40% increase seen between 2005 and 2006. Estimates of Chinese imports of higher grade ores in 2008, mostly from Australia and Brazil, showed an increase of about 16% compared with those of 2007.

In early 2009, China's state-run aluminum company attempted to purchase 18% ownership of Rio Tinto plc. Following the breakdown of this $19.5 billion deal, a nonbinding agreement was signed between BHP Billiton Ltd. and Rio Tinto. This joint venture, combining these companies' Western Australian iron ore properties, would represent a major collaboration within the global iron ore industry.[7]

In 2008, China imported one-half of the world's total iron ore exports and produced about one-half of the world's pig iron. Since international iron ore trade and production of iron ore and pig iron are key indicators of iron ore

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IRON ORE

consumption, this clearly shows that iron ore consumption in China is the major factor upon which the expansion of the international iron ore industry depends.

China continued to actively invest in overseas ventures in Africa, Australia, and South America in order to provide raw materials for its growing urbanization. Earlier interest in importation of North American ores by China has decreased somewhat, as exemplified by the sale of its minority interest in one North American operation. Subsequently, investigation and development, by companies seeking sales to China, of several lower grade iron ore deposits in Alaska, Arizona, Missouri, Nevada, New Mexico, and Utah, has slowed.

The Mesabi Nugget project—a direct-reduced iron nugget plant—was completed in Minnesota in the fourth quarter of 2009. The $260 million plant produces 96%-to-98% iron-content nuggets. After receiving necessary permits, an adjacent iron ore mine was planned to be reopened in late 2010.

World Mine Production and Reserves: The mine production estimates for China are based on crude ore, rather than usable ore, which is reported for the other countries. The iron ore reserves estimates for Australia, China, India, and Iran have been revised based on new information from those countries.

	Mine production		Reserves[8]	
	2008	2009[e]	Crude ore	Iron content
United States	54	26	6,900	2,100
Australia	342	370	20,000	13,000
Brazil	355	380	16,000	8,900
Canada	31	27	1,700	1,100
China	824	900	22,000	7,200
India	220	260	7,000	4,500
Iran	32	33	2,500	1,400
Kazakhstan	23	21	8,300	3,300
Mauritania	11	11	700	400
Mexico	12	12	700	400
Russia	100	85	25,000	14,000
South Africa	49	53	1,000	650
Sweden	24	18	3,500	2,200
Ukraine	73	56	30,000	9,000
Venezuela	21	16	4,000	2,400
Other countries	47	47	11,000	6,200
World total (rounded)	2,220	2,300	160,000	77,000

World Resources: United States resources are estimated to be about 110 billion tons of ore containing 27 billion tons of iron. 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 800 billion tons of crude ore containing more than 230 billion tons of iron.

Substitutes: Iron ore, used directly, as lump ore, or converted to briquettes, concentrates, pellets, or sinter, is the only source of primary iron. Ferrous scrap may constitute as much as 7% of the blast furnace feedstock at some blast furnace operations. Scrap is extensively used in steelmaking in electric arc furnaces and in iron and steel foundries, but scrap availability can be an issue in any given year. In general, large price increases for lump and fine iron ores and iron ore pellets through the last quarter of 2008 were offset by price increases in the alternative—scrap. The margin between iron ore and scrap import prices has greatly decreased since then; therefore, the relative attractiveness of scrap compared to iron ore has increased markedly.

[e]Estimated. E Net exporter.
[1]See also Iron and Steel and Iron and Steel Scrap.
[2]Agglomerates, concentrates, direct-shipping ore, and byproduct ore for consumption.
[3]Includes weight of lime, flue dust, and other additives in sinter and pellets for blast furnaces.
[4]Estimated from reported value of ore at mines.
[5]Information regarding consumer stocks at receiving docks and plants has not been available since 2003 (these stock changes were estimated).
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]Jorgenson, J.D., 2009, Iron ore in June 2009: U.S. Geological Survey Mineral Industry Surveys, August, 8 p.
[8]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

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 2009 that were estimated to be valued at $110 billion. Pig iron was produced by 8 companies operating integrated steel mills in about 18 locations. About 57 companies, producing raw steel at about 116 plants, had combined production capability of about 113 million tons. Indiana accounted for 29% of total raw steel production, followed by Ohio, 10%, Pennsylvania, 10%, and Michigan, 4%. The distribution of steel shipments was estimated to be: warehouses and steel service centers, 20%; construction, 18%; transportation (predominantly automotive), 11%; cans and containers, 4%; and other, 47%.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Pig iron production[2]	37.2	37.9	36.3	33.7	18
Steel production:	94.9	98.2	98.1	91.9	56
Basic oxygen furnaces, percent	45.0	42.9	41.8	42.6	36
Electric arc furnaces, percent	55.0	57.1	58.2	57.4	64
Continuously cast steel, percent	96.8	96.7	96.7	96.4	97
Shipments:					
Steel mill products	95.2	99.3	96.5	89.3	52
Steel castings[3]	0.7	[e]0.7	[e]0.7	[e]0.7	0.4
Iron castings[3]	7.4	[e]7.4	[e]7.4	[e]7.4	4.0
Imports of steel mill products	29.1	41.1	30.2	29.0	14
Exports of steel mill products	8.5	8.8	10.1	12.2	8
Apparent steel consumption[4]	113	120	116	102	56
Producer price index for steel mill products (1982=100)[5]	159.7	174.1	182.9	220.6	180
Steel mill product stocks at service centers yearend[6]	11.7	15.0	9.3	7.8	8.0
Total employment, average, number					
Blast furnaces and steel mills	[e]134,000	[e]132,000	[e]128,000	125,000	124,000
Iron and steel foundries[e]	115,000	115,000	115,000	115,000	115,000
Net import reliance[7] as a percentage of apparent consumption	15	17	16	13	7

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

Import Sources (2005-08): Canada, 18%; European Union, 15%; China, 12%; Mexico, 10%; and other, 45%.

Tariff:

Item	**Number**	**Normal Trade Relations 12-31-09**
Pig iron	7201.10.0000	Free.
Carbon steel:		
Semifinished	7207.12.0050	Free.
Hot-rolled, pickled	7208.27.0060	Free.
Sheets, hot-rolled	7208.39.0030	Free.
Cold-rolled	7209.18.2550	Free.
Galvanized	7210.49.0090	Free.
Bars, hot-rolled	7213.20.0000	Free.
Structural shapes	7216.33.0090	Free.
Stainless steel:		
Semifinished	7218.91.0015	Free.
Do.	7218.99.0015	Free.
Cold-rolled sheets	7219.33.0035	Free.
Bars, cold-finished	7222.20.0075	Free.
Pipe and tube	7304.41.3045	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 global GDP growth forecast for 2010 and 2011 was 2.0% and 3.2%, respectively, after a decline of 2.9% in 2009. The Federal Reserve Bank of Philadelphia survey of forecasters showed the economy expanding in 2010, 2011, and 2012 at rates of 2.3%, 2.9%, and 3.2%, respectively, after contracting at a rate of 2.6% in 2009.

MEPS (International) Inc. forecast total world steel production in 2009 to be down 12% from that in 2008 (MEPS, 2009). MEPS also forecast declining steel production in 2009 in the European Union, South America, the Commonwealth of Independent States (CIS), Africa, and Asia, of 26%, 24%, 18%, 9%, and 3%, respectively. World Steel Dynamics (WSD) forecast world crude steel production to decrease by 9% in 2009 and increase by 14%, 6%, and 5% in 2010, 2011, and 2012, respectively. WSD also forecast crude steel production in China to decrease by 25% in 2009 and increase by 21%, 3%, and 2% in 2010, 2011, and 2012, respectively.

According to the World Steel Association, world apparent steel consumption (ASC) was expected to increase by 9.2% in 2010, after declining by 8.6% during 2009. China's ASC was expected to increase by 5% in 2010, and was expected to account for 48% of world steel consumption. ASC in India was expected to grow by 12% in 2010. The U.S. ASC was expected to decline by 39% in 2009 and increase by 19% in 2010. In Japan and the CIS, the ASC was expected to increase by 16% and 8%, respectively, in 2010. The European Union ASC was expected to increase by almost 15% in 2010 after declining almost 33% in 2009, according to the European Confederation of Iron and Steel Industries.

Seven U.S. steel producers and the United Steelworkers Union filed an antidumping suit against China with the U.S. International Trade Commission and the U.S. Department of Commerce, covering $2.7 billion of steel imports into the United States. Steel producers contended that tariff increases were needed to help them survive the global recession. China intended to cut excess steelmaking capacity by consolidating its producers into three major steel groups. Also, China was planning to protect its steel industry by gradually raising import duties.

World Production:

	Pig iron		Raw steel	
	2008	**2009[e]**	**2008**	**2009[e]**
United States	34	18	92	56
Brazil	35	22	34	24
China	471	540	500	550
France	12	7	18	12
Germany	29	17	46	29
Italy	11	5	30	18
Japan	86	61	119	79
Korea, Republic of	31	26	53	47
Russia	48	40	69	55
Ukraine	31	25	37	28
United Kingdom	11	7	14	9
Other countries	133	96	318	226
World total (rounded)	932	860	1,330	1,100

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. Do. Ditto.
[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 + imports, excluding semifinished steel products.
[5]U.S. Department of Labor, Bureau of Labor Statistics.
[6]Metals Service Center Institute.
[7]Defined as imports – exports + adjustments for Government and industry stock changes.

IRON AND STEEL SCRAP[1]

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

Domestic Production and Use: Total value of domestic purchases (receipts of ferrous scrap by all domestic consumers from brokers, dealers, and other outside sources) and exports was estimated to be $13.7 billion in 2009, down by 54% from that of 2008. U.S. apparent steel consumption, an indicator of economic growth, decreased to about 57 million metric tons in 2009. Manufacturers of pig iron, raw steel, and steel castings accounted for about 85% 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 15% 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 2009, raw steel production was an estimated 55.9 million tons, down about 39% from that of 2008; annual steel mill capability utilization was about 50% compared with 81% for 2007. Net shipments of steel mill products were estimated to have been about 52 million tons compared with 89 million tons for 2008.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production:					
Home scrap	15	13	12	12	11
Purchased scrap[2]	58	58	65	72	67
Imports for consumption[3]	4	5	4	4	3
Exports[3]	13	15	17	22	22
Consumption, reported	66	64	64	66	48
Price, average, dollars per metric ton delivered, No. 1 Heavy Melting composite price, Iron Age Average, Pittsburgh, Philadelphia, Chicago	189	214	249	349	195
Stocks, consumer, yearend	5.0	4.4	4.4	4.6	4.6
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 2008, the latest year for which statistics were available, was about 106%. A recycling rate greater than 100% is a result of the steel industry recycling more steel from automobiles than was used in the domestic production of new vehicles. The automotive recycling industry recycled through more than 220 car shredders more than 15 million tons of steel from end-of-life vehicles, the equivalent of nearly 14.5 million automobiles. More than 12,000 vehicle dismantlers throughout North America resell parts.

The recycling rates for appliances and steel cans in 2008 were 90% and 65%, respectively. Recycling rates for construction materials in 2008 were 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 to increase, 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 55% post-consumer (old, obsolete) scrap, 23% prompt scrap (produced in steel-product manufacturing plants), and 22% home scrap (recirculating scrap from current operations).

Import Sources (2005-08): Canada, 73%; United Kingdom, 9%; Mexico, 6%, Sweden, 4%; and other, 8%.

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IRON AND STEEL SCRAP

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
Iron and steel waste and scrap:		
No. 1 Bundles	7204.41.0020	Free.
No. 1 Heavy Melting	7204.49.0020	Free.
No. 2 Heavy Melting	7204.49.0040	Free.
Shredded	7204.49.0070	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: Hot-rolled steel prices decreased steadily during 2009 to a low in June, after which they increased to December 2008 through January 2009 levels. During 2009, prices of hot-rolled steel were lower than those in 2008. The producer price index for steel mill products decreased to 153 in May 2009 from 258 in August 2008. Steel mill production capability utilization peaked at 97.3% in September 2004, and decreased dramatically to a low of 40.8% in April 2009. During the first 8 months of 2009, the capability utilization was 46.2%, compared with 90.3% during the same period in 2008.

Scrap prices fluctuated widely between about $141 and $199 per metric ton in 2009. Composite prices published by Iron Age Scrap Price Bulletin for No. 1 Heavy Melting steel scrap delivered to purchasers in Chicago, IL, and Philadelphia and Pittsburgh, PA, averaged about $194 per metric ton during the first 9 months of 2009. As reported by Iron Age Scrap Price Bulletin, the average price for nickel-bearing stainless steel scrap delivered to purchasers in Pittsburgh was about $1,526 per ton in 2009, which was lower than the 2008 average price of $2,522 per ton. The prices fluctuated widely between $2,108 per ton in August and September 2009 and a low of $863 in January 2009. Exports of ferrous scrap increased in 2009 to an estimated 22.0 million tons from 21.5 million tons during 2008, mainly to China, Turkey, the Republic of Korea, Taiwan, and Canada, in descending order of export tonnage. Export scrap value decreased from $10.4 billion in 2008 to an estimated $7.2 billion in 2009.

Following record-high global steel product production and prices in mid-2008, demand and prices began to decline. As of yearend 2009, significant recovery in the industry did not seem likely until well into 2010, if not later, because the major steel-consuming industries were continuing to experience low demand as a result of cancellation of State and local infrastructure projects, declining housing construction, weak consumer confidence, and weak demand for durable goods and automotive products.

World Mine Production and Reserves: Not applicable.

World Resources: Not applicable.

Substitutes: About 1.8 million tons of direct-reduced iron was used in the United States in 2008 as a substitute for iron and steel scrap, up from 2.1 million tons in 2007.

[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 1992 Census of Wholesale Trade for 2001, and 2002 Census of Wholesale Trade for 2002 through 2005.
[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: Iron and steel slags are coproducts of iron- and steelmaking. Data on U.S. slag production are unavailable but output is estimated as having declined by nearly one-half to a range of 8 to 12 million tons in 2009, as a result of numerous idlings of steel plants during the year. Slag sales are estimated to have declined less severely, based on their being largely from stockpiles. An estimated 13 million tons of iron and steel slag, valued at nearly $300 million[1] (f.o.b. plant), was sold during the year. Iron or blast furnace slag accounted for about 60% of the tonnage sold and had a value of about $260 million; nearly 85% of this value was granulated slag. Steel slag produced from basic oxygen and electric arc furnaces accounted for the remainder.[2] Slag was processed by about 30 companies servicing active iron and/or steel facilities or reprocessing old slag piles; iron slag at about 40 sites in about 14 States and steel slag at about 100 sites in 30 States. Included in these data 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 the weighted average for a variety of ferrous slag types. Actual prices per ton ranged widely in 2009 from about $0.20 for steel slags for some applications to more than $100 for some GGBFS. The major uses of air-cooled iron slag and for steel slag are as aggregates for asphaltic paving, fill, and road bases, and as a feed for cement kilns; air-cooled slag also is used as an aggregate for concrete. In contrast, almost all GGBFS is used as a partial substitute for portland cement in concrete mixes and in blended cements. Owing to their low unit values, most slag types are shipped by truck only over short distances, but rail and waterborne transportation can be longer. Because of its much higher unit value, GGBFS can be shipped economically over longer distances.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production, marketed[1, 3]	21.6	20.3	19.6	18.8	13.0
Imports for consumption[4]	1.6	1.6	1.9	1.3	1.0
Exports	([5])	0.1	0.1	([5])	([5])
Consumption, apparent[4, 6]	21.6	20.2	19.6	18.8	13.0
Price average value, dollars per ton, f.o.b. plant	17.60	20.00	22.00	18.00	23.00
Stocks, yearend	NA	NA	NA	NA	NA
Employment, number[e]	2,600	2,500	2,200	2,100	2,000
Net import reliance[7] as a percentage of apparent consumption	7	8	9	7	8

Recycling: Some slags are returned to the blast and steel furnaces as ferrous and flux feed. Entrained metal, particularly in steel slag, is routinely recovered during slag processing for return to the furnaces. However, data for such furnace-feed uses are unavailable.

Import Sources (2005-08): Year-to-year import data for ferrous slags show that the dominant form is granulated blast furnace slag (mostly unground), but show significant variations in both tonnage and unit value. Many past data contain discrepancies; and the official data in recent years appear to significantly underreport imports of granulated blast furnace slag. Principal country sources for 2005-08 were Japan, 36%; Canada, 35%; Italy, 19%; France, 5%; and other, 5%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
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

<u>Events, Trends, and Issues</u>: Depletion of old slag piles and the closure of many blast furnaces have led to a steady decline in the availability of air-cooled blast furnace slag in recent years, and especially in 2008-09. No new blast furnaces are under construction or are planned. Granulation cooling is currently installed at only four active blast furnaces, but others are under evaluation as candidates for this type of cooling, contingent on the furnaces remaining active. Pelletized blast furnace slag, used mainly as a lightweight aggregate, remains in limited supply, but it is unclear if any additional pelletizing capacity is being planned. Steel slag from integrated iron and steel works is in significant decline, owing to the idling of several plants and an increasing trend of returning slag to the furnaces. Slag from electric arc steel furnaces (largely fed with steel scrap) remains abundant. Slags compete with natural aggregates in various construction applications but are more geographically restricted than natural aggregates overall. Within the relatively restricted slag markets, slag sales in 2008 declined less than did those for natural aggregates and for cement. In 2009, however, slag sales were estimated to have declined more significantly than those of natural aggregates because of limited slag availability. For performance and environmental reasons, demand has been growing for GGBFS as a cementitious ingredient in concrete, and GGBFS prices have generally increased in recent years. Long-term growth in the supply of GGBFS is likely to hinge on imports, either of the ground or unground material.

<u>World Mine Production and Reserves</u>: 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 2009 was on the order of 200 to 250 million tons, and steel slag about 110 to 160 million tons, based on typical ratios of slag to crude iron and steel output.

<u>World Resources</u>: Not applicable.

<u>Substitutes</u>: Slag competes with crushed stone and sand and gravel as aggregates in the construction sector. Fly ash, certain rock types, and silica fume are common alternatives to GGBFS as cementitious additives in blended cements and concrete. Slags (especially steel slag) can be used as a partial substitute for limestone and some other natural (rock) materials as raw material for clinker (cement) manufacture.

[e]Estimated. NA Not available.

[1]The data (obtained from an annual survey of slag processors) pertain to the quantities of processed slag sold rather than that processed or produced during the year. The data exclude any entrained metal that may be recovered during slag processing and returned to iron and, especially, steel furnaces, or any slag itself returned to the furnaces. Data for such recovered metal and returned slag were unavailable.

[2]There were very minor sales of open hearth furnace steel slag from stockpiles but no domestic production of this slag type in 2005-09.

[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 significantly understate the true imports of granulated slag. Of these apparently missing imports, the USGS canvass appears to capture only about 30% within its sales data. Thus the apparent consumption statistics are likely too low by about 0.5 to 1.3 million tons per year.

[5]Less than ½ unit.

[6]Defined as total sales of slag (includes that from imported feed) minus exports. Calculation is based on unrounded original data.

[7]Defined as total sales of imported slag minus exports of slag. Data are not available to allow adjustments for changes in stocks.

KYANITE AND RELATED MATERIALS

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: One firm in Virginia with integrated mining and processing operations produced kyanite from hard-rock open pit mines. Another company produced synthetic mullite in Georgia. Of the kyanite-mullite output, 90% was estimated to have been used in refractories and 10% in other uses. Of the refractory usage, an estimated 60% to 65% was used in ironmaking and steelmaking and the remainder in the manufacture of chemicals, glass, nonferrous metals, and other materials.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production:					
Mine[e]	112	112	118	115	80
Synthetic mullite[e]	40	40	40	40	50
Imports for consumption (andalusite)	6	4	2	6	8
Exports[e]	35	35	35	36	32
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent[e]	123	121	125	125	106
Price, average, dollars per metric ton:[1]					
U.S. kyanite, raw	NA	NA	224	229	256
U.S. kyanite, calcined	272	313	333	357	383
Andalusite, Transvaal, South Africa	238	248	235	263	352
Stocks, producer	NA	NA	NA	NA	NA
Employment, kyanite mine, office, and plant, number[e]	130	135	130	120	120
Employment, mullite mine, office, and plant, number[e]	190	200	200	190	170
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2005-08): South Africa, 89%; France, 5%; Japan, 4%; and United Kingdom, 2%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
Andalusite, kyanite, and sillimanite	2508.50.0000	Free.
Mullite	2508.60.0000	Free.

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

Government Stockpile: None.

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KYANITE AND RELATED MATERIALS

Events, Trends, and Issues: Because of the recession in 2009, steel production in the United States declined by 51% in the first 7 months of 2009 as compared with that of the same period in 2008. This notable contraction and weak demand from metal manufacturers resulted in the temporary mothballing of a refractory plant in Alabama that produced mullite and andalusite brick.

Of the total world refractories market, estimated to be approximately 20 million tons, crude steel manufacturing consumed around 70% of production. Crude steel production for the first half of 2009 increased in China by 1.2% compared with that of the first half of 2008, despite total world production declining by 21% during the same period. India reported a 1.7% annualized increase in crude steel production in the first 7 months of 2009.

Anticipation of long-term growth in the andalusite market was pushing expansion in South Africa, which was projected to increase production by 40% in order to alleviate tight supply conditions caused by production constraints in France.

World Mine Production and Reserves:

	Mine production		Reserves[3]
	2008	2009[e]	
United States[e]	115	80	Large in the United States.
France	65	65	
India	24	24	
South Africa	260	265	
Other countries	6	6	
World total (rounded)	470	440	

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

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

[e]Estimated. E Net exporter. NA Not available. — Zero.
[1]Source: Industrial Minerals.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

LEAD

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

Domestic Production and Use: The value of recoverable mined lead in 2009, based on the average North American producer price, was $671 million. Five lead mines in Missouri, plus lead-producing mines in Alaska and Idaho, yielded most of the totals. Primary lead was processed at one smelter-refinery in Missouri. Of the 21 plants that produced secondary lead, 15 had annual capacities of 15,000 tons or more and accounted for more than 99% of secondary production. Lead was consumed at about 76 manufacturing plants. The lead-acid battery industry continued to be the principal user of lead, accounting for about 88% of the reported U.S. lead consumption for 2009. Lead-acid batteries were primarily used as starting-lighting-ignition (SLI) batteries for automobiles and trucks and as industrial-type batteries for uninterruptible power-supply equipment for computer and telecommunications networks; for load-leveling equipment for electrical power systems; and for motive power.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production:					
Mine, lead in concentrates	437	429	444	410	400
Primary refinery	143	153	123	135	115
Secondary refinery, old scrap	1,150	1,160	1,180	1,150	1,120
Imports for consumption:					
Lead in concentrates	—	([1])	([1])	([1])	([1])
Refined metal, wrought and unwrought	310	343	267	314	275
Exports:					
Lead in concentrates	390	298	300	277	275
Refined metal, wrought and unwrought	65	68	56	75	85
Shipments from Government stockpile excesses, metal	29	24	—	—	—
Consumption:					
Reported	1,490	1,490	1,570	1,470	1,400
Apparent[2]	1,480	1,580	1,540	1,500	1,420
Price, average, cents per pound:					
North American Producer	61.0	77.4	124	120	79.0
London Metal Exchange	44.2	58.0	117	94.8	69.0
Stocks, metal, producers, consumers, yearend	47	54	39	57	70
Employment:					
Mine and mill (peak), number[3]	1,100	1,070	1,100	1,200	1,000
Primary smelter, refineries	240	240	240	240	240
Secondary smelters, refineries	1,600	1,600	1,600	1,600	1,600
Net import reliance[4] as a percentage of apparent consumption	E	E	E	E	E

Recycling: In 2009, about 1.12 million tons of secondary lead was produced, an amount equivalent to 80% of reported domestic lead consumption. Nearly all of it was recovered from old (post-consumer) scrap.

Import Sources (2005-08): Metal, wrought and unwrought: Canada, 70%; Mexico, 10%; Peru, 7%; China, 5%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations[5] 12-31-09
Unwrought (refined)	7801.10.0000	2.5% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: Lead prices remained fairly stable throughout the first half of 2009 following declines that took place in late 2008. The forced temporary closures of several Chinese smelters in August, owing to environmental concerns, were partially responsible for sharp price increases in the third quarter that extended through yearend. Despite the loss of more than 300,000 tons per year of refined lead-production capacity worldwide, the elevated level of stocks held in LME and producer warehouses indicated that there was still ample supply of material.

Global mine production of lead concentrate increased slightly in 2009. Production increases in China, accounting for 40% of global lead mine production, offset declines in other regions. Lead is frequently recovered as a byproduct of zinc production, so lead production was affected by the downturn in the zinc market. In February, a lead-producing

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LEAD

mine in northeastern Washington was placed on care-and-maintenance status owing to reduced demand for zinc. A lead-producing mine in Montana was depleted of ore in late 2008 and ceased operations after all stockpiled resources were processed in early 2009. Production rates were slowed at lead mines in Missouri owing to the decrease in lead prices. Production in Canada and Peru was expected to decline by more than 10% in 2009 as compared with that in 2008. Increases in mine production took place in Bolivia where a recently opened mine began operating at full production levels in 2009. A significant new mine in Mexico was entering the final phases of development and was expected to begin producing lead concentrates in 2010. A lead mine in Australia, shuttered since 2007, was scheduled to restart production in early 2010. Production increased in China, but in most other regions, refined lead production declined in response to the global financial crisis. In late 2008, one of two blast furnaces at the Missouri lead smelter was shut down, and production of primary lead was curtailed owing to the decline in lead prices. In March, a producer temporarily closed a secondary lead smelter in Louisiana owing to market conditions.

Lead consumption was expected to increase by 3% in 2009 worldwide owing to a nearly 25% increase in Chinese lead consumption, which was driven by growth in the automobile and electric bicycle markets. The Chinese trade balance changed in 2009 as China became a net importer of refined lead. In most other regions, lead consumption was expected to remain flat or decline. According to Battery Council International statistics, North American shipments of replacement SLI batteries through August 2009 were slightly lower, and shipments of original equipment batteries declined by 30% from those through August 2008. The Battery Council forecast a 3% decline in shipments of SLI lead-acid batteries in 2009 and a 19% decline in shipments of industrial-type lead-acid batteries as compared with those of 2008.

In response to a petition from a dozen environmental and public health organizations, the U.S. Environmental Protection Agency reversed its 2005 decision and began the rulemaking process to ban lead wheel weights.

World Mine Production and Reserves: Reserves estimates were revised based on information released by producers in the respective countries.

	Mine production		Reserves[6]
	2008	2009[e]	
United States	410	400	7,700
Australia	645	516	23,000
Bolivia	82	100	1,400
Canada	99	95	700
China	1,500	1,690	12,000
India	87	88	2,600
Ireland	54	50	500
Mexico	101	155	4,700
Peru	345	305	6,000
Poland	62	40	3,500
Russia	60	78	900
South Africa	46	50	300
Sweden	60	70	1,300
Other countries	289	268	14,000
World total (rounded)	3,840	3,900	79,000

World Resources: In recent years, significant lead resources have been demonstrated in association with zinc and/or silver or copper deposits in Australia, China, Ireland, Mexico, Peru, Portugal, and the United States (Alaska). Identified lead resources of the world total more than 1.5 billion tons.

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

[e]Estimated. E Net exporter. NA Not available. — Zero.
[1]Less than ½ unit.
[2]Apparent consumption defined as mine production + secondary refined + imports (concentrates and refined) – exports (concentrates and refined) + adjustments for Government and industry stock changes.
[3]Includes lead and zinc-lead mines for which lead was either a principal or significant product.
[4]Defined as imports – exports + adjustments for Government and industry stock changes; includes trade in both concentrates and refined lead.
[5]No tariff for Mexico and Canada for item shown.
[6]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

LIME[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2009, an estimated 15.0 million tons (16.5 million short tons) of quicklime and hydrate was produced (excluding commercial hydrators) at a value of about $1.6 billion. At yearend, there were 32 companies producing lime, which included 22 companies with commercial sales and 10 companies that produced lime strictly for internal use (for example, sugar companies). These companies had 75 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 23 States from 30 lime plants and 12 separate hydrating plants. Combined, these plants accounted for about 80% of U.S. lime production. Principal producing States, each with production of more than 1 million tons, were Alabama, Kentucky, Missouri, and Texas. Major markets for lime were, in descending order of consumption, steelmaking, flue gas desulfurization (fgd), construction, water treatment, mining, precipitated calcium carbonate, and pulp and paper.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production[2]	20,000	21,000	20,200	19,900	15,000
Imports for consumption	310	298	375	307	380
Exports	133	116	144	174	94
Consumption, apparent	20,200	21,200	20,400	20,000	15,000
Quicklime average value, dollars per ton at plant	72.10	78.10	84.60	89.90	101.00
Hydrate average value, dollars per ton at plant	91.10	98.30	102.40	107.20	136.00
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and plant, number	5,300	5,300	5,300	5,400	4,800
Net import reliance[3] as a percentage of apparent consumption	1	1	1	1	2

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 (2005-08): Canada, 84%; Mexico, 15%; and other, 1%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
Calcined dolomite	2518.20.0000	3% ad. val.
Quicklime	2522.10.0000	Free.
Slaked lime	2522.20.0000	Free.
Hydraulic lime	2522.30.0000	Free.

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

Government Stockpile: None.

Events, Trends, and Issues: In 2009, the recession and its aftermath continued to negatively impact lime markets, large and small. Lime production decreased by an estimated 24% compared with that of 2008, a decrease that rivals the previous largest percentage decrease in annual U.S. lime output that happened as a result of the 1981-82 recession. The cause for this large decrease was evident from examining major lime-consuming industries, which reported significant decreases in production or raw material consumption ranging from 12% to 44% compared with the same period in 2008.

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LIME

Prices continued to increase, with quicklime prices increasing about $11 per metric ton and hydrate prices increasing about $19 per ton, although the latter may also reflect a shift in product mix. Large price increases that went into effect beginning in 2009 were announced by some of the leading lime companies in late 2008. It appears that, despite the decrease in sales, lime producers were able to push through higher prices. Fuel surcharges (not included in the 2008 prices reported in the Salient Statistics table) were applied by many of the lime companies in early 2008 but were no longer in effect in 2009 when fuel prices decreased dramatically. In recent years, lime companies have reported that they were unable to keep up with rising production costs, and the large 2009 price increases were lime company efforts to reestablish operating margins.

Seven lime plants were mothballed during 2009 owing to the sharp decrease in demand. These plants were in the Midwest and the West and normally served construction, mining, and steel markets, depending on their location. In addition, individual kilns were idled at some large multiple kiln plants to reduce unneeded capacity.

World Lime Production and Limestone Reserves:

	Production		Reserves[4]
	2008	2009[e]	
United States	19,900	15,000	Adequate for all countries listed.
Austria	2,000	1,700	
Belgium	2,200	1,800	
Brazil	7,400	6,000	
Canada	2,070	1,500	
China	180,000	190,000	
France	4,000	3,000	
Germany	7,000	5,000	
Iran	2,700	2,200	
Italy[5]	6,000	5,000	
Japan (quicklime only)	9,500	8,000	
Mexico	6,500	5,000	
Poland	1,900	1,600	
Russia	8,200	7,000	
South Africa (sales)	1,590	1,300	
Turkey (sales)	3,600	3,000	
United Kingdom	2,000	1,800	
Vietnam	2,200	2,000	
Other countries	27,200	22,000	
World total (rounded)	296,000	280,000	

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

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

[e]Estimated. NA Not available.
[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 + adjustments for Government and industry stock changes; stock changes are assumed to be zero for apparent consumption and net import reliance calculations.
[4]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[5]Includes hydraulic lime.

LITHIUM

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

Domestic Production and Use: Chile was the leading lithium chemical producer in the world; Argentina, China, and the United States also were major producers. Australia, Canada, Portugal, and Zimbabwe were major producers of lithium ore concentrates. The United States remained the leading importer of lithium minerals and compounds and the leading producer of value-added lithium materials. Because only one company produced lithium compounds from domestic resources, reported production and value of production were withheld from publication to avoid disclosing company proprietary data. Estimation of value for the lithium mineral compounds produced in the United States is extremely difficult because of the large number of compounds used in a wide variety of end uses and the great variability of the prices for the different compounds. Two companies produced a large array of downstream lithium compounds in the United States from domestic or South American lithium carbonate. A U.S. recycling company produced a small quantity of lithium carbonate from solutions recovered during the recycling of lithium batteries.

Although lithium markets vary by location, global end-use markets are estimated as follows: ceramics and glass, 31%; batteries, 23%; lubricating greases, 10%; air treatment, 5%; continuous casting, 4%; primary aluminum production, 3%; and other uses, 24%. Lithium use in batteries expanded significantly in recent years because rechargeable lithium batteries were being used increasingly in portable electronic devices and electrical tools.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production	W	W	W	W	W
Imports for consumption	3,580	3,260	3,140	3,160	2,000
Exports	1,720	1,500	1,760	1,820	1,000
Consumption:					
Apparent	W	W	W	W	W
Estimated	2,500	2,500	2,100	2,000	1,200
Employment, mine and mill, number	59	61	68	68	68
Net import reliance[1] as a percentage of apparent consumption	>50%	>50%	>50%	>50%	>50%

Recycling: Insignificant, but increasing through the recycling of lithium batteries.

Import Sources (2005-08): Chile, 63%; Argentina, 35%; China, 1%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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: Market conditions deteriorated for lithium-based products in 2009. Sales volumes for the major lithium producers were reported to be down between 15% and 42% by mid-2009. Consumption by lithium end-use markets for batteries, ceramics and glass, grease, and pharmaceuticals all decreased. A major spodumene producer in Canada closed its mine owing to market conditions. The leading lithium producer in Chile announced it would lower its lithium prices by 20% in 2010. Despite the economic downturn in the lithium market, a host of new companies explored for lithium on claims worldwide in 2009. Many claims in Nevada, as well as in Argentina, Australia, Bolivia, and Canada, have been leased or staked.

The only active lithium carbonate plant in the United States was a brine operation in Nevada. Subsurface brines have become the dominant raw material for lithium carbonate production worldwide because of lower production costs compared with the mining and processing costs for hard-rock ores. Two brine operations in Chile dominate the world market and a facility at a brine deposit in Argentina produced lithium carbonate and lithium chloride. A second brine operation was under development in Argentina. Worldwide, most lithium minerals mined were used directly as ore concentrates in ceramics and glass applications rather than as feedstock for lithium carbonate and other lithium compounds.

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LITHIUM

Batteries, especially rechargeable batteries, are the market for lithium compounds with the largest growth potential. Demand for rechargeable lithium batteries continued to gain market share over rechargeable nonlithium batteries for use in cordless tools, portable computers and telephones, and video cameras. Major automobile companies were pursuing the development of lithium batteries for hybrid electric vehicles—vehicles with an internal combustion engine and a battery-powered electric motor. Most commercially available hybrid vehicles use other types of batteries, although future generations of these vehicles may use lithium. Nonrechargeable lithium batteries were used in calculators, cameras, computers, electronic games, watches, and other devices.

As part of the American Recovery and Reinvestment Act of 2009, the U.S. Department of Energy funded $2.4 billion in grants to accelerate the development of United States manufacturing capacity for batteries and electric-drive components and for the deployment of electric-drive vehicles. The grants, designed to help launch an advanced battery industry in the United States, represent the single largest investment in advanced battery technology for hybrid and electric-drive vehicles ever made. Lithium-ion battery technology figured prominently in the grant awards, with approximately $940 million in grant money received by lithium battery materials suppliers, lithium battery manufacturers, and a lithium battery recycler.

World Mine Production and Reserves: Reserves estimates for Argentina, Australia, and Chile have been revised based on new information from Government and industry sources.

	Mine production		Reserves[2]
	2008	2009[e]	
United States	W	W	38,000
Argentina	3,170	2,200	800,000
Australia	6,280	4,400	580,000
Brazil	160	110	190,000
Canada	690	480	180,000
Chile	10,600	7,400	7,500,000
China	3,290	2,300	540,000
Portugal	700	490	NA
Zimbabwe	500	350	23,000
World total (rounded)	[3]25,400	[3]18,000	9,900,000

World Resources: The identified lithium resources total 2.5 million tons in the United States and approximately 23 million tons in other countries. Among the other countries, identified lithium resources for Bolivia and Chile total 9 million tons and in excess of 7.5 million tons, respectively. Argentina and China each contain approximately 2.5 million tons of identified lithium resources.

Substitutes: Substitutes for lithium compounds are 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 engineering resins.

[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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[3]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 54% of U.S. magnesium compounds production in 2009. Magnesium oxide and other compounds were recovered from seawater by three companies in California, Delaware, and Florida; 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 two companies in North Carolina and Washington. About 52% of the magnesium compounds consumed in the United States was used for refractories. The remaining 48% was used in agricultural, chemical, construction, environmental, and industrial applications.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production	301	282	342	274	255
Imports for consumption	391	371	357	342	110
Exports	31	28	26	25	13
Consumption, apparent	661	624	673	591	352
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant, number[e]	370	370	370	370	300
Net import reliance[2] as a percentage of apparent consumption	54	55	49	54	28

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

Import Sources (2005-08): China, 79%; Austria, 5%; Canada, 4%; Australia, 2%; and other, 10%.

Tariff:[3] **Item**	**Number**	**Normal Trade Relations 12-31-09**
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: U.S. magnesia consumption fell significantly in 2009 because of a steep decline in U.S. steel production, the principal consuming industry for magnesia. Through the first 9 months of 2009, U.S. steel production was 47% lower than production in the corresponding period of 2008. As a result of lower steel production, U.S. imports, which have supplied the bulk of U.S. magnesium consumption, also declined. Through the first 7 months of 2009, imports of caustic-calcined magnesia were 40% lower than those in the same period of 2008, and imports of dead-burned magnesia were 85% lower than those in the first 7 months of 2008. An 88% decline in imports of dead-burned magnesia from China primarily was responsible for the decrease in total imports. Because of reduced demand, China canceled its export licenses for the second half of 2009. The original license quotas were scheduled to be for a total of 1.1 million tons, with 720,000 tons issued in the first half of the year; however, only 119,000 tons of magnesite was exported in the first 6 months of 2009.

After filing for bankruptcy in 2008, the Texas mine and processing plant of the sole brucite producer in the United States was for sale. In addition, one of the magnesium compounds producers in Michigan stopped producing magnesium compounds at its plant in Manistee at the beginning of 2009.

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MAGNESIUM COMPOUNDS

The U.S. Department of Commerce, International Trade Administration, began an antidumping duty investigation of imports of magnesia-carbon bricks from China and Mexico and a countervailing duty investigation of imports of magnesia-carbon bricks from China.

Some proposed expansions in magnesia production capacity that had been announced, mostly in 2008, were postponed, most notably a 100,000-ton-per-year caustic-calcined magnesia expansion in Australia. These expansions initially were planned in response to reduced exports from China, particularly to the European Union and the United States. Despite sluggish global economic conditions, one firm in Saudi Arabia announced plans to build a 140,000-ton-per-year magnesite processing plant, although no timetable was determined. A new magnesite producer in Turkey was expected to have a 100,000-ton-per-year dead-burned magnesia plant onstream by the beginning of 2010 as well. In Brazil, a small seawater magnesia producer announced that it would double its production capacity to 12,000 tons per year by yearend 2010.

In July, the leading olivine producer in Norway, with a total mine capacity of 2.4 million metric tons per year, announced that it was temporarily suspending operations at two of its three mines because of reduced demand for olivine from the steel industry. Another olivine producer in Norway filed for bankruptcy in September citing reduced sales for the company's product. The company had been producing olivine only since 2004 at a 150,000-ton-per-year plant and had planned to expand capacity to 250,000 to 300,000 tons per year.

World Magnesite Mine Production and Reserves: Reserves data for Brazil, China, Slovakia, and Turkey were revised based on new information from the respective country Governments.

	Mine production		Reserves[4]
	2008	2009[e]	
United States	W	W	10,000
Australia	130	130	100,000
Austria	230	200	15,000
Brazil	115	100	99,000
China	2,880	2,800	400,000
Greece	101	100	30,000
India	101	100	14,000
Korea, North	346	50	450,000
Russia	346	350	650,000
Slovakia	274	270	36,000
Spain	133	130	10,000
Turkey	605	600	49,000
Other countries	165	160	390,000
World total (rounded)	[5]5,430	[5]4,990	2,300,000

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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[5]Excludes U.S. production.

MAGNESIUM METAL[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2009, magnesium was produced by one company at a plant in Utah by an electrolytic process that recovered magnesium from brines from the Great Salt Lake. Magnesium used as a constituent of aluminum-based alloys that were used for packaging, transportation, and other applications was the leading use for primary magnesium, accounting for 41% of primary metal use. Structural uses of magnesium (castings and wrought products) accounted for 32% of primary metal consumption. Desulfurization of iron and steel accounted for 13% of U.S. consumption of primary metal, and other uses were 14%.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production:					
Primary	W	W	W	W	W
Secondary (new and old scrap)	73	82	83	76	75
Imports for consumption	85	75	72	83	50
Exports	10	12	15	14	16
Consumption:					
Reported, primary	82	78	72	58	55
Apparent[2]	130	120	130	140	100
Price, yearend:					
Metals Week, U.S. spot Western, dollars per pound, average	1.23	1.40	2.25	3.15	2.40
Metal Bulletin, China free market, dollars per metric ton, average	1,510	2,050	4,550	2,800	2,650
Stocks, producer and consumer, yearend	W	W	W	W	W
Employment, number[e]	400	400	400	400	400
Net import reliance[3] as a percentage of apparent consumption	60	53	47	50	35

Recycling: In 2009, about 22,000 tons of secondary production was recovered from old scrap.

Import Sources (2005-08): Canada, 40%; Israel, 22%; Russia, 11%; China, 8%; and other, 19%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
Unwrought metal	8104.11.0000	8.0% ad val.
Unwrought alloys	8104.19.0000	6.5% ad val.
Wrought metal	8104.90.0000	14.8¢/kg on Mg content + 3.5% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: The U.S. primary magnesium producer announced that it would reduce production and delay expansion at its 52,000-ton-per-year plant in Rowley, UT. The company cited weak demand as the reason for the announcement. The company also delayed its planned increase in production capacity to 70,000 tons per year until demand improves.

Slumping demand for magnesium in automotive applications led to additional closures of magnesium diecasting capacity; vehicle production in North America for the first three quarters of 2009 was more than 40% lower than production in the comparable period of 2008. Companies based in Canada, Illinois, and Michigan either filed for bankruptcy protection or closed their operations because of the reduced demand by the auto industry. One of the leading U.S. aluminum sheet producers (a significant magnesium consumer) filed for bankruptcy protection in mid-February citing a decrease in demand from the auto industry as the principal reason for the filing.

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MAGNESIUM METAL

Quoted magnesium prices continued the decline begun in the fourth quarter of 2008, and press reports indicated that most of the drop in prices in the United States resulted from renegotiations of contracts, not spot sales. In addition, consumers were delaying deliveries because of the slowdown in the magnesium end-use markets and a cutback in consumption in secondary aluminum products. Contracts for 2010 were expected to be negotiated at prices significantly lower than those in 2009. Many companies, however, did not negotiate contracts during the typical period of the second week of October because of the uncertainty in the market for 2010.

The U.S. Department of Commerce, International Trade Administration (ITA), rescinded the antidumping duty order for one of two Russian magnesium producers because it had not shipped magnesium to the United States during the review period. The other Russian magnesium producer chose not to participate in the administrative review, so the ITA set its antidumping duty for pure magnesium at 43.58% ad valorem.

The National Statistics Bureau of China reported that magnesium production in the country in the first half of 2009 was 215,000 tons, 47% lower than production in the first half of 2008. Although production has declined in China, some companies still were announcing capacity increases.

A Malaysia-based company expected to complete construction of its primary magnesium plant in Perak, Malaysia, by September 2009. The company would mine dolomite from nearby Dolomite Hills and was constructing the first of two production lines for magnesium with a 15,000-ton-per-year capacity. When the second line is completed, the plant's total capacity would be 30,000 tons per year.

The remaining magnesium producer in Canada completed the divestiture of its magnesium business in July. The company merged its remaining extrusion businesses with the magnesium operations of a China-based firm. The merged company had processing facilities in China, Mexico, and the United States. Also in July, the magnesium producer in Israel purchased the 35% share of its plant from a German auto manufacturer that had held the stake since the 35,000-ton-per-year primary magnesium plant was built in 1996. This gave the Israeli firm 100% ownership of the plant.

The joint venture between Norwegian and Dutch companies postponed secondary magnesium alloy production, which was originally scheduled to start in 2009 in Porsgrunn, Norway. The company cited the drop in magnesium consumption and price since autumn 2008 and difficulty in magnesium scrap collection. The company still planned to start primary magnesium metal production from olivine as originally scheduled in 2011.

World Primary Production and Reserves:

	Primary production	
	2008	**2009[e]**
United States	W	W
Brazil	15	15
China	559	470
Israel	35	30
Kazakhstan	21	20
Russia	37	30
Serbia	2	2
Ukraine	3	3
World total[5] (rounded)	671	570

Reserves[4]

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

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

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

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]See also Magnesium Compounds.
[2]Rounded to two significant digits to protect proprietary data.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[5]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 30%, 11%, and 12%, respectively, of manganese demand. 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 $510 million.

Salient Statistics—United States:[1]	2005	2006	2007	2008	2009[e]
Production, mine[2]	—	—	—	—	—
Imports for consumption:					
Manganese ore	656	572	602	571	300
Ferromanganese	255	358	315	448	100
Silicomanganese[3]	327	400	414	365	130
Exports:					
Manganese ore	13	2	29	48	19
Ferromanganese	14	22	29	23	28
Shipments from Government stockpile excesses:[4]					
Manganese ore	34	73	101	9	-9
Ferromanganese	36	56	68	18	29
Consumption, reported:[5]					
Manganese ore[6]	368	365	351	386	410
Ferromanganese	286	297	272	304	150
Consumption, apparent, manganese[7]	773	1,060	975	868	390
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]	4.39	3.22	3.10	12.15	5.77
CNF[8] China, Ryan's Notes	3.21	2.33	6.05	14.70	[9]5.84
Stocks, producer and consumer, yearend:					
Manganese ore[6]	337	153	114	285	110
Ferromanganese	30	31	20	25	20
Net import reliance[10] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Manganese was recycled incidentally as a minor 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 (2005-08): Manganese ore: Gabon, 57%; South Africa, 17%; Australia, 10%; Brazil, 5%; and other, 11%. Ferromanganese: South Africa, 52%; China, 20%; Republic of Korea, 7%; Mexico, 6%, and other, 15%. Manganese contained in all manganese imports: South Africa, 34%; Gabon, 21%; China, 10%; Australia, 7%; and other, 28%.

Tariff:

Item	Number	Normal Trade Relations 12-31-09
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—9-30-09[11]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2009	Disposals FY 2009
Manganese ore:				
Battery grade	—	—	18	—
Chemical grade	—	—	23	—
Metallurgical grade	5	5	227	—
Ferromanganese, high-carbon	403	403	91	34
Synthetic dioxide	—	—	3	—

Events, Trends, and Issues: Global financial problems that began during the third quarter of 2008 continued to affect the manganese market in 2009. U.S. steel production in 2009 was 40% less than that in 2008. Imports of manganese materials were significantly less in 2009 than in 2008—47%, 78%, and 64% less for manganese ore, ferromanganese, and silicomanganese, respectively. As a result, U.S. manganese apparent consumption decreased by an estimated 55% to 390,000 metric tons in 2009, the lowest since the late 1930s. The annual average domestic manganese ore contract price followed the decrease in the average international price for metallurgical-grade ore that was set between Japanese consumers and major suppliers in 2009. The average weekly spot market price for 48% manganese ore, CNF China, also decreased 28% to $5.84 per metric ton unit through the first 10 months in 2009, owing to high levels of manganese ore stocks in China and pricing competition between major manganese ore producers. However, U.S. average weekly spot prices for high-carbon ferromanganese and silicomanganese through October 2009 were 4% higher and 44% higher, respectively, than those at the start of the year, owing to lower inventory levels caused by production cutbacks, by one major domestic producer, and reduced imports.

World Mine Production and Reserves (metal content): Reserves estimates have been revised from those previously published for Australia (upward), Brazil (downward), and South Africa (upward), as reported by the Government of Australia and the major manganese producers in Brazil and South Africa.

	Mine production 2008	Mine production 2009[e]	Reserves[12]
United States	—	—	—
Australia	2,320	1,600	87,000
Brazil	1,380	990	29,000
China	[e]2,200	2,400	40,000
Gabon	1,600	810	52,000
India	[e]960	960	56,000
Mexico	170	94	4,000
South Africa	2,900	1,300	130,000
Ukraine	[e]490	310	140,000
Other countries	1,310	1,200	Small
World total (rounded)	13,300	9,600	540,000

World Resources: Land-based manganese resources are large but irregularly distributed; those of the United States are very low grade and have potentially high extraction costs. South Africa accounts for about 80% of the world's identified manganese resources, and Ukraine accounts for 10%.

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

[e]Estimated — 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]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 2009.
[10]Defined as imports – exports + adjustments for Government and industry stock changes.
[11]See Appendix B for definitions.
[12]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

MERCURY

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

Domestic Production and Use: Mercury has not been produced as a primary commodity in the United States since 1992, when the McDermitt Mine, Humboldt County, NV, closed. However, byproduct mercury was produced from processing gold-silver ore at several mines in Nevada. These data were not reported. Secondary, or recycled, mercury was recovered by retorting end-of-use mercury-containing products that include batteries, compact and traditional fluorescent lamps, dental amalgam, medical devices, and thermostats, as well as mercury-contaminated soils. The mercury was processed and refined for resale or exported. Secondary mercury production data were not reported. Mercury use is not carefully tracked in the United States; however, only about 100 metric tons per year of mercury are consumed domestically. The leading domestic end user of mercury was the chlorine-caustic soda industry. Only five mercury cell facilities were operating at yearend 2008, and based on announced plans, only four mercury-cell facilities will be in operation at yearend 2009. Owing to mercury toxicity and concerns for human health, mercury use has declined in the United States. Mercury has been released to the environment from mercury-containing car switches when the automobile is scrapped for recycling, from coal-fired powerplant emissions, and from incinerated mercury-containing medical devices. Mercury is no longer used in batteries and paints manufactured in the United States. Mercury was imported, refined, and then exported for global use in chlorine-caustic soda production, dental amalgam, fluorescent lights, and small-scale gold mining. Some button-type batteries, cleansers, fireworks, folk medicines, grandfather clocks, pesticides, and skin-lightening creams and soaps may contain mercury.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production:					
Mine (byproduct)	NA	NA	NA	NA	NA
Secondary	NA	NA	NA	NA	NA
Imports for consumption (gross weight), metal	212	94	67	155	190
Exports (gross weight), metal	319	390	84	732	700
Price, average value, dollars per flask, free market[2]	555.00	670.00	530.00	600.00	630.00
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: In 2009, six companies in the United States accounted for the majority of secondary mercury reclamation and production. More than 50 smaller companies collected automobile convenience switches, barometers, computers, dental amalgam, medical devices, thermostats, and some mercury-containing toys and shipped them on to larger companies for retorting. The reservoir of mercury-containing products for recycling is shrinking because of increased use of nonmercury substitutes.

Import Sources (2005-08): Peru, 60%; Germany, 10%; Russia, 10%; Chile, 6%; and other, 14%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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 at several sites in the United States; however, the Defense Logistics Agency has indicated that consolidated storage is the preferred alternative. Sales of mercury from the National Defense Stockpile remained suspended. An additional 1,329 tons of mercury was held by the U.S. Department of Energy, Oak Ridge, TN.

Stockpile Status—9-30-09[4]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2009	Disposals FY 2009
Mercury	4,436	4,436	—	—

Events, Trends, and Issues: The United States is a leading exporter of mercury, and in 2009, the principal export destinations were Australia, the Netherlands, and Peru. According to trade journals, the average cost of a flask of domestic mercury was $580 to $680 in 2009. Global consumption of mercury was estimated to be approximately 2,000 tons per year, and approximately 50% of this consumption came from the use of mercury compounds to make vinyl monomer in China and Eastern Europe. Mercury is also widely used for small-scale gold mining in many

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MERCURY

parts of the world, and the rising price of gold, to as high as $1,040 per troy ounce in 2009, has also influenced the global demand for mercury. Diminishing supplies of mercury that can be recycled from end-of-use, mercury-containing products, and availability of mercury from China, Kyrgyzstan, and Spain, also affect the mercury price. Nonmercury technology for the production of chlorine and caustic soda and the ultimate closure of the world's mercury-cell chlor-alkali plants will put tons of mercury on the global market for recycling, sale, or storage. The Federal Government is trying to find a location to store the Nation's excess mercury, and seven States—Colorado, Idaho, Missouri, Nevada, South Carolina, Texas, and Washington—are being considered. The U.S. Geological Survey completed a study of mercury in fish, bed sediments, and water in 291 streams across the United States. Mercury contamination that exceeded the U.S. Environmental Protection Agency (EPA) human-health criterion of 0.3 microgram per gram wet weight was detected in 25% of the samples. The EPA continued its efforts to provide the technology necessary to reduce mercury emissions from gold shops in Brazil, Peru, and other parts of South America. Mercury is widely used in small-scale gold mining, and it is common practice to burn the mercury-gold amalgam in order to purify the gold for sale. The Washington, D.C. Circuit Court rescinded the EPA's rule removing coal-fired powerplants from the Clean Air Act list of sources of hazardous air pollutants. At the same time, the Court rescinded the Clean Air Mercury Rule, which was issued in 2005 and was the first-ever rule to regulate mercury emissions form coal-fired powerplants. Governmental regulations and environmental standards are likely to continue as major factors in domestic mercury recycling, supply, and demand. Byproduct mercury production is expected to continue from domestic and foreign gold-silver mining and processing, as is secondary production of mercury from a diminishing supply of mercury-containing products such as thermostats. Mercury may also be recovered and recycled from compact and traditional fluorescent lamps. Domestic mercury consumption will continue to decline as nonmercury-containing products, such as digital thermometers, are substituted.

World Mine Production and Reserves: Reserves data for China were included based on official Government statistics.

	Mine production		Reserves[5]
	2008	2009[e]	
United States	NA	NA	—
China	800	800	21,000
Kyrgyzstan	250	250	7,500
Peru (byproduct)	136	100	NA
Spain	NA	NA	NA
Other countries	130	130	38,000
World total (rounded)	1,320	1,280	67,000

World Resources: China, Kyrgyzstan, Russia, Slovenia, Spain, and Ukraine have most of the world's estimated 600,000 tons of mercury resources. 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, and production is from stockpiled material. In the United States, there are mercury occurrences in Alaska, Arkansas, California, Nevada, and Texas; however, mercury has not been mined as a principal metal 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 thermometers. Mercury-cell technology is being replaced by newer diaphragm and membrane cell technology at chlor-alkali plants. Light-emitting diodes that contain indium substitute for mercury-containing fluorescent lamps. Lithium, nickel-cadmium, and zinc-air batteries replace mercury-zinc batteries in the United States, indium compounds substitute for mercury in alkaline batteries, and organic compounds have been substituted for mercury fungicides in latex paint.

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

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

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

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

[4]See Appendix B for definitions.

[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

MICA (NATURAL), SCRAP AND FLAKE[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Scrap and flake mica production, excluding low-quality sericite, was estimated to be 90,000 tons in 2009. North Carolina accounted for 26% of U.S. mine production. The remaining output came from Alabama, Georgia, South 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 2009 scrap mica production was estimated to be $22 million. Ground mica sales in 2008 were valued at about $27 million and were expected to decrease in value in 2009. There were 10 domestic producers of scrap and flake mica.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production[2, 3]					
Mine	78	110	97	84	90
Ground	120	123	85	98	92
Imports, mica powder and mica waste	36	45	41	27	19
Exports, mica powder and mica waste	9	7	8	9	8
Consumption, apparent[4]	105	148	130	102	101
Price, average, dollars per metric ton, reported:					
Scrap and flake	248	204	149	143	146
Ground:					
Wet	776	784	794	651	720
Dry	226	237	246	251	240
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine, number	NA	NA	NA	NA	NA
Net import reliance[5] as a percentage of apparent consumption	26	26	26	18	11

Recycling: None.

Import Sources (2005-08): Canada, 35%; China, 33%; India, 24%; Finland, 5%; and other, 3%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
Mica powder	2525.20.0000	Free.
Mica waste	2525.30.0000	Free.

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

Government Stockpile: None.

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MICA (NATURAL), SCRAP AND FLAKE

Events, Trends, and Issues: Domestic production of ground mica was estimated to decrease in 2009, based on data through September. The decrease primarily resulted from a decline in demand for most mica-containing products, including the principal uses—paint and drywall compound. Canada remained the main source of imported phlogopite mica for the United States. Canada and China were the leading sources of imported mica powder, and India and Canada were the principal sources of mica waste. U.S. imports of both mica powder and mica waste decreased in 2009 compared with those of 2008, based on data through September. India was the major source of imported crude and rifted mica valued at under $1.00 per kilogram, and these imports also declined in 2009. Finland, Russia, and the United States were major world producers of scrap and flake mica in 2009. Imported mica scrap and flake is primarily used for making mica paper and as a filler and reinforcer in plastics.

World Mine Production and Reserves:

	Mine production[e]		Reserves[6]
	2008	**2009**	
United States[2]	84	90	Large
Brazil	4	4	Large
Canada	17	17	Large
China	NA	NA	Large
Finland:			Large
Muscovite concentrate	11	10	
Biotite	58	60	
France	20	20	Large
India	4	4	Large
Korea, Republic of	42	40	Large
Norway	3	3	Large
Russia	100	100	Large
Other countries	32	30	Large
World total (rounded)	374	380	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.

Substitutes: Some of the lightweight aggregates, such as diatomite, perlite, and vermiculite, may be substituted for ground mica when used as a filler. Ground synthetic fluorophlogopite, a fluorine-rich mica, may replace natural ground mica for uses that require thermal and electrical properties of mica.

[e]Estimated. NA Not available.
[1]See also Mica (Natural), Sheet.
[2]Sold or used by producing companies.
[3]Excludes low-quality sericite used primarily for brick manufacturing.
[4]Based on scrap and flake mica production.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

MICA (NATURAL), SHEET[1]

(Data in metric tons unless otherwise noted)

Domestic Production and Use: A minor amount of sheet mica was produced in 2009 as a byproduct at a gemstone mine in Amelia, VA, and as incidental production from feldspar mining in the Spruce Pine area of North Carolina. The domestic consuming industry was dependent upon imports to meet demand for sheet mica. During 2009, an estimated 51 tons of unworked mica split block and mica splittings valued at $405,000 were imported. Mica block and film were consumed by five companies in four States and splittings were consumed by nine companies in eight States, mainly in the East and the Midwest. Most sheet mica was fabricated into parts for electronic and electrical equipment. An additional estimated 1,500 tons of imported worked mica valued at $15.2 million also was consumed.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009**[e]
Production, mine[e]	([2])	([2])	([2])	([2])	([2])
Imports, plates, sheets, strips; worked mica; split block; splittings; other >$1.00/kg	1,390	1,770	1,950	1,880	1,600
Exports, plates, sheets, strips; worked mica; crude and rifted into sheet or splittings >$1.00/kg	1,430	1,400	1,300	2,020	1,200
Shipments from Government stockpile excesses	38	6	7	([2])	—
Consumption, apparent	[3]3	[3]380	[3]683	([3, 4])	380
Price, average value, dollars per kilogram, muscovite and phlogopite mica, reported:					
Block	125	130	132	122	130
Splittings	1.56	1.53	1.57	1.53	1.60
Stocks, fabricator and trader, yearend	NA	NA	NA	NA	NA
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2005-08): China, 23%; Brazil, 20%; Belgium, 19%; India, 19%; and other, 19%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
Split block mica	2525.10.0010	Free.
Mica splittings	2525.10.0020	Free.
Unworked—other	2525.10.0050	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.

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

Government Stockpile: The mica remaining in the National Defense Stockpile (NDS) was shipped in 2008. All remaining uncommitted stocks of mica, 239 kilograms of muscovite block, were sold in April 2008. Stocks of muscovite film in the NDS were depleted by the end of fiscal year (FY) 2004. Stocks of phlogopite splittings were sold out in FY 2005. The remaining stocks of muscovite splittings were sold out in FY 2007. The remaining stocks of mica in the NDS (muscovite block) were sold and shipped in FY 2008.

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MICA (NATURAL), SHEET

Events, Trends, and Issues: Overall demand for sheet mica decreased in 2009, and imports of worked and unworked sheet mica declined for the second year in a row. Changes in imports in different categories were mixed in 2009 compared with those of 2008. Imports of worked sheet decreased an estimated 19% for "plates, sheets, and strips of agglomerated or reconstituted mica," and increased 18% for "mica, worked, and articles of mica not classified elsewhere." U.S. imports of unworked sheet mica (based on data through September) decreased 61%, primarily the result of decreases in all of the categories "mica, worked, and articles of mica not classified elsewhere," "mica splittings," and "split block mica."

Imports were the principal source of domestic supply of sheet mica in 2009. Significant stocks of mica previously sold from the NDS to domestic and foreign mica traders, brokers, and processors were exported, however, causing the United States to appear to have a small apparent consumption in 2005 and possibly resulting in understating apparent consumption in 2006 through 2009. Future supplies were expected to come increasingly from imports, primarily from Brazil, China, India, and Russia. Prices for imported sheet mica also were expected to increase, and good-quality sheet mica remained in short supply. Imported high-quality sheet mica sold for as much as $1,000 to $2,000 per kilogram. There were no environmental concerns associated with the manufacture and use of mica products.

World Mine Production and Reserves:

	Mine production[e]		Reserves[6]
	2008	2009	
United States	([2])	([2])	Very small
India	3,500	3,500	Very large
Russia	1,500	1,500	Moderate
Other countries	200	200	Moderate
World total	5,200	5,200	Very large

World Resources: There has been no formal evaluation of world resources of sheet mica 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. These domestic resources are uneconomic because of the high cost of hand labor required to mine and process sheet mica from pegmatites.

Substitutes: Many materials can be substituted for mica in numerous electrical, electronic, and insulation uses. Substitutes include acrylic, Benelex®, cellulose acetate, Delrin®, Duranel® N, fiberglass, fishpaper, Kapton®, Kel F®, Kydex®, Lexan®, Lucite®, Mylar®, Nomex®, Noryl®, nylon, nylatron, phenolics, Plexiglass®, polycarbonate, polyester, styrene, Teflon®, 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. — Zero.
[1]See also Mica (Natural), Scrap and Flake.
[2]Less than ½ unit.
[3]See explanation in the Events, Trends, and Issues section.
[4]Apparent consumption calculation in 2008 results in a negative number.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

MOLYBDENUM

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

Domestic Production and Use: In 2009, molybdenum, valued at about $1.3 billion (based on average oxide price), was produced by 11 mines. Molybdenum ore was produced as a primary product at four mines—one each in Colorado, Idaho, Nevada, and New Mexico—whereas seven copper mines (four in Arizona, one each in Montana, 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 75% of the molybdenum consumed.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production, mine	58,000	59,800	57,000	55,900	50,000
Imports for consumption	20,700	16,700	18,300	14,500	14,000
Exports	42,100	34,500	33,700	34,700	35,000
Consumption:					
Reported	18,900	19,000	20,500	20,900	19,000
Apparent	34,700	44,300	41,000	36,100	29,000
Price, average value, dollars per kilogram[1]	70.11	54.62	66.79	62.99	25.80
Stocks, mine and plant concentrates, product, and consumer materials	9,400	7,000	7,600	7,200	7,600
Employment, mine and plant, number	880	910	940	940	920
Net import reliance[2] 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 (2005-08): Ferromolybdenum: China, 52%; Chile, 30%; Canada, 10%; and other, 8%. Molybdenum ores and concentrates: Chile, 34%; Mexico, 31%; Canada, 22%; Peru, 12%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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 2009 decreased about 11% from that of 2008. U.S. imports for consumption decreased slightly from those of 2008, while the U.S. exports increased slightly from those of 2008. Domestic roasters operated at full production levels in 2008 but only at between 80% and 90% of full production capacity in 2009. U.S. reported consumption decreased 9% from that of 2008 while apparent consumption decreased about 20%. Mine capacity utilization in 2009 was about 71%.

Molybdenum prices declined during the first quarter of 2009 only to begin a gradual increase in the third quarter. Both byproduct and primary molybdenum mines in the United States decreased production levels in the first quarter of 2009. The Henderson Mine in Empire, CO, reduced molybdenum production by 25% in 2009. The byproduct molybdenum circuits at the Chino Mine in Grant County, NM, and the Mission Mine in Pima County, AZ, suspended molybdenum production in 2009. The Ashdown Mine, near Denio, NV, restarted molybdenum operations in the second quarter of 2009 after temporarily being placed on care and maintenance in November 2008. The Mineral Park Mine, near Kingman, AZ, started molybdenum operations in the fourth quarter of 2008.

World Mine Production and Reserves: Reserves for Mongolia were revised based on new information published in a mining company's annual report.

	Mine production		Reserves[3]
	2008	2009[e]	(thousand metric tons)
United States	55,900	50,000	2,700
Armenia	4,250	4,000	200
Canada	7,720	7,200	450
Chile	33,700	32,000	1,100
China	81,000	77,000	3,300
Iran	3,800	3,100	50
Kazakhstan	400	400	130
Kyrgyzstan	250	250	100
Mexico	7,810	7,200	135
Mongolia	2,000	3,000	100
Peru	16,700	15,000	140
Russia[e]	3,600	3,400	240
Uzbekistan[e]	500	400	60
World total (rounded)	218,000	200,000	8,700

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

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

[e]Estimated. E Net exporter.
[1]Time-average price per kilogram of molybdenum contained in technical-grade molybdic oxide, as reported by Platts Metals Week.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

NICKEL

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

Domestic Production and Use: The United States did not have any active nickel mines in 2009. Limited amounts of byproduct nickel were recovered from copper and palladium-platinum ores mined in the Western United States. On a monthly or annual basis, 111 facilities reported nickel consumption. The principal consuming State was Pennsylvania, followed by Kentucky, West Virginia, and Illinois. Approximately 45% of the primary nickel consumed went into stainless and alloy steel production, 39% into nonferrous alloys and superalloys, 11% into electroplating, and 5% into other uses. End uses were as follows: transportation, 32%; chemical industry, 14%; electrical equipment, 10%; construction, 8%; fabricated metal products, 8%; petroleum industry, 8%; household appliances, 6%; machinery, 6%; and other, 8%. The estimated value of apparent primary consumption was $1.32 billion.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production, refinery byproduct	W	W	W	W	W
Shipments of purchased scrap[1]	142,000	145,000	185,000	159,000	138,000
Imports: Primary	143,000	153,000	125,000	129,000	96,800
Imports: Secondary	15,500	20,300	16,200	20,100	18,000
Exports: Primary	7,630	8,050	13,100	11,600	6,980
Exports: Secondary	55,600	59,300	103,000	94,600	92,700
Consumption: Reported, primary	100,000	105,000	98,600	93,800	70,500
Consumption: Reported, secondary	102,000	106,000	98,600	84,500	63,500
Consumption: Apparent, primary	135,000	144,000	114,000	118,000	88,100
Consumption: Total[2]	237,000	250,000	213,000	202,000	152,000
Price, average annual, London Metal Exchange:					
Cash, dollars per metric ton	14,738	24,244	37,216	21,104	14,941
Cash, dollars per pound	6.685	10.997	16.881	9.572	6.777
Stocks: Consumer, yearend	12,900	13,500	13,600	12,900	14,100
Stocks: Producer, yearend[3]	5,940	6,450	3,990	4,050	4,400
Net import reliance[4] as a percentage of apparent consumption	48	50	22	34	18

Recycling: About 63,500 tons of nickel was recovered from purchased scrap in 2009. This represented about 42% of reported secondary plus apparent primary consumption for the year.

Import Sources (2005-08): Canada, 44%; Russia, 15%; Australia, 9%; Norway, 9%; and other, 23%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Nickel oxide, chemical grade	2825.40.0000	Free.
Ferronickel	7202.60.0000	Free.
Nickel oxide, metallurgical grade	7501.20.0000	Free.
Unwrought nickel, not alloyed	7502.10.0000	Free.

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

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

Events, Trends, and Issues: In late 2008, the United States was in a severe recession. U.S. raw steel production collapsed in the fall of 2008, and by yearend, capacity utilization at U.S. steelworks had dropped to 41% from the January-August plateau of 90%. The niche market for stainless steel, only 2% of total U.S. steel consumption, fared somewhat better than the much larger market for carbon steel. U.S. production of austenitic (nickel-bearing) stainless steel slipped to 1.29 million tons in 2008, only 4% less than the 1.35 million tons in 2007. 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. The European Union produced 5.79 million tons of austenitic stainless steel in 2008, followed by China with 5.40 million tons. By February 2009, the recession had spread globally, causing both world sales of stainless steel and the price of nickel to plunge. The global steel industry produced only 10.8 million tons of stainless steel in the first half of 2009, 27% less than that in the first half of 2008.

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NICKEL

In March 2009, the London Metal Exchange (LME) cash mean for 99.8%-pure nickel averaged $9,693 per metric ton ($4.40 per pound), compared with $27,680 per metric ton ($12.56 per pound) in January 2008. In the third quarter of 2009, the global economy stopped contracting and slowly began to turn upward—in part owing to stimulus programs funded by at least 23 National Governments. In October 2009, the LME cash mean averaged $18,520 per metric ton ($8.40 per pound), up 91% from the mean for March 2009. At yearend 2009, high unemployment and tight credit continued to hobble several of the more developed economies, weakening demand for nickel. A leading nickel producer halted production at its new Ravensthorpe Mine in Western Australia after nickel prices dropped sharply and has put the $2.2 billion operation up for sale. Several competitors suspended or slowed work on greenfield nickel mining projects in Canada, Guatemala, Vietnam, and Zambia. Mine development and construction of downstream facilities, however, continued at laterite projects in Brazil, Madagascar, and Turkey. Nickel prices remained subdued throughout the summer of 2009, despite a labor strike at a key nickel smelting and refining complex in Canada. Several North American automobile manufacturers were in financial trouble and began switching production to smaller, more fuel-efficient vehicles to boost sales. Some dealers had to put buyers on waiting lists for the more popular hybrid motor vehicles. Nickel-metal hydride batteries continued to be widely used in the latest hybrids, despite inroads made by lithium-ion batteries. Financially strapped airlines cut back, postponed, or canceled orders for new aircraft, reducing demand for nickel-based superalloys. Environmental concerns and increasing prices for natural gas have triggered a renaissance in the nuclear power industry. The U.S. Nuclear Regulatory Commission was actively reviewing 13 applications from utilities wanting to construct 22 new nuclear reactors—facilities that would require sizeable amounts of austenitic stainless steel and other nickel-bearing alloys.

World Mine Production and Reserves: Estimates of reserves for Canada, Colombia, the Dominican Republic, and Venezuela were revised based on new mining industry information from published sources.

	Mine production		Reserves[5]
	2008	2009[e]	
United States	—	—	—
Australia	200,000	167,000	26,000,000
Botswana	38,000	36,000	490,000
Brazil	58,500	56,700	4,500,000
Canada	260,000	181,000	4,100,000
China	68,400	84,300	1,100,000
Colombia	76,400	93,000	1,700,000
Cuba	67,300	65,000	5,500,000
Dominican Republic	31,300	—	840,000
Greece	18,600	14,000	490,000
Indonesia	193,000	189,000	3,200,000
New Caledonia[6]	103,000	107,000	7,100,000
Philippines	83,900	85,000	940,000
Russia	277,000	266,000	6,600,000
South Africa	31,700	34,000	3,700,000
Spain	8,140	7,800	57,000
Venezuela	13,000	12,000	490,000
Other countries	46,000	28,600	3,800,000
World total (rounded)	1,570,000	1,430,000	71,000,000

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. In addition, extensive deep-sea resources of nickel are in manganese crusts and nodules covering large areas of the ocean floor, particularly in the Pacific Ocean.

Substitutes: To offset high nickel prices, engineers have been substituting low-nickel, duplex, or ultrahigh-chromium stainless steels for austenitic grades in a few construction applications. Nickel-free specialty steels are sometimes used in place of stainless steel within the power-generating and petrochemical industries. Titanium alloys or specialty plastics can substitute for nickel metal or nickel-based alloys in highly corrosive chemical environments. Cost savings in manufacturing lithium-ion batteries allow them to compete against NiMH 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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[6]Overseas territory of France.

NIOBIUM (COLUMBIUM)

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

Domestic Production and Use: Significant U.S. niobium mine production has not been reported since 1959. Domestic niobium resources are of low grade, some are mineralogically complex, and most are not commercially recoverable. Companies in the United States produced ferroniobium and niobium compounds, metal, and other alloys from imported niobium minerals, oxides, and ferroniobium. Niobium was consumed mostly in the form of ferroniobium by the steel industry and as niobium alloys and metal by the aerospace industry. Major end-use distribution of reported niobium consumption was as follows: steels, 76%; and superalloys, 24%. In 2008, the estimated value of niobium consumption was $324 million and was expected to be about $108 million in 2009, as measured by the value of imports.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production:					
Mine	—	—	—	—	—
Recycling	NA	NA	NA	NA	NA
Imports for consumption[e, 1]	7,610	10,500	10,120	9,230	2,800
Exports[e, 1]	337	561	1,100	781	600
Government stockpile releases[e, 2]	152	156	—	—	—
Consumption:[e]					
Apparent	7,430	10,100	9,020	8,450	2,200
Reported[3]	4,600	5,050	6,510	6,000	3,000
Price, ferroniobium, dollars per pound[4]	6.58	NA	NA	NA	NA
Unit value, ferroniobium, dollars per metric ton[5]	13,197	14,022	21,918	34,398	39,000
Net import reliance[6] 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 (2005-08): Niobium contained in niobium and tantalum ore and concentrate; ferroniobium; and niobium metal and oxide: Brazil, 85%; Canada, 8%; Germany, 2%, Estonia, 2%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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[7]	8112.92.0600	Free.
Alloys, metal, powders	8112.92.4000	4.9% ad val.
Niobium, other[7]	8112.99.9000	4.0% ad val.

Depletion Allowance:[8] 22% (Domestic), 14% (Foreign).

Government Stockpile: For fiscal year (FY) 2009 (October 1, 2008, through September 30, 2009), the Defense National Stockpile Center (DNSC), Defense Logistics Agency, disposed of no niobium materials. The DNSC's niobium mineral concentrate inventory was exhausted in FY 2007; niobium carbide powder, in FY 2002; and ferroniobium, in FY 2001. The DNSC announced maximum disposal limits for FY 2009 of about 9 tons[9] of niobium metal ingots.

Stockpile Status—9-30-09[8]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2009	Disposals FY 2009
Niobium metal	10.1	10.1	[9]9	—

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NIOBIUM (COLUMBIUM)

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 about the same as that of 2008, when Brazil was the leading niobium supplier. By weight in 2008, Brazil supplied 87% of total U.S. niobium imports, 91% of ferroniobium, 87% of niobium metal, and 63% of niobium oxide. The leading suppliers of niobium in ore and concentrate were Australia (73%) and Canada (22%). Niobium apparent consumption is believed to have decreased in 2009 compared with that of 2008. Financial market problems and the subsequent economic slowdown were expected to result in reduced niobium material consumption and production.

World Mine Production and Reserves: Reserves for Brazil were revised based on new information published by the Brazilian Government. Reserves for Canada were revised based on new information published by a mining company.

	Mine production		Reserves[10]
	2008	2009[e]	
United States	—	—	—
Brazil	58,000	57,000	2,900,000
Canada	4,380	4,300	46,000
Other countries	483	400	NA
World total (rounded)	62,900	62,000	2,900,000

World Resources: World resources are more than adequate to supply projected needs. Most of the world's identified resources of niobium occur mainly as pyrochlore in carbonatite [igneous rocks that contain more than 50% by volume carbonate (CO_3) minerals] deposits and are outside the United States. The United States has approximately 150,000 tons of niobium resources in identified deposits, all of which were considered uneconomic at 2009 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 releases are the uncommitted inventory change as reported by the Defense National Stockpile Center.
[3]Includes ferroniobium and nickel niobium.
[4]Price is time-weighted (by week) average of trade journal reported ferroniobium price per pound of contained niobium, standard (steelmaking) grade. Ferroniobium price was discontinued in 2005; columbite price was discontinued in 2000; and pyrochlore price was discontinued in 1993.
[5]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.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]This category includes other than niobium-containing material.
[8]See Appendix B for definitions.
[9]Actual quantity limited to remaining sales authority; additional legislative authority is required.
[10]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

NITROGEN (FIXED)—AMMONIA

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

Domestic Production and Use: Ammonia was produced by 13 companies at 23 plants in 16 States in the United States during 2009; 5 additional plants were idle for the entire year. Sixty percent of total U.S. ammonia production capacity was centered in Louisiana, Oklahoma, and Texas because of their large reserves of natural gas, the dominant domestic feedstock. In 2009, U.S. producers operated at about 83% 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 89% 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]	**2005**	**2006**	**2007**	**2008**	**2009**[e]
Production[2]	8,340	8,190	8,540	7,850	7,700
Imports for consumption	6,520	5,920	6,530	6,020	5,060
Exports	525	194	145	192	50
Consumption, apparent	14,400	14,000	15,000	13,500	12,800
Stocks, producer, yearend	254	201	157	368	300
Price, dollars per ton, average, f.o.b. Gulf Coast[3]	304	302	309	590	250
Employment, plant, number[e]	1,150	1,150	1,050	1,100	1,050
Net import reliance[4] as a percentage of apparent consumption	42	41	43	42	40

Recycling: None.

Import Sources (2005-08): Trinidad and Tobago, 55%; Canada, 14%; Russia, 14%; Ukraine, 10%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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 $2 and $6 per million British thermal units for most of the year. Natural gas prices declined for most of 2009 and began an upward trend in September. Higher prices may be a result of increased demand for natural gas because of colder temperatures and an increase in crude oil prices. The average Gulf Coast ammonia price gradually increased from $210 per short ton at the beginning of 2009 to a high of around $350 per short ton in October. The average ammonia price for the year likely will be about $250 per short ton. The U.S. Department of Energy, Energy Information Administration, projected that Henry Hub natural gas spot prices would average $4.89 per million British thermal units in 2010.

A California-based company planned to build a $105 million bioammonia plant near Menlo, IA, by late 2011. The plant was expected to use 118,000 tons per year of corncobs to produce 45,000 tons per year of ammonia. This would be the first plant in the United States to use corncobs as feedstock to produce ammonia.

Plans to activate a portion of a urea ammonium nitrate production facility in Pryor, OK, were underway. Although the plant primarily will be producing urea ammonium nitrate, approximately 32,000 tons per year of ammonia was expected to be produced at the plant. The estimated cost to activate the Pryor facility was between $15 and $20 million. The plant had been idle for several years because of high natural gas prices.

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NITROGEN (FIXED)—AMMONIA

Several companies have announced plans to build new ammonia plants in Algeria, Qatar, and Uzbekistan, which would add 3.4 million tons of annual capacity within the next 2 to 3 years. Many of the ammonia plants that were idled in late 2008 as a result of the economic slowdown were back online in early 2009.

According to the U.S. Department of Agriculture, U.S. corn growers planted 34.4 million hectares of corn in the 2009 crop year (July 1, 2008, through June 30, 2009), which was a slight decrease from the area planted in 2008. The decrease in plantings was principally in response to lower corn prices in comparison to record highs in 2007, and unstable input costs were discouraging some growers from planting corn. Corn plantings for the 2010 crop year, however, were expected to increase to 35.6 million hectares. Corn acreage is expected to remain at historically high levels owing in part to continued U.S. ethanol production and the U.S. corn exports in response to a strong global demand for feed grains.

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

World Ammonia Production and Reserves:

	Plant production		Reserves[5]
	2008	2009[e]	
United States	7,850	7,700	Available atmospheric nitrogen and sources of natural gas for production of ammonia are considered adequate for all listed countries.
Bangladesh	1,300	1,300	
Canada	4,780	4,500	
China	44,000	44,000	
Egypt	1,750	3,000	
Germany	2,820	2,800	
India	11,100	11,100	
Indonesia	4,500	4,600	
Iran	2,000	2,000	
Japan	1,110	1,000	
Netherlands	1,800	1,800	
Pakistan	2,300	2,300	
Poland	2,000	2,000	
Qatar	1,800	1,800	
Romania	1,300	1,300	
Russia	10,400	10,400	
Saudi Arabia	2,600	2,600	
Trinidad and Tobago	5,130	5,150	
Ukraine	4,000	3,000	
Other countries	20,400	20,400	
World total (rounded)	133,000	133,000	

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

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

[e]Estimated.
[1]U.S. Department of Commerce (DOC) data unless otherwise noted.
[2]Annual and preliminary data as reported in Current Industrial Reports MQ325B (DOC).
[3]Source: Green Markets.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

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 $17.0 million in 2009. Peat was harvested and processed by about 37 companies in 14 of the conterminous States. The Alaska Department of Commerce, Office of Minerals Development, which conducted its own canvass of producers, reported 64,100 cubic meters of peat was produced in 2008; output was reported only by volume.[2] A production estimate was unavailable for Alaska for 2009. Florida, Minnesota, and Maine were the leading producing States, in order of quantity harvested. Reed-sedge peat accounted for approximately 81% of the total volume produced, followed by sphagnum moss, 9%, hypnum moss, 6%, and humus, 4%. More than 92% 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:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production	685	551	635	615	610
Commercial sales	751	734	694	648	641
Imports for consumption	891	924	977	936	980
Exports	36	41	56	[e]56	80
Consumption, apparent[3]	1,600	1,500	1,590	1,440	1,532
Price, average value, f.o.b. mine, dollars per ton	27.76	27.34	25.59	26.42	26.50
Stocks, producer, yearend	195	128	98	152	130
Employment, mine and plant, number[e]	700	650	625	620	610
Net import reliance[4] as a percentage of apparent consumption	57	63	60	57	60

Recycling: None.

Import Sources (2005-08): Canada, 97%; and other, 3%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-09**
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 600,000 tons per year and imported peat from Canada to account for more than 60% of domestic consumption.

Peatland restoration is growing in importance in Europe and North America. The British Government is intending to eliminate peat used in horticulture applications, which includes using peat as a soil improver or growing media. However, other countries such as Russia and Ukraine are proposing to use additional peat as a fuel source.

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

	Mine production		Reserves[5]
	2008	2009[e]	
United States	615	610	150,000
Belarus	2,600	2,600	400,000
Canada	1,150	1,250	720,000
Estonia	920	900	60,000
Finland	9,100	9,100	6,000,000
Ireland	4,300	4,300	([6])
Latvia	1,000	1,000	76,000
Lithuania	322	325	190,000
Moldova	475	475	([6])
Russia	1,300	1,300	1,000,000
Sweden	1,280	1,200	([6])
Ukraine	400	400	([6])
Other countries	1,520	1,530	1,400,000
World total (rounded)	25,000	25,000	10,000,000

World Resources: Peat is a renewable resource, continuing to accumulate on 60% of global peatlands. However, the volume of global peatlands has been decreasing at a rate of 0.05% annually owing to harvesting and land development. Many countries evaluate peat resources based on volume or area because the variations in densities and thickness of peat deposits make it difficult to estimate tonnage. Volume data have been converted using the average bulk density of peat produced in that country. Reserves 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. reserve base is contained in peatlands in undisturbed areas of Alaska. Total world resources of peat were estimated to be between 5 trillion to 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., Alaska Office of Economic Development, oral commun., 2009.
[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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[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 2009 was $18.6 million. Crude ore production came from nine mines operated by seven companies in six Western States. New Mexico continued to be the major producing State. Processed crude perlite was expanded at 55 plants in 28 States. The principal end uses were building construction products, 59%; fillers, 13%; horticultural aggregate, 13%; filter aid, 8%; and other, 7%.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production[1]	508	454	409	434	380
Imports for consumption[e]	196	245	229	187	135
Exports[e]	32	30	28	37	35
Consumption, apparent	672	669	610	584	480
Price, average value, dollars per ton, f.o.b. mine	41	43	45	45	49
Employment, mine and mill	128	113	110	103	97
Net import reliance[2] as a percentage of apparent consumption	24	32	33	26	21

Recycling: Not available.

Import Sources (2005-08): Greece, 100%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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 about 12% compared with that reported for 2008. Imports also decreased as demand for perlite-based construction products fell with the weak U.S. economy and lower construction activity.

The amount of processed crude perlite sold or used was at its lowest amount since 1968. Concurrently, imports of processed crude perlite were at the lowest levels since 1997.

Perlite mining generally takes place in remote areas, and its environmental impact is not severe. The mineral fines, overburden, and reject ore produced during ore mining and processing are used to reclaim the mined-out areas, and, therefore, little waste remains. Airborne dust is captured by baghouses, and there is practically no runoff that contributes to water pollution.

World Processed Perlite Production and Reserves: Greece surpassed the United States in processed perlite production starting in 2003. Information for China and several other countries is unavailable, making it unclear whether or not Greece and the United States are the world's leading producers.

	Production		Reserves[3]
	2008	2009[e]	
United States	434	380	50,000
Greece	525	500	50,000
Hungary	70	70	3,000
Japan	230	230	([4])
Mexico	54	50	([4])
Turkey	270	250	([4])
Other countries	205	210	600,000
World total (rounded)	1,790	1,690	700,000

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.
[1]Processed perlite sold and used by producers.
[2]Defined as imports - exports + adjustments for Government and industry stock changes; changes in stocks were not available and assumed to be zero for apparent consumption and net import reliance calculations.
[3]See Appendix C for definitions. Reserves data are for crude ore. Reserve base estimates were discontinued in 2009; see Introduction.
[4]Included with "Other countries."

PHOSPHATE ROCK

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Phosphate rock ore was mined by 6 firms at 12 mines in 4 States and upgraded to an estimated 27.2 million tons of marketable product valued at $1.4 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:	2005	2006	2007	2008	2009[e]
Production, marketable	36,100	30,100	29,700	30,200	27,200
Sold or used by producers	35,200	30,200	31,100	28,850	23,900
Imports for consumption	2,630	2,420	2,670	2,754	1,800
Consumption[1]	37,800	32,600	33,800	31,600	25,700
Price, average value, dollars per ton, f.o.b. mine[2]	29.61	30.49	51.10	76.76	50.00
Stocks, producer, yearend	6,970	7,070	4,970	6,335	8,000
Employment, mine and beneficiation plant, number[e]	2,700	2,500	2,500	2,550	2,600
Net import reliance[3] as a percentage of apparent consumption	7	7	14	4	1

Recycling: None.

Import Sources (2005-08): Morocco, 100%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
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: In 2009, U.S. phosphate rock production and reported usage were at their lowest point since the mid-1960s, and consumption was at its lowest level since the early 1970s. The weak market conditions were the result of the global economic crisis that started in late 2008 and carried into 2009. After phosphate rock and fertilizer prices reached highs in mid-2008, phosphate fertilizer producers were left with high inventories of both phosphate rock and fertilizer as farmers delayed purchases until the price dropped. This led to the temporary closure of many phosphate rock mines and fertilizer plants. The price for phosphate rock also fell rapidly during the same period. U.S. exports of phosphate fertilizers increased slightly on the strength of DAP sales to India.

The phosphate rock producer in North Carolina received a permit from the U.S. Army Corps of Engineers to expand its mining operation in the State. In Idaho, the leading phosphate rock producer in the Western States received a permit to expand its mining operation in the Caribou-Targhee National Forest in Eastern Idaho. The two other phosphate rock producers in Idaho announced plans for new mines, which will replace existing mines when the reserves are exhausted.

Worldwide, phosphate rock mine production capacity is expected to increase gradually through 2013 to about 30% more than that in 2008. New mines are scheduled to open in Australia and Peru in 2010 and Namibia and Saudi Arabia in 2011. Expansions to existing operations are planned in Brazil, China, Egypt, Finland, Morocco, Russia, and Tunisia. In Canada, a significant phosphate rock deposit in Northern Ontario was being evaluated for development, and another deposit in British Columbia was being investigated.

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PHOSPHATE ROCK

A similar percentage increase was expected for phosphoric acid production capacity through 2013, with the bulk of the growth happening in China, Morocco, and Saudi Arabia. Most of the projected capacity growth for phosphoric acid and fertilizers will be captive production, as more countries attempt to limit reliance on imported fertilizers.

World Mine Production and Reserves: Reserves data for the United States, Canada, Jordan, Senegal, and Togo were revised based on new individual company data. Reserves data for China were revised using official government sources. Reserves data for Kazakhstan, Peru, and Saudi Arabia (in "Other countries") were revised based on new information from companies in those countries.

	Mine production		Reserves[4]
	2008	2009[e]	
United States	30,200	27,200	1,100,000
Australia	2,800	2,500	82,000
Brazil	6,200	6,000	260,000
Canada	950	900	15,000
China[5]	50,700	55,000	3,700,000
Egypt	3,000	3,300	100,000
Israel	3,090	3,000	180,000
Jordan	6,270	6,000	1,500,000
Morocco and Western Sahara	25,000	24,000	5,700,000
Russia	10,400	9,000	200,000
Senegal	700	700	80,000
South Africa	2,290	2,300	1,500,000
Syria	3,220	3,000	100,000
Togo	800	800	60,000
Tunisia	8,000	7,000	100,000
Other countries	7,440	7,000	950,000
World total (rounded)	161,000	158,000	16,000,000

World Resources: Domestic reserves data were based on U.S. Geological Survey and individual company information. Phosphate rock resources occur principally as sedimentary marine phosphorites. The largest sedimentary deposits are found in northern Africa, China, the Middle East, and the United States. Significant igneous occurrences are found in Brazil, Canada, 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.

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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[5]Production data for China do not include small "artisanal" mines.

PLATINUM-GROUP METALS

(Platinum, palladium, rhodium, ruthenium, iridium, osmium)
(Data in kilograms unless otherwise noted)

Domestic Production and Use: The Stillwater and East Boulder Mines in south-central Montana were the only primary platinum-group metals (PGMs) mines in the United States and were owned by one company. Small quantities of PGMs were also recovered as byproducts of copper refining by companies in Texas and Utah. The leading demand sector for PGMs continued to be catalysts for air-pollution abatement in both light- and heavy-duty vehicles. PGMs are also used in the chemical sector as catalysts for manufacturing bulk chemicals such as nitric acid; in the petroleum refining sector; and in the fabrication of laboratory equipment. In the electronics sector, PGMs are used in computer hard disks, multilayer ceramic capacitors, and hybridized integrated circuits. PGMs are used by the glass manufacturing sector in the production of fiberglass, liquid crystal displays, and flat-panel displays. Platinum alloys, in cast or wrought form, are commonly used for jewelry. Platinum, palladium, and a variety of complex gold-silver-copper alloys are used as dental restorative materials. Platinum and palladium can be used as investment tools in the form of exchange traded notes and exchange traded funds.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Mine production:[1]					
Platinum	3,920	4,290	3,860	3,580	3,800
Palladium	13,300	14,400	12,800	11,900	12,500
Imports for consumption:					
Platinum	106,000	114,000	181,000	150,000	112,000
Palladium	139,000	119,000	113,000	120,000	50,000
Rhodium	13,600	15,900	16,600	12,600	10,200
Ruthenium	23,200	36,000	48,700	49,800	21,600
Iridium	3,010	2,800	3,410	2,550	1,300
Osmium	39	56	23	11	80
Exports:					
Platinum	20,700	45,500	28,900	15,600	20,000
Palladium	27,000	53,100	41,800	26,400	31,000
Rhodium	615	1,600	2,210	1,980	950
Other PGMs	1,080	3,390	8,190	6,450	1,800
Price,[2] dollars per troy ounce:					
Platinum	899.51	1,144.42	1,308.44	1,578.26	1,187.00
Palladium	203.54	322.93	357.34	355.12	254.00
Rhodium	2,059.73	4,561.06	6,203.09	6,533.57	1,468.00
Ruthenium	74.41	193.09	573.74	324.60	91.00
Iridium	169.51	349.45	444.43	448.34	420.40
Employment, mine, number[1]	1,620	1,720	1,630	1,360	1,000
Net import reliance as a percentage of apparent consumption[e]					
Platinum	93	90	91	89	89
Palladium	84	75	73	79	47

Recycling: An estimated 17,000 kilograms of PGMs was recovered from new and old scrap in 2009.

Import Sources (2005-08): Platinum: South Africa, 27%; Germany, 17%; United Kingdom, 12%; Canada, 5%; and other, 39%. Palladium: Russia, 46%; South Africa, 21%; United Kingdom, 17%; Belgium, 4%; and other, 12%.

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 2009.

Stockpile Status—9-30-09[3]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2009	Disposals FY 2009
Platinum	261	261	[4]778	—
Iridium	18	18	[4]186	—

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PLATINUM-GROUP METALS

Events, Trends, and Issues. Prices of platinum, palladium, and rhodium trended higher during the year, whereas prices of iridium and ruthenium remained relatively flat. Prices of platinum and rhodium nearly reached parity in March, for the first time in almost 5 years.

The global economic deterioration had several adverse effects on the PGM industry. The poor economy resulted in lower demand and production of automobiles, in which catalytic converters are the major use of PGMs. Some mining companies placed mines on care and maintenance and others cut back on production in response to lower metal prices in 2009 compared with the high prices in 2008. One of the leading U.S. auto manufacturers filed for Chapter 11 bankruptcy protection and cancelled its contract with the U.S. PGMs producer to purchase palladium and rhodium. The U.S. Government instituted a “cash for clunkers” auto scrap plan to encourage consumers to scrap old vehicles and purchase new, more fuel-efficient vehicles. The effect may be an increase in supply of recycled PGMs from scrapped vehicles because older models contain higher quantities of PGMs in their catalytic converters than newer models. Demand for platinum jewelry increased in India and China as a result of lower prices in 2009 compared with prices of 2008. A decrease in car sales in Europe and North America can be expected to result in a decrease in use of platinum and palladium in these regions in 2010 and beyond. The tightening of emissions standards in China, Europe, Japan, and other parts of the world is expected to lead to higher average platinum loadings on catalysts, especially in light-duty diesel vehicles, as particulate matter emissions become more closely controlled. In the United States, thrifting is continuing at most manufacturers and is likely to lead to a reduction in the use of platinum in autocatalysts. The large price differential between platinum and palladium has led to the assumption that automobile manufacturers will continue to change PGMs ratios in gasoline-engine vehicles in favor of palladium, as well as continue efforts to increase the proportion of palladium used in diesel vehicles. Research is likely to continue on fuel cells for automobiles, with some progress having been made in the use of palladium rather than more expensive platinum, in the catalysts. The sales of platinum jewelry are expected to increase in some regions, in response to lower prices than in the recent past. Investor interest in exchange-traded notes and funds is expected to continue to rise.

World Mine Production and Reserves:

	Mine production				PGMs
	Platinum		Palladium		Reserves[5]
	2008	2009[e]	2008	2009[e]	
United States	3,580	3,800	11,900	12,500	900,000
Canada	7,000	5,000	15,000	9,000	310,000
Colombia	1,500	1,200	NA	NA	([6])
Russia	23,000	20,000	87,700	80,000	6,200,000
South Africa	146,000	140,000	75,500	79,000	63,000,000
Zimbabwe	5,640	6,000	4,390	4,800	([6])
Other countries	2,140	2,000	9,500	9,800	800,000
World total (rounded)	189,000	178,000	204,000	195,000	71,000,000

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: Some motor vehicle manufacturers have substituted palladium for the more expensive platinum in catalytic converters. Until recently, only platinum could be used in diesel catalytic converters; however, new technologies allow as much as 25% palladium to be used. For most other end uses, PGMs can be substituted for other PGMs, with some losses in efficiency. In addition, electronic parts manufacturers are reducing the average palladium content of the conductive pastes used to form the electrodes of multilayer ceramic capacitors by substituting base metals or silver-palladium pastes that contain significantly less palladium.

[e]Estimated. NA Not available. — Zero.
[1]Estimates from published sources.
[2]Engelhard Corporation unfabricated metal.
[3]See Appendix B for definitions.
[4]Actual quantity limited to remaining inventory.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[6] Included with “Other countries.”

POTASH

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

Domestic Production and Use: In 2009, the production value of marketable potash, f.o.b. mine, was about $686 million. Domestic 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 separations, or combinations of these processes, and provided more than 77% of total U.S. producer sales. In Utah, which has three operations, one company extracted underground sylvinite ore by deep-well solution mining. Solar evaporation crystallized the sylvinite ore from the brine solution, and a flotation process separated the potassium chloride (muriate of potash or MOP) from byproduct sodium chloride. Two companies processed surface and subsurface brines by solar evaporation and flotation to produce MOP, potassium sulfate (sulfate of potash or SOP), and byproducts. In Michigan, one company used deep-well solution mining and mechanical evaporation for crystallization of MOP and byproduct sodium chloride.

The fertilizer industry used about 85% of U.S. potash sales, and the chemical industry used the remainder. More than 60% of the produced potash 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:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production, marketable[1]	1,200	1,100	1,100	1,100	840
Imports for consumption	4,920	4,470	4,970	5,800	2,400
Exports	200	332	199	116	142
Consumption, apparent[1]	5,900	5,200	5,900	6,800	3,100
Price, dollars per metric ton of K_2O, average, muriate, f.o.b. mine[2]	280	290	400	700	820
Employment, number:					
Mine	500	500	500	500	475
Mill	630	630	630	630	600
Net import reliance[3] as a percentage of apparent consumption	80	79	81	84	73

Recycling: None.

Import Sources (2005-08): Canada, 86%; Belarus, 5%; Germany, 1%; Russia, 1%; and other, 7%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-09**
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.

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POTASH

Events, Trends, and Issues: Beginning in late 2008 and continuing through 2009, the global economic crisis caused a collapse in world potash demand and affected world production and trade. In addition, potash prices remained over $700 per metric ton into the first half of 2009, which resulted in farmers delaying purchases until the price dropped further. World production in 2009 fell by more than 10 million tons from that of 2008, as companies temporarily closed mines to reduce stocks and wait for demand to increase.

About 93% of the world potash production was consumed by the fertilizer industry. The United States ranked eighth in world production. Potassium chloride is the main fertilizer product, containing an average 61% of K_2O equivalent. Other potassium fertilizers include potassium nitrate, potassium magnesium sulfate, and potassium sulfate.

Global potash demand is projected to rebound in 2010 based on projected world increases in fruit, grain, oilseed, and vegetable production and the corresponding growth in population. World annual production capacity is forecast to increase by 14.3 million tons by 2013, with expansion projects planned in Canada, China, Israel, Jordan, and Russia. New mines were under development in Argentina, Canada, Congo (Brazzaville), Ethiopia, Laos, and Turkmenistan.

World Mine Production and Reserves: Reserves data for China were revised using official government sources.

	Mine production		Reserves[4]
	2008	2009[e]	
United States	[1]1,100	[1]840	90,000
Belarus	4,970	3,850	750,000
Brazil	471	500	300,000
Canada	10,500	6,500	4,400,000
Chile	559	600	10,000
China	2,750	2,750	200,000
Germany	3,280	2,300	710,000
Israel	2,300	2,000	[5]40,000
Jordan	1,220	1,100	[5]40,000
Russia	6,730	3,600	1,800,000
Spain	435	400	20,000
Ukraine	11	10	25,000
United Kingdom	427	400	22,000
Other countries	—	—	50,000
World total (rounded)	35,000	25,000	8,500,000

World Resources: Estimated domestic potash resources total about 7 billion tons. Most of these lie at depths between 1,800 and 3,100 meters in a 3,110-square-kilometer area of Montana and North Dakota as an extension of the Williston Basin deposits in 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 1 billion tons. A large potash resource lies about 2,100 meters under central Michigan. The U.S. reserves figure above includes approximately 40 million tons in central Michigan. Estimated world resources total about 250 billion tons.

Substitutes: There are no substitutes for potassium as an essential plant nutrient and an essential nutritional requirement for animals and humans. Manure and glauconite (greensand) are low-potassium-content sources that can be profitably transported only short distances to the crop fields.

[e]Estimated. — Zero.
[1]Data are rounded to no more than two significant digits to avoid disclosing company proprietary data.
[2]Average prices based on actual sales; excludes soluble and chemical muriates.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[5]Total reserves in the Dead Sea are arbitrarily divided equally between Israel and Jordan for inclusion in this tabulation.

PUMICE AND PUMICITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: The estimated value of pumice and pumicite sold or used in 2009 was about $16 million. Domestic output came from 18 producers in 7 States. Pumice and pumicite were mined in Arizona, California, Idaho, New Mexico, Oregon, Nevada, and Kansas, in descending order of production. Approximately 50% of all production came from Arizona and California. About 78% of mined pumice was used toward the production of construction building block. Horticulture consumed nearly 6%; concrete admixture and aggregate, 5%; abrasives, 1%; and the remaining 10% was used for absorbent, filtration, landscaping, laundry stone washing, and other applications.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production, mine[1]	1,270	1,540	1,270	791	800
Imports for consumption[2]	240	109	37	65	39
Exports[e, 2]	15	18	9	15	11
Consumption, apparent	1,500	1,630	1,300	841	828
Price, average value, dollars per ton, f.o.b. mine or mill	31.00	28.85	22.85	20.13	20.00
Employment, mine and mill, number	100	110	110	110	110
Net import reliance[3] as a percentage of apparent consumption	15	6	2	6	3

Recycling: Not available.

Import Sources (2005-08): Greece, 72%; Turkey, 21%; Iceland, 2%; Mexico, 2% and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Pumice, crude or in irregular pieces, including crushed	2513.10.0010	Free.
Pumice, except crude or crushed	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 2009 increased slightly to 800,000 tons, compared with 791,000 tons in 2008. Imports decreased by nearly 40% compared with those of 2008. Approximately 95% of pumice imports originated from Greece and Montserrat to supply markets in the Eastern United States and Gulf Coast regions. This is the first year there have been significant levels of pumice imports from Montserrat. Apparent consumption decreased slightly in 2009 compared with that of 2008.

In 2009, a stabilization for pumice demand in the construction industry led to a slight increase in pumice and pumicite domestic mine production, despite a decrease in apparent consumption. 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 domestic pumice and pumicite mining in 2009 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[4]
	2008	2009[e]	
United States[1]	791	800	Large in the United States. Quantitative estimates of reserves for most countries are not available.
Algeria	575	575	
Cameroon	600	600	
Chile	1,100	1,000	
Ecuador	750	800	
Ethiopia	280	280	
Greece	2,250	2,250	
Iran	1,500	1,500	
Italy	3,020	3,000	
New Zealand	350	350	
Saudi Arabia	700	700	
Spain	600	600	
Syria	901	900	
Turkey	4,000	4,200	
Other countries	1,900	2,040	
World total (rounded)	19,300	19,600	

World Resources: The identified U.S. resources of pumice and pumicite are concentrated in the West 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, Iran, Chile, Syria, and the United States. There are large resources of pumice and pumicite 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. NA Not available.
[1]Quantity sold and used by producers.
[2]The data for the 2006 imports for consumption and the 2004-07 exports are based on revised U.S. Census Bureau information.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

QUARTZ CRYSTAL (INDUSTRIAL)

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Cultured quartz crystal production capacity still exists in the United States but 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 2009, 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 export and import statistics on electronic and optical-grade quartz crystal; however, the quartz crystal export and import quantities and values reported in previous years included zirconia that was inadvertently reported to be quartz crystal. Lumbered quartz, which is as-grown quartz that has been processed by sawing and grinding, was estimated to be $199 per kilogram in 2009. Other salient statistics were not available.

Recycling: None.

Import Sources (2005-08): The United States is 100% import reliant on cultured quartz crystal. Although no definitive data exists 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 12-31-09
Sands:		
95% or greater silica	2505.10.10.00	Free.
Less than 95% silica	2505.10.50.00	Free.
Quartz (including lascas)	2506.10.00.50	Free.
Piezoelectric quartz	7104.10.00.00	3% ad val.

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

Government Stockpile: As of September 30, 2009, the National Defense Stockpile (NDS) 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 NDS in 2009, and the Federal Government does not intend to dispose of or sell any of the remaining material. Previously, only individual crystals in the NDS inventory that weighed 10 kilograms or more and could be used as seed material were sold.

Stockpile Status—9-30-09[2]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2009	Disposals FY 2009
Quartz crystal	7	—	—	—

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QUARTZ CRYSTAL (INDUSTRIAL)

Events, Trends, and Issues: Trends indicate that demand for quartz crystal devices will continue to increase, and consequently, quartz crystal production is expected to remain strong well into the future. Growth of the consumer electronics market (for products such as personal computers, electronic games, and cellular telephones) will continue to drive global production. The growing global electronics market may require additional production capacity worldwide.

World Mine Production and Reserves:[3] 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]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

RARE EARTHS[1]

[Data in metric tons of rare-earth oxide (REO) content unless otherwise noted]

Domestic Production and Use: In 2009, rare earths were not mined in the United States; however, rare-earth concentrates previously produced at Mountain Pass, CA, were processed into lanthanum concentrate and didymium (75% neodymium, 25% praseodymium) products. Rare-earth concentrates, intermediate compounds, and individual oxides were available from stocks. The United States continued to be a major consumer, exporter, and importer of rare-earth products in 2009. The estimated value of refined rare earths imported by the United States in 2009 was $84 million, a decrease from $186 million imported in 2008. Based on final 2008 reported data, the estimated 2008 distribution of rare earths by end use, in decreasing order, was as follows: metallurgical applications and alloys, 29%; electronics, 18%; chemical catalysts, 14%; rare-earth phosphors for computer monitors, lighting, radar, televisions, and x-ray-intensifying film, 12%; automotive catalytic converters, 9%; glass polishing and ceramics, 6%; permanent magnets, 5%; petroleum refining catalysts, 4%; and other, 3%.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production, bastnäsite concentrates	—	—	—	—	—
Imports:[2]					
Thorium ore (monazite or various thorium materials)	—	—	—	—	20
Rare-earth metals, alloy	880	867	784	679	210
Cerium compounds	2,170	2,590	2,680	2,080	1,190
Mixed REOs	640	1,570	2,570	2,390	2,760
Rare-earth chlorides	2,670	2,750	1,610	1,310	390
Rare-earth oxides, compounds	8,550	10,600	9,900	8,740	2,160
Ferrocerium, alloys	130	127	123	125	100
Exports:[2]					
Thorium ore (monazite or various thorium materials)	—	—	1	61	23
Rare-earth metals, alloys	636	733	1,470	1,390	6,500
Cerium compounds	2,210	2,010	1,470	1,380	690
Other rare-earth compounds	2,070	2,700	1,300	663	420
Ferrocerium, alloys	4,320	3,710	3,210	4,490	2,540
Consumption, apparent (excludes thorium ore)	6,060	9,350	10,200	7,410	([3])
Price, dollars per kilogram, yearend:					
Bastnäsite concentrate, REO basis[e]	5.51	6.06	6.61	8.82	5.73
Monazite concentrate, REO basis[e]	0.54	0.87	0.87	0.87	0.87
Mischmetal, metal basis, metric ton quantity[4]	5-6	5-6	7-8	8-9	8-9
Stocks, producer and processor, yearend	W	W	W	W	W
Employment, mine and mill, number at yearend	71	65	70	100	110
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Small quantities, mostly permanent magnet scrap.

Import Sources (2005-08): Rare-earth metals, compounds, etc.: China, 91%; France, 3%; Japan, 3%; Russia, 1%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Rare-earth metals, whether or not intermixed or interalloyed	2805.30.0000	5.0% ad val.
Cerium compounds	2846.10.0000	5.5% ad val.
Mixtures of REOs (except cerium oxide)	2846.90.2010	Free.
Mixtures of rare-earth chlorides (except cerium chloride)	2846.90.2050	Free.
Rare-earth compounds, individual REOs (excludes cerium compounds)	2846.90.8000	3.7% ad val.
Ferrocerium and other pyrophoric alloys	3606.90.3000	5.9% ad val.

Depletion Allowance: Monazite, 22% on thorium content and 14% on rare-earth content (Domestic), 14% (Foreign); bastnäsite and xenotime, 14% (Domestic and foreign).

Government Stockpile: None.

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RARE EARTHS

Events, Trends, and Issues: Domestic consumption of rare earths in 2009 decreased substantially, based on apparent consumption (derived from 8 months of trade data). Only one of seven rare-earth import categories increased when compared with those of 2008—the category "mixtures of REOs (except cerium oxide)." Prices were generally lower in 2009 compared with those of 2008 for most rare-earth products amid decreased consumption and a declining supply. Consumption for most rare-earth uses in the United States decreased as a consequence of the worldwide economic downturn. The economic downturn lowered consumption of cerium compounds used in automotive catalytic converters and in glass additives and glass-polishing compounds; rare-earth chlorides used in the production of fluid-cracking catalysts used in oil refining; rare-earth compounds used in automotive catalytic converters and many other applications; rare-earth metals and their alloys used in armaments, base-metal alloys, lighter flints, permanent magnets, pyrophoric alloys, and superalloys; yttrium compounds used in color televisions and flat-panel displays, electronic thermometers, fiber optics, lasers, and oxygen sensors; and phosphors for color televisions, electronic thermometers, fluorescent lighting, pigments, superconductors, x-ray-intensifying screens, and other applications. The trend is for a continued increase in the use of rare earths in many applications, especially automotive catalytic converters, permanent magnets, and rechargeable batteries for electric and hybrid vehicles.

The rare-earth separation plant at Mountain Pass, CA, resumed operations in 2007 and continued to operate throughout 2009. Bastnäsite concentrates and other rare-earth intermediates and refined products continued to be sold from mine stocks at Mountain Pass. Exploration for rare earths continued in 2009; however, global economic conditions were not as favorable as in early 2008. Economic assessments continued at Bear Lodge in Wyoming; Diamond Creek in Idaho; Elk Creek in Nebraska; Hoidas Lake in Saskatchewan, Canada; Nechalacho (Thor Lake) in Northwest Territories, Canada; Kangankunde in Malawi; Lemhi Pass in Idaho-Montana; Nolans Project in Northern Territory, Australia; and various other locations around the world. At the Mount Weld rare-earth deposit in Australia, the initial phase of mining of the open pit was completed in June 2008. A total of 773,000 tons of ore was mined at an average grade of 15.4% REO; however, no beneficiation plant existed to process the ore into a rare-earth concentrate. Based on the fine-grained character of the Mt. Weld ore, only 50% recovery of the REO was expected.

World Mine Production and Reserves: Reserves data for Australia, China, and India were updated based on data from the respective countries.

	Mine production[e]		Reserves[6]
	2008	2009	
United States	—	—	13,000,000
Australia	—	—	5,400,000
Brazil	650	650	48,000
China	120,000	120,000	36,000,000
Commonwealth of Independent States	NA	NA	19,000,000
India	2,700	2,700	3,100,000
Malaysia	380	380	30,000
Other countries	NA	NA	22,000,000
World total (rounded)	124,000	124,000	99,000,000

World Resources: Rare earths are relatively abundant in the Earth's crust, but discovered minable concentrations are less common than for most other ores. U.S. and world resources are contained primarily in bastnäsite and monazite. Bastnäsite deposits in China and the United States constitute the largest percentage of the world's rare-earth economic resources, while monazite deposits in Australia, Brazil, China, India, Malaysia, South Africa, Sri Lanka, Thailand, and the United States 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]Without drawdown in producer stocks (withheld), apparent consumption calculations in 2009 resulted in a negative number.
[4]Price range from Elements—Rare Earths, Specialty Metals and Applied Technology, Trade Tech, Denver, CO, and Web-based High Tech Materials, Longmont, CO, and Hefa Rare Earth Canada Co. Ltd., Richmond, British Columbia, Canada.
[5]Defined as imports – exports + adjustments for Government and industry stock changes. For 2007 through 2009, excludes producer stock changes.
[6]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

RHENIUM

(Data in kilograms of rhenium content unless otherwise noted)

Domestic Production and Use: During 2009, ores containing rhenium were mined at five operations (three in Arizona, and one each in Montana 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 the end use. Bimetallic platinum-rhenium catalysts were used in petroleum-reforming for the production of high-octane hydrocarbons, which are used in the production of lead-free gasoline. Rhenium improves the high-temperature (1,000° C) strength properties of some nickel-based superalloys. Rhenium alloys were used in crucibles, electrical contacts, electromagnets, electron tubes and targets, heating elements, ionization gauges, mass spectrographs, metallic coatings, semiconductors, temperature controls, thermocouples, vacuum tubes, and other applications. The estimated value of rhenium consumed in 2009 was about $72 million.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production[1]	7,900	8,100	7,100	7,900	7,400
Imports for consumption	28,900	38,800	41,000	43,600	26,000
Exports	NA	NA	NA	NA	NA
Consumption, apparent	36,900	46,900	48,100	51,500	33,000
Price,[2] average value, dollars per kilogram, gross weight:					
Metal powder, 99.99% pure	1,070	1,260	1,620	2,030	2,400
Ammonium perrhenate	680	840	2,730	2,190	3,100
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	78	83	85	85	79

Recycling: Small amounts of molybdenum-rhenium and tungsten-rhenium scrap have been processed by several companies during the past few years. All spent platinum-rhenium catalysts were recycled.

Import Sources (2005-08): Rhenium metal powder: Chile, 93%; Netherlands, 3%; and other, 4%. Ammonium perrhenate: Kazakhstan, 68%; China, 8%; Germany, 7%; Chile, 5%; and other, 12%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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 2009, average rhenium metal price, based on U.S. Census Bureau customs value, was about $2,400 per kilogram, about 17% more than that of 2008. Rhenium imports for consumption decreased by about 41% owing to the increase in price as well as the downturn in the financial markets. Rhenium production in the United States decreased by about 6% owing to decreased production of byproduct molybdenum concentrates in the United States. The four larger working copper-molybdenum mines decreased byproduct molybdenum production levels in 2009, while the one remaining smaller operation made incremental decreases in production in 2009. Three smaller operations ceased byproduct molybdenum production in 2009.

The United States continued to rely on imports for much of its supply of rhenium, and Chile and Kazakhstan supplied the majority of the imported rhenium. Owing to strong demand, both APR and metal powder spot prices rose sharply at the end of 2008. However, in 2009, catalytic-grade APR price decreased from about $10,000 per kilogram in January to about $7,500 per kilogram in April to about $6,200 per kilogram in November. Metal powder price decreased from about $9,700 per kilogram in January to about $6,900 per kilogram in April to about $4,900 in November. Demand for catalyst-grade APR, supported by the petroleum industry, was expected to continue to remain strong. Demand for rhenium in the aerospace industry, although more unpredictable, was also expected to remain strong. However, the major aerospace companies were expected to continue testing superalloys that contain half the current rhenium content for engine blades, as well as rhenium-free alloys for other engine components.

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.

World Mine Production and Reserves:

	Mine production[4]		Reserves[5]
	2008	2009[e]	
United States	7,900	7,400	390,000
Armenia	1,200	1,200	95,000
Canada	1,600	1,600	32,000
Chile[6]	27,600	25,000	1,300,000
Kazakhstan	7,700	7,500	190,000
Peru	5,000	4,000	45,000
Russia	1,500	1,500	310,000
Other countries	4,000	4,000	91,000
World total (rounded)	56,500	52,000	2,500,000

World Resources: Most rhenium occurs with molybdenum in porphyry copper deposits. Identified U.S. resources are estimated to be about 5 million kilograms, and the identified resources of the rest of the world are approximately 6 million kilograms. In Kazakhstan, rhenium also exists in sedimentary copper deposits.

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.
[1]Based on 80% recovery of estimated rhenium contained in MoS_2 concentrates.
[2]Average price per kilogram of rhenium in pellets or ammonium perrhenate, based on U.S. Census Bureau customs value.
[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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[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: Worldwide, rubidium occurrences may be associated with zoned pegmatites in the minerals pollucite, a source of cesium, or lepidolite, a source of lithium. Rubidium is not mined in the United States; however, rubidium concentrate is imported from Canada for processing in the United States. There are rubidium occurrences in Maine and South Dakota, and rubidium may also be found with some evaporite minerals in other States. Applications for rubidium and its compounds include biomedical research, photoelectrics, specialty glass, and pyrotechnics. Rubidium is used as an atomic resonance frequency standard in 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. Other applications include the use of high-purity rubidium (>98%) in vapor cells as a wavelength reference. Rubidium-82, an isotope of rubidium, is used to trace blood flow in the heart. Rubidium-87, a natural decay product of strontium-82, may be extracted from potassium-bearing minerals, such as micas, and used for dating episodes of heating and deformation in rocks.

Salient Statistics—United States: One mine in Canada produced byproduct rubidium concentrate, which was then imported into the United States for processing. Production data from the Canadian mine, and U.S. consumption, export, and import data, are not available. In the United States, consumption of rubidium may amount to only a few thousand kilograms per year. No market price is available because the metal is not traded. In 2009, one company offered 1-gram ampoules of 99.75%-grade rubidium (metals basis) at $68.40 each, a 12.5% increase from that of 2008. The price for 100 grams of the same material was $1,258.00, a 7.7% increase from that of 2008.

Recycling: None.

Import Sources (2004-07): The United States is 100% import reliant on byproduct rubidium concentrate imported from Canada.

Tariff:

Item	Number	Normal Trade Relations 12-31-09
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 available commercially as a byproduct of lithium chemicals production for 40 years. Demand is limited by the lack of supply, but discovery of new sources of rubidium, increases in lithium exploration, as well as higher grade rubidium discoveries, may create new supplies leading to expanded commercial applications. The use of rubidium in atomic clocks for GPS continues to increase. Rubidium carbonate glass has been extensively tested for use in anticollision devices for motor vehicles. The use of rubidium-82 positron emission tomography (PET) combined with computed tomography angiography (CT) in the evaluation and care of patients with suspected coronary artery disease continues to increase. Advances have been made in the use of rubidium in quantum computing. Rubidium forms interesting amalgams with mercury and alloys with gold, properties that may expand usage. Small amounts of rubidium are released into the atmosphere during coal combustion; however, there have been no adverse environmental or human health issues associated with the processing or use of rubidium.

World Mine Production and Reserves:[1] There are no minerals 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 some pegmatites. The rubidium-bearing minerals lepidolite and pollucite may be found in some zoned pegmatites, which are exceptionally coarse-grained plutonic rocks that form late in the crystallization of a silicic magma. Lepidolite, a lithium-bearing mica, is the principal ore mineral of rubidium and may contain up to 3.15% rubidium. Pollucite, a cesium aluminosilicate mineral, may contain up to 1.35% rubidium.

World Resources: Rubidium-bearing zoned pegmatites are known in several locations in Canada, and there are also pegmatite occurrences in Afghanistan, Namibia, Peru, Russia, and Zambia. Minor amounts of rubidium are reported in brines in northern Chile and China and in evaporites in France, Germany, and the United States (New Mexico and Utah). World resources of rubidium are unknown.

Substitutes: Rubidium and cesium are in proximity in the periodic table of the elements, have similar atomic radii, and, therefore, have similar physical properties. These metals may be used interchangeably in many applications.

[1]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

SALT

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Domestic production of salt decreased by an estimated 3% in 2009. The total value was estimated to be more than $1.7 billion. Thirty-one companies operated 64 plants in 16 States. The estimated percentage of salt sold or used, by type, was rock salt, 45%; salt in brine, 38%; vacuum pan, 10%; and solar salt, 8%.

Salt for highway deicing accounted for 43% of U.S. demand. The chemical industry consumed about 35% of total salt sales, with salt in brine representing about 90% of the type of salt used for feedstock. The chlorine and caustic soda manufacturing sector was the main consumer within the chemical industry. The remaining markets for salt, in declining order, were distributors, 8%; agricultural, 3%; food, 3%; general industrial, 3%; water treatment, 3%; and other combined with exports, 2%.

Salient Statistics—United States:[1]	2005	2006	2007	2008	2009[e]
Production	45,100	44,400	44,500	47,300	46,000
Sold or used by producers[2]	45,000	40,600	45,500	47,600	45,000
Imports for consumption	12,100	9,490	8,640	13,900	12,000
Exports	879	973	833	1,030	1,100
Consumption:					
Reported	53,100	42,400	53,300	53,100	56,900
Apparent[2]	56,200	49,100	53,200	60,500	56,900
Price, average value of bulk, pellets and packaged salt, dollars per ton, f.o.b. mine and plant:					
Vacuum and open pan salt	130.75	145.90	154.95	158.42	165.00
Solar salt	58.14	65.06	61.50	64.53	67.00
Rock salt	25.84	24.98	27.84	31.39	35.00
Salt in brine	7.03	6.99	7.11	10.25	8.00
Employment, mine and plant, number[e]	4,100	4,100	4,100	4,100	4,100
Net import reliance[3] as a percentage of apparent consumption	20	17	15	21	19

Recycling: None.

Import Sources (2005-08): Canada, 39%; Chile, 30%; Mexico, 8%; Peru, 4%; and other, 19%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Salt (sodium chloride)	2501.00.0000	Free.

Depletion Allowance: 10% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: A major U.S. salt company was purchased for $1.68 billion by a German salt company in April. The acquisition made the German company the largest salt producer in the world.

Another U.S. salt producer that produced solar salt in the San Francisco Bay area opted to not renew its 40-year-old land conservation contract with the local city that cleared the way to convert most of its solar evaporation ponds to urban use. The salt company, through a joint venture with a land development company, intended to construct 12,000 homes, and 92,900 square meters of office space, and restore more than 160 hectares of wetlands.

The problems of rock salt shortages and high prices in 2008 appeared to be resolved in 2009, as many transportation departments submitted their bids earlier than in past years to ensure they would receive their share of salt supplies for the upcoming winter season. Despite an apparent abundance of salt for the 2009-10 winter, many cities indicated they would be conservative in applying salt to the roads.

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SALT

A large-scale solar salt project was under development at Lake Assal in Djibouti. The facility was designed to produce 4 million tons of salt per year but could be expanded as market demand increased. The area is in an ideal location because it has high evaporation rates, high temperatures, and a rich brine feed from the Red Sea. About 85% of the solar salt could be for chemical markets in the Middle East and East Asia, with the remaining 15% being sold to the road-deicing markets in Europe and North America. Completion of the project was scheduled for mid-2010.

Budget constraints for local and State governments may affect the availability and consumption of rock salt for highway deicing in 2010. It is anticipated that the domestic salt industry will strive to have adequate salt available from domestic and foreign sources for emergency use if adverse winter weather develops.

World Production and Reserves:

	Production		Reserves[4]
	2008	2009[e]	
United States[1]	47,300	46,000	Large. Economic and subeconomic deposits of salt are substantial in principal salt-producing countries. The oceans contain a virtually inexhaustible supply of salt.
Australia	11,000	11,500	
Brazil	6,900	7,000	
Canada	14,400	14,000	
Chile	6,430	6,500	
China	59,500	60,000	
France	6,100	6,000	
Germany	16,400	16,500	
India	16,000	15,800	
Mexico	8,810	8,800	
Netherlands	5,000	5,000	
Poland	4,390	4,400	
Spain	4,550	4,600	
Ukraine	5,500	5,500	
United Kingdom	5,800	5,800	
Other countries	39,900	42,600	
World total (rounded)	258,000	260,000	

World Resources: World continental resources of salt are practically unlimited, and the salt content in the oceans is virtually inexhaustible. Domestic resources of rock salt and salt from brine are in the Northeast, Central Western, and Gulf Coast States. Saline lakes and solar evaporation salt facilities are near populated regions in the Western United States. Almost every country in the world has salt deposits or solar evaporation operations of various sizes.

Substitutes: There are no economic substitutes or alternates for salt. Calcium chloride and calcium magnesium acetate, hydrochloric acid, and potassium chloride can be substituted for salt in deicing, certain chemical processes, and food flavoring, but at a higher cost.

[e]Estimated.
[1]Excludes Puerto Rico production.
[2]Reported stock data are incomplete. For apparent consumption and net import reliance calculations, changes in annual stock totals are assumed to be the difference between salt produced and salt sold or used.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

SAND AND GRAVEL (CONSTRUCTION)[1]

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

Domestic Production and Use: Construction sand and gravel valued at $6.2 billion was produced by an estimated 4,000 companies from about 6,400 operations in 50 States. Leading producing States, in order of decreasing tonnage, were Texas, California, Arizona, Colorado, Wisconsin, Michigan, Minnesota, New York, Nevada, and Ohio, which together accounted for about 50% of the total output. It is estimated that about 44% of construction sand and gravel was used as concrete aggregates; 23% for road base and coverings and road stabilization; 14% as construction fill; 12% as asphaltic concrete aggregates and other bituminous mixtures; 3% for plaster and gunite sands; 1% for concrete products, such as blocks, bricks, and pipes; and the remaining 3% for filtration, golf courses, railroad ballast, roofing granules, snow and ice control, and other miscellaneous uses.

The estimated output of construction sand and gravel in the 48 conterminous States, shipped for consumption in the first 6 months of 2009, was about 344 million tons, a decrease of 29% compared with the revised total for the same period in 2008. 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:	2005	2006	2007	2008	2009[e]
Production	1,280	1,320	1,230	1,040	800
Imports for consumption	7	5	4	3	3
Exports	1	1	([3])	1	1
Consumption, apparent	1,290	1,320	1,240	1,050	802
Price, average value, dollars per ton	5.86	6.47	7.01	7.48	7.70
Employment, mines, mills, and shops, number	37,700	38,500	38,000	35,200	30,400
Net import reliance[4] as a percentage of apparent consumption	([3])	1	([3])	([3])	([3])

Recycling: Asphalt road surface layers, cement concrete surface layers, and concrete structures were recycled on an increasing basis.

Import Sources (2005-08): Canada, 75%; Mexico, 19%; The Bahamas, 4%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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: As the U.S. economy continued to falter, construction sand and gravel output dropped for the third straight year, down by about 25%, or nearly 240 million tons, compared with that of 2008. Demand for construction aggregate fell because total U.S. construction again saw a double-digit percentage decline compared with construction in 2008. It is estimated that 2010 domestic production will be about equal to the 2009 levels of 800 million tons as housing construction and home prices begin to recover from the historically low levels of 2009, but will have difficulty growing as revenues to governments are affected by lower home values. Decreased revenues could curtail publicly funded construction projects, which in turn would lower demand for construction sand and gravel.

Crushed stone, the other major construction aggregate, continues to replace natural sand and gravel, especially in more densely populated areas of the Eastern United States. The construction sand and gravel industry continues to be concerned with environmental, health, permitting, safety, and zoning regulations. Movement of sand and gravel operations away from densely populated centers is expected to continue where environmental, land development, and local zoning regulations discourage them. Consequently, shortages of construction sand and gravel would support higher-than-average price increases in industrialized and urban areas.

World Mine Production and Reserves:

	Mine production		Reserves[5]
	2008	2009[e]	
United States	1,040	800	The reserves are controlled largely by
Other countries[6]	NA	NA	land use and/or environmental concerns.
World total	NA	NA	

World Resources: Sand and gravel resources of the world are large. 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 remains the predominant 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 2009.

[e]Estimated. NA Not available.
[1]See also Sand and Gravel (Industrial).
[2]See Appendix A for conversion to short tons.
[3]Less than ½ unit.
[4]Defined as imports – exports.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[6]No reliable production information for most countries is available owing to the wide variety of ways in which countries report their sand and gravel production. Some countries do not report production for this mineral commodity. Production information for some countries is available in the country chapters of the USGS Minerals Yearbook.

SAND AND GRAVEL (INDUSTRIAL)[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Industrial sand and gravel valued at about $827 million was produced by 70 companies from 144 operations in 35 States. Leading States, in order of tonnage produced, were Texas, Illinois, Wisconsin, Minnesota, Oklahoma, California, North Carolina, and Michigan. Combined production from these States represented 61% of the domestic total. About 31% of the U.S. tonnage was used as glassmaking sand, 27% as hydraulic fracturing sand and well-packing and cementing sand, 14% as foundry sand, 7% as whole-grain fillers and building products, 4% as whole-grain silica, 3% as golf course sand, 3% as ground and unground silica for chemical applications, and 11% for other uses.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production	30,600	28,900	30,100	30,400	27,400
Imports for consumption	711	855	511	355	83
Exports	2,910	3,830	3,000	3,100	2,800
Consumption, apparent	28,400	25,900	27,600	27,700	24,700
Price, average value, dollars per ton	24.57	26.26	27.64	30.82	30.17
Employment, quarry and mill, number[e]	1,400	1,400	1,400	1,400	1,400
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: There is some recycling of foundry sand, and recycled cullet (pieces of glass) represents a significant proportion of reused silica.

Import Sources (2005-08): Canada, 54%; Mexico, 21%; and other, 25%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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 in 2009 declined by 10% compared with those of 2008, owing to the economic downturn and decreased demand. However, mined output was sufficient to accommodate many uses, which included ceramics, chemicals, fillers (ground and whole-grain), container, filtration, flat and specialty glass, hydraulic fracturing, and recreational uses. U.S. apparent consumption was 24.7 million tons in 2009, down from that of the previous year. Imports of industrial sand and gravel in 2009 decreased to 83,000 tons from 355,000 tons in 2008. 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 2009 decreased to 2.8 million tons from 3.1 million tons in 2008.

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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 2009. Local shortages were expected to continue to increase owing to local zoning regulations and land development alternatives. 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]
	2008	2009	
United States	30,400	27,400	
Australia	5,300	5,300	Large. Industrial sand and gravel deposits are widespread. Calculation of the reserves is determined mainly by the location of population centers.
Austria	2,000	1,500	
Belgium	1,800	1,800	
Bulgaria	1,500	1,500	
Canada	1,990	2,000	
Chile	1,400	600	
Czech Republic	1,000	1,900	
France	5,000	5,000	
Gambia	1,400	1,400	
Germany	8,190	6,500	
Hungary	3,800	300	
India	1,700	1,700	
Iran	2,000	2,000	
Italy	13,800	14,000	
Japan	4,500	4,500	
Korea, Republic of	2,000	2,000	
Mexico	2,780	2,800	
Norway	1,500	1,500	
Poland	4,000	5,300	
Slovakia	2,000	2,000	
South Africa	3,650	2,900	
Spain	5,000	5,000	
Turkey	1,200	1,200	
United Kingdom	5,600	5,600	
Other countries	7,500	6,200	
World total (rounded)	121,000	112,000	

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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.

SCANDIUM[1]

(Data in kilograms of scandium oxide content unless otherwise noted)

Domestic Production and Use: Demand for scandium decreased slightly in 2009. Domestically, scandium-bearing minerals have not been mined nor recovered from tailings since 1990. However, quantities sufficient to meet demand were available in domestic tailings. Principal sources were imports from China, Russia, and Ukraine. Domestic companies with scandium-processing capabilities were in Mead, CO, and Urbana, IL. Capacity to produce ingot and distilled scandium metal was in Ames, IA; Phoenix, AZ; and Urbana, IL. Scandium used in the United States was essentially derived from foreign sources. Principal uses for scandium in 2009 were aluminum alloys for sporting equipment (baseball and softball bats, bicycle frames, crosse handles (lacrosse stick handles), golf clubs, gun frames, and tent poles), metallurgical research, high-intensity metal halide lamps, analytical standards, electronics, oil well tracers, and lasers.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Price, yearend, dollars:					
Per kilogram, oxide, 99.0% purity	500	700	700	900	900
Per kilogram, oxide, 99.9% purity	1,300	1,400	1,400	1,400	1,400
Per kilogram, oxide, 99.99% purity[2]	2,500	1,450	1,620	1,620	1,620
Per kilogram, oxide, 99.999% purity[2]	3,000	1,500	2,540	2,540	2,540
Per kilogram, oxide, 99.9995% purity[2]	NA	2,100	3,260	3,260	3,260
Per gram, dendritic, metal[3]	162.50	208.00	208.00	188.00	189.00
Per gram, metal, ingot[4]	131.00	131.00	131.00	152.00	155.00
Per gram, scandium acetate, 99.99% purity[5]	70.30	74.00	74.00	NA	NA
Per gram, scandium chloride, 99.9% purity[5]	48.70	48.70	48.70	57.40	60.40
Per gram, scandium fluoride, 99.9% purity[5]	193.80	193.80	193.80	224.20	224.60
Per gram, scandium iodide, 99.999% purity[5]	174.00	174.00	174.00	201.00	203.00
Per kilogram, scandium-aluminum alloy[2]	NA	NA	74.00	74.00	74.00
Net import reliance[6] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2005-08): Although no definitive data exist listing import sources, imported material is thought to be mostly from China, Russia, and Ukraine.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Mineral substances not elsewhere specified or included, including scandium ores	2530.90.8050	Free.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed, including scandium	2805.30.0000	5.0% ad val.
Mixtures of rare-earth oxides except cerium oxide, including scandium oxide mixtures	2846.90.2010	Free.
Rare-earth compounds, including individual rare-earth oxides, hydroxides, nitrates, and other individual compounds, including scandium oxide	2846.90.8000	3.7% ad val.
Aluminum alloys, other, including scandium-aluminum	7601.20.9090	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Nominal prices for domestically produced scandium oxide remained unchanged for all purities while other scandium compounds increased slightly from those of the previous year. The supply of domestic and foreign scandium remained stable. Although demand decreased in 2009, the total market remained very small. Domestic decreases in scandium demand were primarily related to recently developed applications in carbon fiber and carbon nanotube technology for baseball and softball bats; however, scandium-aluminum baseball and softball bats remained popular high-end sports equipment, and sports equipment remained the leading use of scandium. New demand is expected to come from future fuel-cell markets and aerospace applications.

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SCANDIUM

Scandium's use in metal halide lighting continued. Scandium, as the metal or the iodide, mixed with other elements, was added to halide light bulbs to adjust the color to simulate natural sunlight. Future development of alloys for aerospace and specialty markets is expected. Scandium's availability from Kazakhstan, Russia, and Ukraine increased substantially in 1992, after export controls were relaxed, and sales continue to provide the Western World with most of its scandium alloys, compounds, and metal. China also continued to supply scandium compounds and metal to the U.S. market.

World Mine Production and Reserves:[7] Scandium was produced as byproduct material in China, Kazakhstan, Russia, and Ukraine. Foreign mine production data were not available. No scandium was mined in the United States in 2009. Scandium occurs in many ores in trace amounts, but has not been found in sufficient quantities to be considered as a reserve. 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 actual and potential 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 equivalent Sc_2O_3. Ferromagnesium minerals commonly occur in the igneous rocks basalt and gabbro. Enrichment of scandium also occurs in aluminum phosphate minerals, beryl, cassiterite, columbite, garnet, muscovite, rare-earth minerals, and wolframite. Scandium that was produced domestically was primarily from the scandium-yttrium silicate mineral thortveitite, and from byproduct leach solutions from uranium operations. One of the principal domestic scandium resources is the fluorite tailings from the mined-out Crystal Mountain deposit near Darby, MT. Tailings from the mined-out fluorite operations, which were generated from 1952 to 1971, contain thortveitite and associated scandium-enriched minerals. Resources also are contained in the tantalum residues previously processed at Muskogee, OK. Smaller resources are associated with molybdenum, titanium-tungsten, and tungsten minerals from the Climax molybdenum deposit in Colorado and in crandallite, kolbeckite, and variscite at Fairfield, UT. Other lower grade domestic resources are present in ores of aluminum, cobalt, iron, molybdenum, nickel, phosphate, tantalum, tin, titanium, tungsten, zinc, and zirconium. Process residues from tungsten operations in the United States also contain significant amounts of scandium.

Foreign scandium resources are known in Australia, China, Kazakhstan, Madagascar, Norway, Russia, and Ukraine. Resources in Australia are contained in nickel and cobalt deposits in Syerston and Lake Innes, New South Wales. China's resources are in iron, tin, and tungsten deposits in Fujian, Guangdong, Guangxi, Jiangxi, and Zhejian Provinces. Resources in Russia are in apatites and eudialytes in the Kola Peninsula and in uranium-bearing deposits in Kazakhstan. Scandium in Madagascar is contained in pegmatites in the Befanomo area. Resources in Norway are dispersed in the thortveitite-rich pegmatites of the Iveland-Evje Region and a deposit in the northern area of Finnmark. In Ukraine, scandium is recovered as a byproduct of iron ore processing at Zheltye Voda. An occurrence of the mineral thortveitite is reported from Kobe, Japan. Undiscovered scandium resources are thought to be very large.

Substitutes: In applications such as lighting and lasers, scandium is generally not subject to substitution. Titanium and aluminum high-strength alloys, as well as carbon fiber and carbon nanotube material, may substitute in sporting goods, especially baseball and softball bats and bicycle frames. Light-emitting diodes, also known as LEDs, are beginning to displace halides in industrial lighting, residential safety and street lighting, and buoys and maritime lamp applications.

[e]Estimated. NA Not available.
[1]See also Rare Earths.
[2]Scandium oxide (as a white powder) and scandium-aluminum master alloy (with a 2% scandium metal content and sold in metric ton quantities) from Stanford Materials Corporation.
[3]Scandium pieces, 99.9% purity, distilled dendritic; 2005-07 prices converted from 0.5-gram price, and 2008-09 price from 2-gram price, from Alfa Aesar, a Johnson Matthey company.
[4]Metal ingot pieces, 99.9% purity, 2005-09, 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]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

SELENIUM

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

Domestic Production and Use: Primary selenium was recovered from anode slimes generated in the electrolytic refining of copper. One copper refinery in Texas reported production of primary selenium. One copper refiner exported semirefined selenium for toll-refining in Asia, and one other refiner generated selenium-containing slimes, which were exported for processing.

In glass manufacturing, selenium is used to decolorize the green tint caused by iron impurities in container glass and other soda-lime silica glass and is used in architectural plate glass to reduce solar heat transmission. Cadmium sulfoselenide pigments are used in plastics, ceramics, and glass to produce a ruby-red color. Selenium is used in catalysts to enhance selective oxidation; in plating solutions, where it improves appearance and durability; in blasting caps and gun bluing; in rubber compounding chemicals; in the electrolytic production of manganese to increase yields; and in brass alloys to improve machinability.

Selenium is used as a human dietary supplement and in antidandruff shampoos. The leading agricultural uses are as a dietary supplement for livestock and as a fertilizer additive to enrich selenium-poor soils. It is used as a metallurgical additive to improve machinability of copper, lead, and steel alloys. Historically, the primary electronic use was as a photoreceptor on the replacement drums for older plain paper photocopiers, which are gradually being replaced by newer models that do not use selenium in the reproduction process. Selenium is also used in thin-film photovoltaic copper indium gallium diselenide (CIGS) solar cells.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production, refinery	W	W	W	W	W
Imports for consumption, metal and dioxide	589	409	544	518	286
Exports, metal, waste and scrap	254	191	562	545	540
Consumption, apparent[1]	590	410	545	520	300
Price, dealers, average, dollars per pound, 100-pound lots, refined	51.44	24.57	32.90	32.29	23.00
Stocks, producer, refined, yearend	W	W	W	W	W
Net import reliance[2] as a percentage of apparent consumption	57	53	E	E	E

Recycling: The amount of domestic production of secondary selenium was estimated to be very small because most scrap xerographic and electronic materials were exported for recovery of the contained selenium.

Import Sources (2005-08): Belgium, 46%; Canada, 14%; Germany, 13%; Japan, 7%; and other, 20%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Selenium metal	2804.90.0000	Free.
Selenium dioxide	2811.29.2000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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SELENIUM

Events, Trends, and Issues: The supply of selenium is directly affected by the supply of the materials from which it is a byproduct—copper, and to a lesser extent, nickel. Estimated domestic selenium production was unchanged in 2009 compared with that of 2008.

China, which remained the leading consumer of selenium, continued to use selenium as a fertilizer supplement and ingredient in glassmaking, and selenium dioxide was used as a substitute for sulfur dioxide in the manganese refining process. It is believed that consumption of selenium in China increased in the first half of 2008 owing to increases in consumption from the manganese refining industry. In the second half of 2008 and into 2009, consumption and price dropped because of the decrease in production of manganese in China.

Domestic use of selenium in glass and in copiers in 2009 continued to decline. The use of selenium as a substitute for lead in free-machining brasses was also lower owing to the economic downturn. The use of selenium in fertilizers and supplements in the plant-animal-human food chain and as human vitamin supplements increased as its health benefits were documented. Although small amounts of selenium are considered beneficial, it can be hazardous in larger quantities. An increased interest in solar cell technologies has increased the consumption of selenium in CIGS solar cells.

World Refinery Production and Reserves: Reserves estimates for Peru and the Philippines were revised based on new information derived from government and industry reports.

	Refinery production		Reserves[3]
	2008	2009[e]	
United States	W	W	10,000
Belgium	200	200	—
Canada	156	150	6,000
Chile	78	70	20,000
Finland	60	60	—
India	14	14	—
Japan	754	755	—
Peru	45	45	9,000
Philippines	65	65	500
Russia	110	110	20,000
Sweden	20	20	—
Other countries[4]	9	10	23,000
World total (rounded)	[5]1,510	[5]1,500	88,000

World Resources: Reserves for selenium are based on identified copper deposits. Coal generally contains between 0.5 and 12 parts per million of selenium, or about 80 to 90 times the average for copper deposits. The recovery of selenium from coal, although technically feasible, does not appear likely in the foreseeable future.

Substitutes: High-purity silicon has replaced selenium in high-voltage rectifiers. Silicon is also the major substitute for selenium in low- and medium-voltage rectifiers and solar photovoltaic cells. Organic pigments have been developed as substitutes for cadmium sulfoselenide pigments. Other substitutes include cerium oxide as either a colorant or decolorant in glass; tellurium in pigments and rubber; bismuth, lead, and tellurium in free-machining alloys; and bismuth and tellurium in lead-free brasses. Sulfur dioxide can be used as a replacement for selenium dioxide in the production of electrolytic manganese metal.

The selenium-tellurium photoreceptors used in some xerographic copiers and laser printers have been replaced by organic photoreceptors in newer machines. Amorphous silicon and cadmium telluride are the two principal competitors to copper indium diselenide in thin film photovoltaic power cells.

[e]Estimated. E Net exporter. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Imports for consumption were used as a proxy for apparent consumption.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[4]In addition to the countries listed, Australia, China, Kazakhstan, and the United Kingdom are known to produce refined selenium, but output is not reported, and information is inadequate for formulation of reliable production estimates.
[5]Excludes U.S. production.

SILICON

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

Domestic Production and Use: Estimated value of silicon alloys and metal (excluding semiconductor- and solar-grade silicon) produced in the United States in 2009 was $470 million. Four companies produced silicon materials in six plants. Of those companies, three produced ferrosilicon in four plants. Metallurgical-grade silicon metal was produced by two companies in four plants. One of the four companies produced both products at two plants. All of the ferrosilicon and silicon metal plants were east of the Mississippi River. Most ferrosilicon was consumed in the ferrous foundry and steel industries, predominantly in the eastern part of the 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:	2005	2006	2007	2008	2009[e]
Production:					
Ferrosilicon, all grades[1]	125	146	155	164	140
Silicon metal[2]	145	W	W	W	W
Imports for consumption:					
Ferrosilicon, all grades[1]	197	223	208	190	62
Silicon metal	152	146	147	168	99
Exports:					
Ferrosilicon, all grades[1]	8	5	7	10	8
Silicon metal	23	27	28	35	34
Consumption, apparent:					
Ferrosilicon, all grades[1]	317	363	359	344	200
Silicon metal[2]	275	W	W	W	W
Price,[3] average, cents per pound Si:					
Ferrosilicon, 50% Si	55.0	62.9	74.0	116	77
Ferrosilicon, 75% Si	48.0	54.9	65.6	109	68
Silicon metal[2]	76.2	79.3	113	162	120
Stocks, producer, yearend:					
Ferrosilicon, all grades[1]	13	16	14	14	14
Silicon metal[2]	6	W	W	W	W
Net import reliance[4] as a percentage of apparent consumption:					
Ferrosilicon, all grades[1]	61	59	58	52	27
Silicon metal[2]	47	<50	<50	<50	<50

Recycling: Insignificant.

Import Sources (2005-08): Ferrosilicon: China, 49%; Russia, 20%; Venezuela, 15%; Canada, 8%; and other, 8%. Silicon metal: Brazil, 38%; South Africa, 24%; Canada, 16%; Australia, 8%; and other, 14%. Total: China, 29%; Brazil, 17%; Canada, 11%, Russia, 11%; and other, 32%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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.

Depletion Allowance: Quartzite, 14% (Domestic and foreign); gravel, 5% (Domestic and foreign).

Government Stockpile: None.

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SILICON

Events, Trends, and Issues: Global financial problems that began during the third quarter of 2008 continued to affect the silicon market in 2009. Domestic ferrosilicon production in 2009, expressed in terms of contained silicon, was expected to be 13% less than that of 2008. Imports of silicon materials were expected to be significantly less in 2009 than in 2008—67% and 40% less for ferrosilicon and silicon metal, respectively. As a result, U.S. ferrosilicon net import reliance dropped to 27% in 2009, the lowest it has been since 1991. Average annual U.S. spot market prices were also significantly less in 2009 than in 2008; 50% and 75% ferrosilicon prices were about one-third less and the metallurgical-grade silicon metal price was 28% less than in 2008.

Demand for silicon metal comes primarily from the aluminum and chemical industries. Domestic secondary aluminum production—the primary materials source for aluminum-silicon alloys—was projected to decrease by 6% in 2009, compared with that in 2008. Domestic chemical production was projected to decrease by 8% in 2009. Domestic apparent consumption of ferrosilicon in 2009 was projected to decrease by 43% compared with that of 2008. The annual growth rate for ferrosilicon consumption usually falls in the range of 1% to 2%, in line with long-term trends in steel production; however, through the first 9 months of 2009, domestic steel production was 47% lower than that of the same period in 2008.

Two major developments affected the global supply of silicon materials in 2009. China's exports of ferrosilicon and silicon metal declined considerably because the Chinese Government imposed export tariffs in 2008—25% for ferrosilicon, 15% for metallurgical-grade silicon, and 10% for other silicon metal. Nearly all leading-producing countries curtailed production of silicon materials—most notably China and Russia. India, where ferrosilicon production increased slightly, was the exception.

World Production and Reserves:

	Production[e, 5] 2008	Production[e, 5] 2009	Reserves[6]
United States[7]	164	140	The reserves in most major producing countries are ample in relation to demand. Quantitative estimates are not available.
Brazil	259	230	
Canada	72	51	
China	4,000	3,500	
France	112	73	
Iceland	73	59	
India	40	41	
Norway	235	190	
Russia	605	510	
South Africa	154	150	
Ukraine	99	88	
Venezuela	61	56	
Other countries	288	310	
World total (rounded)	6,160	5,400	

Ferrosilicon accounts for about four-fifths of world silicon production (gross-weight basis). The leading countries, in descending order of production, for ferrosilicon production were China, Russia, the United States, South Africa, and Norway, and for silicon metal production were China, Brazil, Norway, and France. China was by far the leading producer of both ferrosilicon (2,700,000 tons) and silicon metal (780,000 tons) in 2009.

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%—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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[7]Ferrosilicon only.

SILVER

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

Domestic Production and Use: In 2009, the United States produced approximately 1,230 tons of silver with an estimated value of $520 million. Silver was produced as a byproduct from 33 base- and precious-metal mines. Alaska continued as the country's leading silver-producing State, followed by Nevada; however, company production data are proprietary and were withheld. There were 21 refiners of commercial-grade silver, with an estimated total output of 4,020 tons from domestic and foreign ores and concentrates, and from old and new scrap. Silver's traditional use categories include coins and medals, industrial applications, jewelry and silverware, and photography. The physical properties of silver include ductility, electrical conductivity, malleability, and reflectivity. The demand for silver in industrial applications continues to increase and includes use of silver in bandages for wound care, batteries, brazing and soldering, in catalytic converters in automobiles, in cell phone covers to reduce the spread of bacteria, in clothing to minimize odor, electronics and circuit boards, electroplating, hardening bearings, inks, mirrors, solar cells, water purification, and wood treatment to resist mold. Silver was used for miniature antennas in Radio Frequency Identification Devices (RFIDs) 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.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production:					
Mine	1,230	1,160	1,280	1,230	1,230
Refinery:					
Primary	2,530	2,210	791	779	1,600
Secondary (new and old scrap)	981	1,110	1,220	1,530	1,500
Imports for consumption[2]	4,540	4,840	5,000	4,680	3,550
Exports[2]	341	1,670	797	685	360
Consumption, apparent[e]	6,140	4,620	5,950	5,950	5,310
Price, dollars per troy ounce[3]	7.34	11.61	13.43	15.02	13.37
Stocks, yearend:					
Treasury Department[4]	220	220	220	220	220
COMEX, CBT[5]	3,750	4,000	4,130	4,160	4,000
Exchange Traded Fund[6]	—	3,770	5,350	8,240	10,300
Employment, mine and mill,[7] number	900	900	900	900	850
Net import reliance[8] as a percentage of apparent consumption[e]	72	63	68	67	63

Recycling: In 2009, approximately 1,500 tons of silver was recovered from old and new scrap. This includes 60 to 90 tons of silver that is reclaimed and recycled annually from photographic wastewater.

Import Sources (2005-08):[2] Mexico, 54%; Canada, 26%; Peru, 15%; Chile, 3%; and other, 2%.

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: In 2009, silver prices averaged $13.37 per troy ounce and peaked at $15.94 per troy ounce on June 2. The overall rise in silver prices corresponded to continued investment interest and holdings in new silver exchange traded funds (ETF) that have opened since the first silver ETF was established in April 2006. Silver ETF inventories totaled approximately 11,700 tons of silver through the end of October.

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SILVER

Industrial demand for silver declined modestly. In the United States, demand for silver in photography fell to slightly more than 900 tons since peaking in 1999 at 2,290 tons. Silver is still used in x-ray films; however, many hospitals have begun to use digital systems. Approximately 99% of the silver in photographic wastewater may be recycled. Silver demand for industrial, photographic, jewelry, silverware, and coins decreased while demand in electronic applications increased. Silver was used as a replacement metal for platinum in catalytic converters in automobiles. Silver was used in clothing to help regulate body heat and to control odor in shoes and in sports and everyday clothing. The use of trace amounts of silver in bandages for wound care and minor skin infections is also increasing. World silver mine production increased to 21,400 tons in response to increased production at new and existing polymetallic mines.

On a global scale, silver output from Bolivia increased somewhat owing to production at San Cristobal; however, water problems at the mine may limit production in 2010. Increased silver production took place at other lead-zinc mines, such as the Lucky Friday Mine in Idaho and Uchucchacua Mine in Peru. Silver production began at the Parmarejo Mine in Mexico and the San Bartolome Mine in Bolivia. In October, the Rochester Mine in Nevada announced an expansion of mining operations.

World Mine Production and Reserves: Reserves information for Canada, China, Peru, and Poland were revised based on new information from Government and industry sources. Data for Bolivia were reported separately because of significant new mine production.

	Mine production		Reserves[9]
	2008	2009[e]	
United States	1,230	1,230	25,000
Australia	1,930	1,800	31,000
Bolivia	1,110	1,360	18,000
Canada	730	700	16,000
Chile	1,400	2,000	70,000
China	2,800	3,000	34,000
Mexico	3,240	2,500	37,000
Peru	3,690	3,900	59,000
Poland	1,190	1,200	55,000
Russia	1,300	1,300	NA
Other countries	2,680	2,360	50,000
World total (rounded)	21,300	21,400	400,000

World Resources: Silver was obtained as a byproduct from processing and smelting copper, gold, and lead-zinc ores. Ores from these polymetallic deposits account for more than two-thirds of U.S. and world resources of silver; the remaining silver resources are associated with veins and submicroscopic gold deposits in which gold is the primary commodity. Most recent silver discoveries have been associated with gold occurrences; however, base-metal occurrences that contain byproduct silver will continue to account for a significant share of future reserves and resources. Peru, Mexico, and China are the world's leading producers of silver, in descending order of production.

Substitutes: Digital imaging, film with reduced silver content, silverless black-and-white film, and xerography substitute for silver that has traditionally been used in black-and-white as well as color printing applications. Surgical pins and plates may be made with tantalum and titanium in place of silver. Stainless steel may be substituted for silver flatware, and germanium added to silver flatware will make it tarnish resistant. Nonsilver batteries may replace silver batteries in some applications. Aluminum and rhodium may be used to replace silver that was traditionally used in mirrors and other reflecting surfaces. Silver may be used to replace more costly metals in catalytic converters for off-road vehicles.

[e]Estimated. NA Not available. — Zero.
[1]One metric ton (1,000 kilograms) = 32,150.7 troy ounces.
[2]Ores and concentrates, refined bullion, doré, and other unwrought silver; excludes coinage, and waste and scrap material.
[3]Handy & Harman quotations.
[4]Balance in U.S. Mint only.
[5]COMEX: Commodity Exchange Inc., New York. CBT: Chicago Board of Trade.
[6]Held in the United Kingdom by ETF Securities and iShares Silver Trust and in Switzerland by Zürcher Kantonalbank.
[7]Source: U.S. Department of Labor, Mine Safety and Health Administration.
[8]Defined as imports – exports + adjustments for Government and industry stock changes.
[9]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

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 2009 was estimated to be about $1.4 billion.[1] The U.S. soda ash industry comprised four companies in Wyoming operating five plants, one company in California with one plant, and one company with one mothballed plant in Colorado that owns one of the Wyoming plants. The five producers have a combined annual nameplate capacity of 14.5 million tons. Salt, sodium sulfate, and borax were produced as coproducts of sodium carbonate production in California. Sodium bicarbonate, sodium sulfite, and chemical caustic soda were manufactured as coproducts at several of the Wyoming soda ash plants. Sodium bicarbonate was produced at the Colorado operation using soda ash feedstock shipped from the company's Wyoming facility.

Based on final 2008 reported data, the estimated 2009 distribution of soda ash by end use was glass, 48%; chemicals, 29%; soap and detergents, 10%; distributors, 4%; miscellaneous uses, 3%; and flue gas desulfurization, pulp and paper, and water treatment, 2% each.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production[2]	11,000	11,000	11,100	11,300	10,900
Imports for consumption	8	7	9	13	5
Exports	4,680	4,820	5,130	5,370	4,900
Consumption:					
Reported	6,200	6,110	5,940	5,730	6,100
Apparent	6,380	6,100	6,030	5,860	6,100
Price:					
Quoted, yearend, soda ash, dense, bulk:					
F.o.b. Green River, WY, dollars per short ton	155.00	155.00	155.00	260.00	260.00
F.o.b. Searles Valley, CA, same basis	180.00	180.00	180.00	285.00	285.00
Average sales value (natural source), f.o.b. mine or plant, dollars per short ton	80.19	96.64	103.53	122.11	120.00
Stocks, producer, yearend	243	290	206	259	200
Employment, mine and plant, number	2,600	2,600	2,600	2,500	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 (2005-08): United Kingdom, 29%; China, 25%; Mexico, 24%; Germany, 6%; and other, 16%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Disodium carbonate	2836.20.0000	1.2% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: The global economic problems in 2009 had a negative effect on most soda ash producers in the world, except in China. The Chinese soda ash industry received some assistance from the government in the form of a 9 percent rebate on the Chinese soda ash export sales. By lowering the export price, Chinese soda ash manufacturers were able to increase export sales and maintain high operating rates. The lower priced Chinese soda ash exports adversely affected U.S. soda ash export sales causing domestic producers to reduce output levels for most of the year.

The leading U.S. soda ash producer in Wyoming announced in April it would temporarily suspend production at its Granger facility because of poor domestic and export market sales but hoped to restart the operation later in the year if export sales improved. In July, the company announced it would not resume operations for the remainder of the year.

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SODA ASH

A Wyoming soda ash producer with seven synthetic soda ash plants in Europe announced in January that it would withdraw from the U.S. export association effective at the end of December 2010. The company indicated that it was now fully capable to logistically and technically serve its worldwide customers. This is the second soda ash company to leave the association since its formation in 1984.

The adverse economic conditions in the domestic automobile and housing markets affected soda ash consumption in the flat glass and fiberglass sectors beginning in 2007 and continuing through 2009. Notwithstanding the continuing economic and energy problems in certain areas of the world, overall global demand for soda ash is expected to grow from 1.5% to 2% annually for the next several years. If the domestic economy and export sales improve, U.S. consumption may be slightly higher in 2010.

World Production and Reserves:

	Production		Reserves[4, 5]
Natural:	**2008**	**2009[e]**	
United States	11,300	10,900	[6]23,000,000
Botswana	250	250	400,000
Kenya	513	500	7,000
Mexico	—	—	200,000
Turkey	—	—	200,000
Uganda	NA	NA	20,000
Other countries	—	—	260,000
World total, natural (rounded)	12,100	11,700	24,000,000
World total, synthetic (rounded)	33,900	34,200	XX
World total (rounded)	46,000	46,000	XX

World Resources: Soda ash is obtained from trona and sodium carbonate-rich brines. The world's largest deposit of trona is in the Green River Basin of Wyoming. About 47 billion tons of identified soda ash resources could be recovered from the 56 billion tons of bedded trona and the 47 billion tons of interbedded or intermixed trona and halite that are in beds more than 1.2 meters thick. Underground room-and-pillar mining, using conventional and continuous mining, is the primary method of mining Wyoming trona ore. This method has an average 45% mining recovery, whereas average recovery from solution mining is 30%. Improved solution-mining techniques, such as horizontal drilling to establish communication between well pairs, could increase this extraction rate and entice companies to develop some of the deeper trona beds. Wyoming trona resources are being depleted at the rate of about 15 million tons per year (8.3 million tons of soda ash). Searles Lake and Owens Lake in California contain an estimated 815 million tons of soda ash reserves. There are at least 62 identified natural sodium carbonate deposits 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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[6]From trona, nahcolite, and dawsonite sources.

SODIUM SULFATE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: The domestic natural sodium sulfate industry consisted of two producers operating two plants, one each in California and Texas. Nine companies operating 11 plants in 9 States recovered byproduct sodium sulfate from various manufacturing processes or products, including battery reclamation, cellulose, resorcinol, silica pigments, and sodium dichromate. About one-half of the total output was a byproduct of these plants in 2009. The total value of natural and synthetic sodium sulfate sold was an estimated $40 million. Estimates of U.S. sodium sulfate consumption by end use were soap and detergents, 35%; glass, 18%; pulp and paper, 15%; carpet fresheners and textiles, 4% each; and miscellaneous, 24%.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production, total (natural and synthetic)[1]	309	290	312	319	300
Imports for consumption	75	61	43	69	80
Exports	149	158	101	107	100
Consumption, apparent (natural and synthetic)	235	193	254	281	280
Price, quoted, sodium sulfate (100% Na_2SO_4), bulk, f.o.b. works, East, dollars per short ton	134	134	134	134	127
Employment, well and plant, number[e]	225	225	225	225	225
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: There was some recycling of sodium sulfate by consumers, particularly in the pulp and paper industry, but no recycling by sodium sulfate producers.

Import Sources (2005-08): Canada, 79%; Mexico, 11%; China, 4%; and other, 6%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Disodium sulfate:		
Saltcake (crude)	2833.11.1000	Free.
Other:	2833.11.5000	0.4% ad val.
Anhydrous	2833.11.5010	0.4% ad val.
Other	2833.11.5050	0.4% ad val.

Depletion Allowance: Natural, 14% (Domestic and foreign); synthetic, none.

Government Stockpile: None.

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SODIUM SULFATE

Events, Trends, and Issues: A Canadian industrial mineral producer that purchased the natural sodium sulfate deposit near Whiteshore Lake in Palo, Saskatchewan, in late 2007 started production in early 2009. The operation has a production capacity of 100,000 tons per year. The company signed a 10-year contract to supply sodium sulfate to a major potassium sulfate fertilizer producer.

The primary use of sodium sulfate worldwide is in powdered detergents. Sodium sulfate is a low-cost, inert, white filler in home laundry detergents. Although powdered home laundry detergents may contain as much as 50% sodium sulfate in their formulation, the market for liquid detergents, which do not contain any sodium sulfate, continued to increase. Asia and Latin America are major markets for sodium sulfate consumption because of the increasing demand for packaged powder detergents. Sodium sulfate consumption in the domestic textile industry also has been declining because of imports of less expensive textile products.

Sodium sulfate consumption in 2010 is expected to be comparable with that of 2009, with detergents remaining the leading sodium-sulfate-consuming sector. If the winter of 2009-10 is relatively mild, byproduct recovery of sodium sulfate from automobile batteries may decline because fewer battery failures during mild winter weather reduce recycling. World production and consumption of sodium sulfate have been stagnant but are expected to increase in the next few years, especially in Asia and South America.

World Production and Reserves: Although data on mine production for natural sodium sulfate are not available, total world production of natural sodium sulfate is estimated to be about 4 million tons. Total world production of byproduct sodium sulfate is estimated to be between 1.5 and 2.0 million tons.

	Reserves[3]
United States	860,000
Canada	84,000
Mexico	170,000
Spain	180,000
Turkey	100,000
Other countries	1,900,000
World total (rounded)	3,300,000

World Resources: Sodium sulfate resources are sufficient to last hundreds of years at the present rate of world consumption. In addition to the countries with reserves listed above, the following countries also possess identified resources of sodium sulfate: Botswana, China, Egypt, Italy, Mongolia, Romania, and South Africa. Commercial production from domestic resources is from deposits in California and Texas. The brine in Searles Lake, CA, contains about 450 million tons of sodium sulfate resource, representing about 35% of the lake's brine. In Utah, about 12% of the dissolved salts in the Great Salt Lake is sodium sulfate, representing about 400 million tons of resource. An irregular, 21-meter-thick mirabilite deposit is associated with clay beds 4.5 to 9.1 meters below the lake bottom near Promontory Point, UT. Several playa lakes in west Texas contain underground sodium-sulfate-bearing brines and crystalline material. Other economic and subeconomic deposits of sodium sulfate are near Rhodes Marsh, NV; Grenora, ND; Okanogan County, WA; and Bull Lake, WY. Sodium sulfate also can be obtained as a byproduct from the production of ascorbic acid, battery recycling, boric acid, cellulose, chromium chemicals, lithium carbonate, rayon, resorcinol, and silica pigments. The quantity and availability of byproduct sodium sulfate are dependent on the production capabilities of the primary industries and the sulfate recovery rates.

Substitutes: In pulp and paper, emulsified sulfur and caustic soda (sodium hydroxide) can replace sodium sulfate. In detergents, a variety of products can substitute for sodium sulfate. In glassmaking, soda ash and calcium sulfate have been substituted for sodium sulfate with less effective results.

[e]Estimated. E Net exporter.
[1]Source: U.S. Census Bureau. Synthetic production data are revised in accordance with recent updated Census Bureau statistics.
[2]Defined as imports – exports + adjustments for Government and industry stock changes (if available).
[3]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

STONE (CRUSHED)[1]

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

Domestic Production and Use: Crushed stone valued at $11 billion was produced by 1,600 companies operating 4,000 quarries, 86 underground mines, and 311 sales/distribution yards in 50 States. Leading States, in descending order of production, were Texas, Pennsylvania, Missouri, Illinois, California, Florida, Georgia, Virginia, Ohio, and Kentucky, together accounting for 50% of the total crushed stone output. Of the total crushed stone produced in 2009, about 70% was limestone and dolomite; 14%, granite; 7%, traprock; and the remaining 9% was divided, in descending order of tonnage, among miscellaneous stone, sandstone and quartzite, marble, slate, calcareous marl, volcanic cinder and scoria, and shell. It is estimated that of the 1.11 billion tons of crushed stone consumed in the United States in 2009, 49% was reported by use, 31% was reported for unspecified uses, and 20% of the total consumed was estimated for nonrespondents to the U.S. Geological Survey (USGS) canvasses. Of the 544 million tons reported by use, 83% was used as construction aggregates, mostly for road construction and maintenance; 11%, for cement manufacturing; 2%, for lime manufacturing; 2%, for agricultural uses; and 2%, for special and miscellaneous uses and products. To provide a more accurate estimate of the consumption patterns for crushed stone, the “unspecified uses—reported and estimated,” as defined in the USGS Minerals Yearbook, are not included in the above percentages.

The estimated output of crushed stone in the 48 conterminous States shipped for consumption in the first 6 months of 2009 was 487 million tons, a 26% decrease compared with that of the same period of 2008. Second quarter shipments for consumption also decreased by 26% compared with those of the same period of 2008. 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.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production	1,700	1,780	1,650	1,440	1,110
Imports for consumption	21	20	20	21	21
Exports	1	1	1	1	1
Consumption, apparent[3]	1,730	1,810	1,690	1,490	1,160
Price, average value, dollars per metric ton	7.29	8.03	8.55	9.31	9.71
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e, 4]	81,000	82,600	81,900	81,000	81,000
Net import reliance[5] as a percentage of apparent consumption	1	1	1	1	2

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 were recycled in 48 States and Puerto Rico, and concrete was recycled by 47 States. The amount of material reported to be recycled increased by 45% in 2009 and increased by 31% in 2008 when compared with that of the previous year.

Import Sources (2005-2008): Canada, 43%; Mexico, 38%; The Bahamas, 17%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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 1.11 billion tons in 2009, a decrease of 23% compared with that of 2008. It is estimated that in 2009, apparent consumption will also decrease by 22% to about 1.16 billion tons. Demand for construction aggregates is anticipated to decrease for 2010 based on the slowdown in activity that some of the principal construction markets have experienced over the last 3 years. Long-term projected 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 f.o.b. and delivered prices of crushed stone are expected to be present in 2010, especially in and near metropolitan areas.

The crushed stone industry continued to be concerned with environmental, health, and safety regulations. Shortages in some urban and industrialized areas are expected to continue to increase owing to local zoning regulations and land-development alternatives. These issues are expected to continue and to cause new crushed stone quarries to locate away from large population centers.

World Mine Production and Reserves:

	Mine production		Reserves[6]
	2008	2009[e]	
United States	1,440	1,110	Adequate except where special
Other countries[7]	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]Includes recycled material.
[4]Including office staff.
[5]Defined as imports – exports + adjustments for Government and industry stock changes. Changes in stocks were assumed to be zero in the net import reliance and apparent consumption calculations because data on stocks were not available.
[6]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[7]Reliable production information is not available for other countries owing to a wide variety of ways in which countries report their crushed stone production. Some countries do not report production for this mineral commodity. Production information for some countries is available in the country chapters of the USGS Minerals Yearbook.

STONE (DIMENSION)[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Approximately 1.83 million tons of dimension stone, valued at $377 million, was sold or used by U.S. producers in 2009. Dimension stone was produced by 173 companies, operating 237 quarries, in 37 States. Leading producer States, in descending order by tonnage, were Texas, Wisconsin, Indiana, Georgia, and Arizona. These five States accounted for about 57% of the production and contributed about 36% of the value of domestic production. Approximately 34%, by tonnage, of dimension stone sold or used was limestone, followed by granite (26%), sandstone (19%), miscellaneous stone (18%), marble (2%), and slate (1%). By value, the leading sales or uses were for granite (33%), followed by limestone (27%), miscellaneous stone (15%), sandstone (15%), marble (5%), and slate (5%). Dressed stone represented 49% of the tonnage and 61% of the value of all the dimension stone sold or used by domestic producers, including exports. The leading uses and distribution of dressed stone, by tonnage, were in panels and veneer, tile, blackboards, exports, and unlisted and unspecified uses (29%), ashlars and partially squared pieces (27%), and flagging (15%). Rough stone mainly was sold for building and construction (47%) and irregular-shaped stone (30%), by tonnage.

Salient Statistics—United States:[2]	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Sold or used by producers:					
Tonnage	2,000	1,850	1,920	1,800	1,830
Value, million dollars	329	334	346	324	377
Imports for consumption, value, million dollars	2,180	2,500	2,540	2,150	1,470
Exports, value, million dollars	66	76	74	66	111
Consumption, apparent, value, million dollars	2,440	2,760	2,810	2,400	1,740
Price	Variable, depending on type of product				
Employment, quarry and mill, number[3]	3,000	3,000	3,000	3,000	3,000
Net import reliance[4] as a percentage of apparent consumption (based on value)	87	88	88	87	78
Granite only:					
Production	491	505	536	464	460
Exports (rough and finished)	135	108	112	103	103
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 (2005-08 by value): Dimension stone: Brazil, 20%; Italy, 19%; China, 18%; Turkey, 17%; and other, 26%. Granite only: Brazil, 36%; China, 23%; Italy, 18%; India, 14%; and other, 9%.

Tariff: Dimension stone tariffs ranged from free to 6.5% ad valorem, according to type, degree of preparation, shape, and size, for countries with normal trade relations in 2009. 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 largest market for dimension stone. Imports of dimension stone decreased in value to about $1.5 billion, a decline of 32%, compared with those of 2008. Dimension stone exports increased to about $111 million. Apparent consumption, by value, was $1.7 billion in 2009—a $672 million, or 28%, decrease from that of 2008. Dimension stone for construction and refurbishment is being used commonly in both commercial and residential markets. The devaluation of the U.S. dollar has aided the U.S. export market for dimension stone, but the global economic downturn will tend to decrease demand for and imports of dimension stone in the near term.

World Mine Production and Reserves:

	Mine production		Reserves[5]
	2008	2009[e]	
United States	1,800	1,830	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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.

STRONTIUM

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

Domestic Production and Use: U.S. production of strontium minerals ceased in 1959. The United States is 100% import reliant on celestite, the most common strontium mineral consisting primarily of strontium sulfate. A company in Georgia was the only major U.S. producer of strontium compounds, and analysis of celestite import data indicate that production at this operation has decreased substantially since 2001. Estimates of primary strontium compound end uses in the United States were pyrotechnics and signals, 30%; ferrite ceramic magnets, 30%; master alloys, 10%; pigments and fillers, 10%; electrolytic production of zinc, 10%; and other applications, 10%.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production	—	—	—	—	—
Imports for consumption:					
Strontium minerals	799	671	541	2,030	5,900
Strontium compounds	11,700	8,860	8,550	9,420	5,200
Exports, compounds	255	716	697	745	800
Consumption, apparent, celestite and compounds	12,200	8,820	8,390	10,700	10,000
Price, average value of mineral imports at port of exportation, dollars per ton	56	64	67	64	68
Net import reliance[2] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2005-08): Strontium minerals: Mexico, 100%. Strontium compounds: Mexico, 85%; Germany, 9%; and other, 6%. Total imports: Mexico, 93%; Germany, 4%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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: Consumption of strontium minerals has been shifting away from cathode ray tubes (CRTs), the key commercial market for many years, owing to advances in flat-panel technology, which requires much smaller quantities of strontium carbonate. With global shipments of liquid-crystal display televisions expected to double by 2012, strontium demand for CRTs that was initially stable in Asia and Mexico is expected to vanish. Even without strontium carbonate consumption in CRTs, estimated strontium consumption in ceramics and glass manufacture remained one of the top end-use industries through its use in ceramic ferrite magnets and other ceramic and glass applications. The use of strontium nitrate in pyrotechnics was estimated to equal the use of strontium carbonate in ferrite magnets.

In descending order of production, China, Spain, and Mexico are the world's leading producers of celestite; however, decreases in production in Mexico and Spain are expected in the near term. With new Chinese suppliers and decreased demand for CRTs, Spanish production of celestite is expected to decrease, with a key celestite mine and refinery to be closed at the end of 2009. The Iranian celestite industry is expecting strong growth over the next 3 years owing to strong Chinese demand, low cost of container freights, and government subsidies. Production is expected to reach rates between 2,000 and 20,000 tons per year. Turkey had been another leading celestite producer, but continues to experience significant decline in production.

China, Germany, and Mexico are the world's leading producers of strontium carbonate. China utilizes mostly domestic celestite to supply its strontium carbonate plants; the German producer is 100% reliant on imported celestite; and Mexican producers consume domestic ore for their strontium carbonate production. Major markets for Chinese strontium carbonate are Asia and Europe. Chinese celestite reserves are smaller and lower quality than those in other major producing countries, including Mexico and Spain; therefore, China is becoming more reliant on imported celestite.

World Mine Production and Reserves:[3]

	Mine production 2008	Mine production 2009[e]	Reserves[4]
United States	—	—	—
Argentina	5,000	5,500	All other:
China[e]	200,000	200,000	6,800,000
Mexico	96,900	30,000	
Morocco	2,700	2,700	
Pakistan	1,700	1,700	
Spain	188,000	180,000	
Turkey	1,600	—	
World total (rounded)	496,000	420,000	6,800,000

World Resources: World resources of strontium are thought to exceed 1 billion tons.

Substitutes: The substitution of other materials for strontium in some applications is possible; however, such a change would adversely affect product performance and/or cost. For example, barium replacement of strontium in ferrite ceramic magnets would decrease the maximum energy and temperature characteristics of the magnets. Substituting for strontium in pyrotechnics would be impractical because the desired brilliance and visibility are imparted only 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.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]Metric tons of strontium minerals.
[4]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

SULFUR

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

Domestic Production and Use: In 2009, elemental sulfur and byproduct sulfuric acid were produced at 114 operations in 29 States and the U.S. Virgin Islands. Total shipments were valued at nearly $100 million. Elemental sulfur production was 9.0 million tons; Louisiana and Texas accounted for about 45% of domestic production. Elemental sulfur was recovered, in descending order of tonnage, at petroleum refineries, natural-gas-processing plants, and coking plants by 40 companies at 107 plants in 26 States and the U.S. Virgin Islands. Byproduct sulfuric acid, representing about 8% of production of sulfur in all forms, was recovered at seven nonferrous smelters in five States by six companies. Domestic elemental sulfur provided 74% of domestic consumption, and byproduct acid accounted for 7%. The remaining 19% of sulfur consumed was provided by imported sulfur and sulfuric acid. About 90% of sulfur consumed was in the form of sulfuric acid. Agricultural chemicals (primarily fertilizers) composed about 62% of identified sulfur demand; petroleum refining, 26%; and metal mining, 5%. Other uses, accounting for 7% of demand, were widespread because a multitude of industrial products required sulfur in one form or another during some stage of their manufacture.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production:					
Recovered elemental	8,790	8,390	8,280	8,690	9,000
Other forms	711	674	817	753	810
Total (rounded)	9,500	9,050	9,100	9,450	9,800
Shipments, all forms	9,480	8,960	9,130	9,430	9,700
Imports for consumption:					
Recovered, elemental[e]	2,820	2,950	2,930	3,000	1,600
Sulfuric acid, sulfur content	877	793	851	1,140	460
Exports:					
Recovered, elemental	684	635	922	952	1,500
Sulfuric acid, sulfur content	110	79	110	86	80
Consumption, apparent, all forms	12,400	12,000	11,900	12,500	10,200
Price, reported average value, dollars per ton of elemental sulfur, f.o.b., mine and/or plant	30.88	32.85	36.29	262.32	10.00
Stocks, producer, yearend	160	221	187	211	300
Employment, mine and/or plant, number	2,700	2,600	2,600	2,600	2,600
Net import reliance[1] as a percentage of apparent consumption	24	25	23	25	4

Recycling: Typically, between 3 million and 5 million tons of spent sulfuric acid is reclaimed from petroleum refining and chemical processes during any given year.

Import Sources (2005-08): Elemental: Canada, 71%; Mexico, 14%; Venezuela, 13%; and other, 2%. Sulfuric acid: Canada, 77%; Mexico, 10%; India, 3%, and other, 10%. Total sulfur imports: Canada, 73%; Mexico, 13%; Venezuela, 10%; and other, 4%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-09**
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 compared with those of 2008. Domestic production of elemental sulfur from petroleum refineries increased, and recovery from natural gas operations decreased. Although the sulfur content of imported crude petroleum processed at U.S. refineries was lower than expected, fewer refineries experienced production interruptions than had been the case in recent years, and one large refinery operated at capacity throughout the year after several years of limited production. These factors contributed to the expanded sulfur production. 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 the downturn in the world economy limits investments in those areas.

After elemental sulfur prices reached record highs during 2008, prices collapsed early in 2009 as demand plummeted and the global economy faltered. In August 2008, contract sulfur prices in Tampa, FL, reached about $600 per ton and remained at that level throughout September. By the end of November, however, the Tampa price had declined to less than $150 per ton, and in January 2009, prices were reported to be $0 per ton. The Tampa price recovered to about $30 per ton by the end of 2009. Export prices were higher than domestic prices, so exports were higher than they had been for many years. Sulfur prices were expected to increase more as the global economy improved but will probably never again achieve the levels seen in 2008.

Domestic phosphate rock consumption was lower in 2009 than in 2008, which resulted in decreased demand for sulfur to process the phosphate rock into phosphate fertilizers. The global economic slowdown contributed to the decreased demand for fertilizers.

World Production and Reserves:

	Production—All forms 2008	Production—All forms 2009[e]
United States	9,450	9,800
Australia	938	940
Canada	9,280	9,300
Chile	1,570	1,600
China	8,610	8,500
Finland	615	615
France	1,310	1,300
Germany	2,310	2,400
India	1,170	1,200
Iran	1,570	1,570
Italy	740	740
Japan	3,270	3,300
Kazakhstan	2,800	3,000
Korea, Republic of	1,850	1,900
Kuwait	700	700
Mexico	1,740	1,750
Netherlands	530	530
Poland	1,280	1,200
Russia	7,170	7,200
Saudi Arabia	3,160	3,200
South Africa	569	600
Spain	601	600
United Arab Emirates	1,950	1,950
Uzbekistan	520	520
Venezuela	800	800
Other countries	5,100	5,100
World total (rounded)	69,600	70,300

Reserves[2]

Previously published reserves data are outdated and inadequate for this tabulation because of changes in the world sulfur industry. For this reason, specific country data have been omitted from this report.

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 for which the reserves were attributed. For instance, sulfur from Saudi Arabian oil may be recovered at refineries in the United States.

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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.

TALC AND PYROPHYLLITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Domestic talc production in 2009 was estimated to be 527,000 tons valued at $15 million. There were seven talc-producing mines in four States in 2009. Montana was the leading producer, followed by Texas, Vermont, and California. Two other companies, one in California and one in Virginia, worked from stocks. Sales of talc were estimated to be 514,000 tons valued at $63 million. About 36% of the talc produced domestically was exported in 2009. Talc produced and sold in the United States was used for paint, 21%; paper, 20%; ceramics, 18%; plastics, 10%; roofing, 8%; rubber, 3%; cosmetics, 3%; and other, 17%. About 98,000 tons of talc was imported with more than 75% of the imported talc being used for plastics, cosmetics, and paint applications, in decreasing order by tonnage. The total estimated use of talc in the United States, with imported talc included, was plastics, 22%; paint, 17%; paper, 16%; ceramics, 15%; roofing, 7%; cosmetics, 5%; rubber, 3%; and other, 15%. One company in North Carolina mined pyrophyllite. Production of pyrophyllite decreased from that of 2008. Consumption was, in decreasing order by tonnage, in refractory products, ceramics, and paint.

Salient Statistics—United States:[1]	**2005**	**2006**	**2007**	**2008**	**2009**[e]
Production, mine	856	895	769	706	527
Sold by producers	826	900	720	667	514
Imports for consumption	237	314	221	193	98
Exports	270	253	271	244	190
Shipments from Government stockpile excesses	—	—	—	([2])	—
Consumption, apparent	823	956	719	655	435
Price, average, processed, dollars per ton	86	90	114	125	123
Employment, mine and mill	440	435	430	350	280
Net import reliance[3] as a percentage of apparent consumption	E	6	E	E	E

Recycling: Insignificant.

Import Sources (2005-08): China, 46%; Canada, 33%; Japan, 9%; France, 5%; and other, 7%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-09**
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); and other, 14% (Domestic and foreign).

Government Stockpile:

Stockpile Status—9-30-09[4]
(Metric tons)

Material	**Uncommitted inventory**	**Authorized for disposal**	**Disposal plan FY 2009**	**Disposals FY 2009**
Talc, block and lump	865	865	[5]907	—
Talc, ground	621	621	([6])	—

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TALC AND PYROPHYLLITE

Events, Trends, and Issues: The continued slowdown of the U.S. and world economies affected the talc industry in 2009. Major market sectors, such as automotive, housing, and general manufacturing, declined in 2008 and made no significant recovery by mid-2009. This affected talc sales for such product applications as adhesives, caulks, ceramics, joint compounds, paint, plastics, roofing, and rubber. Many governments instituted economic stimulus programs that helped to improve the stability of banking and finance systems in 2008 but most major world economies continued to decline in early 2009. By mid-2009, there were indications that the world economies were stabilizing. However, concerns over job losses, increased saving rates in the United States, and tight credit have dampened consumer spending. This, in turn, has affected new home construction and the recovery of the manufacturing sector, on which talc sales are strongly dependent. Consumer product inventory draw downs during this time of slow sales further reduced demands by the manufacturing sector. The slowdown in major industries that use pyrophyllite to produce ceramic, paint, and refractory products also negatively affected pyrophyllite sales.

Production and sales of talc declined 25% and 23%, respectively, from those of 2008. The economic recession worldwide resulted in a significant decline in U.S. talc exports in 2009. U.S. exports of talc decreased 22% from those of 2008. Mexico was the leading destination for U.S. talc exports, accounting for 32% of the tonnage. Canada followed closely with 12% of the export tonnage. U.S. imports decreased 49% from those of 2008. In 2009, Canada and China supplied approximately 84% of the imported talc. Apparent consumption decreased by 34% in 2009. U.S. apparent consumption, production, and sales of talc may experience additional declines in 2010 based on current market conditions. The economy's impact on the U.S. talc industry is best illustrated by the fact that U.S. apparent consumption, production, and sales of talc have not been this low since the late 1940s.

Europe's leading world producer of talc entered a joint venture to produce talc in Liaoning Province, China. The venture allows the company to access high quality talc reserves in China and reduce its dependence on talc from its Finnish operation and other sources. The move also was taken because many of the company's customers were relocating in Asia, where markets were expanding. The leading Indian talc producer opened a new talc mill in Thailand to process Indian ore for Southeast Asian markets.

World Mine Production and Reserves:

	Mine production		Reserves[7]
	2008	2009[e]	
United States[1]	706	527	140,000
Brazil	405	405	180,000
China	2,200	2,200	Large
Finland	550	525	Large
India	647	650	4,000
Japan	355	350	100,000
Korea, Republic of	825	800	14,000
Other countries	1,820	1,750	Large
World total (rounded)	7,510	7,210	Large

World Resources: The United States is self-sufficient in most grades of talc and related minerals. Domestic and world resources are estimated to be approximately five times the quantity of reserves.

Substitutes: Substitutes for talc include bentonite, chlorite, kaolin, and pyrophyllite in ceramics; chlorite, kaolin, and mica in paint; calcium carbonate and kaolin in paper; bentonite, kaolin, mica, and wollastonite in plastics; and kaolin and mica in rubber.

[e]Estimated. E Net exporter. — Zero.
[1]Excludes pyrophyllite.
[2]Less than ½ unit.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]Includes block and lump talc and ground talc.
[6]Included in block and lump talc.
[7]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

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 2008 was estimated at about $200 million and was expected to be about $122 million in 2009 as measured by the value of imports.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production:					
Mine	—	—	—	—	—
Recycling	NA	NA	NA	NA	NA
Imports for consumption[e, 1]	1,630	1,160	1,160	1,290	1,300
Exports[e, 1]	984	949	511	662	700
Government stockpile releases[e, 2]	210	289	—	—	—
Consumption, apparent	852	498	644	629	600
Price, tantalite, dollars per pound of Ta_2O_5 content[3]	35	32	36	39	42
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 (2005-08): Tantalum contained in niobium (columbium) and tantalum ore and concentrate; tantalum metal; and tantalum waste and scrap—Australia, 18%; China, 14%; Brazil, 12%; Japan, 9%; and other, 47%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Synthetic tantalum-niobium concentrates	2615.90.3000	Free.
Tantalum ores and concentrates	2615.90.6060	Free.
Tantalum oxide[5]	2825.90.9000	3.7% ad val.
Potassium fluotantalate[5]	2826.90.9000	3.1% ad val.
Tantalum, unwrought:		
Powders	8103.20.0030	2.5% ad val.
Alloys and metal	8103.20.0090	2.5% ad val.
Tantalum, waste and scrap	8103.30.0000	Free.
Tantalum, other	8103.90.0000	4.4% ad val.

Depletion Allowance:[6] 22% (Domestic), 14% (Foreign).

Government Stockpile: In fiscal year (FY) 2009 (October 1, 2008, through September 30, 2009), the Defense National Stockpile Center (DNSC), Defense Logistics Agency, sold no tantalum materials. DNSC announced maximum disposal limits for FY 2010 of about 3.63 tons[7] of tantalum contained in tantalum carbide powder. DNSC 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—9-30-09[6]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2009	Disposals FY 2009
Tantalum carbide powder	1.73	1.73	[7]3.63	—

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TANTALUM

Events, Trends, and Issues: U.S. tantalum apparent consumption in 2009 was estimated to decrease about 5% from that of 2008. Tantalum ore and concentrate, metals, and waste and scrap were the leading imported tantalum materials, with each accounting for approximately equal amounts of tantalum. By weight, from 2005 through 2008, tantalum mineral concentrate imports for consumption were supplied 75% by Australia and 19% by Canada; metal, 23% by Brazil, 14% by China, and 13% by Germany; and waste and scrap, 27% by China, 11% by Japan, and 10% by Mexico. Financial market problems and the subsequent economic slowdown were expected to result in reduced tantalum material consumption and production.

World Mine Production and Reserves: Reserves for Brazil were revised based on new information published by the Brazilian Government.

	Mine production[8]		Reserves[9]
	2008	2009[e]	
United States	—	—	—
Australia	557	560	40,000
Brazil	180	180	65,000
Canada	40	40	NA
Congo (Kinshasa)	100	100	NA
Rwanda	100	100	NA
Other countries[10]	188	180	NA
World total (rounded)	1,170	1,160	110,000

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 2009 prices.

Substitutes: The following materials can be substituted for tantalum, but usually with less effectiveness: niobium in carbides; aluminum and ceramics in electronic capacitors; glass, niobium, platinum, titanium, and zirconium in corrosion-resistant equipment; and hafnium, iridium, molybdenum, niobium, rhenium, and tungsten in high-temperature applications.

[e]Estimated. NA Not available. — Zero.
[1]Imports and exports include the estimated tantalum content of niobium and tantalum ores and concentratres, unwrought tantalum alloys and powder, tantalum waste and scrap, and other tantalum articles.
[2]Disposals reported by DNSC, net quantity (uncommitted inventory).
[3]Price is an average (time-weighted average of prices sampled weekly) based on trade journal reported prices.
[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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[10]Includes Burundi, Ethiopia, Mozambique, Uganda, and Zimbabwe.

TELLURIUM

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

Domestic Production and Use: In the United States, one firm produced commercial-grade tellurium at its refinery complex in Texas, mainly from copper anode slimes but also from lead refinery skimmings, both of domestic origin. Primary and intermediate producers further refined domestic and imported commercial-grade metal and tellurium dioxide, producing tellurium and tellurium compounds in high-purity form for specialty applications.

Tellurium's major use is as an alloying additive in steel to improve machining characteristics. It is also used as a minor additive in copper alloys to improve machinability without reducing conductivity; in lead alloys to improve resistance to vibration and fatigue; in cast iron to help control the depth of chill; and in malleable iron as a carbide stabilizer. It is 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. Tellurium was increasingly used in the production of cadmium-tellurium-based solar cells. Production of bismuth-telluride thermoelectric cooling devices decreased owing to the reduced manufacturing of automobiles containing seat-cooling systems. Other uses include those in photoreceptor and thermoelectric electronic devices, other thermal cooling devices, as an ingredient in blasting caps, and as a pigment to produce various colors in glass and ceramics.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009[e]**
Production, refinery	W	W	W	W	W
Imports for consumption, unwrought, waste and scrap	42	31	44	102	60
Exports	51	4	15	50	5
Consumption, apparent	W	W	W	W	W
Price, dollars per kilogram, 99.95% minimum[1]	96	89	82	211	145
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: There is little or no scrap from which to extract secondary tellurium because the uses of tellurium are nearly all dissipative in nature. Currently, none is recovered in the United States, but a very small amount is recovered from scrapped selenium-tellurium photoreceptors employed in older plain paper copiers in Europe.

Import Sources (2005-08): China, 43%; Belgium, 24%; Canada, 18%; Philippines, 6%; and other, 9%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Tellurium	2804.50.0020	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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TELLURIUM

Events, Trends, and Issues: In 2009, estimated domestic tellurium production remained the same as in 2008. Though detailed information on the world tellurium market was not available, world tellurium consumption was estimated to have decreased slightly in 2009. The price of tellurium decreased in 2009 because the economic downturn reduced demand for thermoelectronic devices and slowed the demand for solar cells. However, there was still an increase in demand for high-purity tellurium for cadmium telluride solar cells. The majority of Japanese production of tellurium was used in the Japanese steel industry to replace lead in steel products.

World Refinery Production and Reserves:

	Refinery production		Reserves[3]
	2008	2009[e]	
United States	W	W	3,000
Canada	19	20	700
Japan	40	40	NA
Peru	30	30	2,300
Other countries[4]	NA	NA	16,000
World total (rounded)	NA	NA	22,000

World Resources: The figures shown for reserves include only tellurium contained in economic copper deposits. These estimates assume that less than one-half of the tellurium contained in unrefined copper anodes is actually recovered. With increased concern for supply of tellurium, companies are investigating other potential resources, such as gold telluride and lead-zinc ores with higher concentrations of tellurium, which are not included in estimated world resources.

More than 90% of tellurium is produced from anode slimes collected from electrolytic copper refining, and the remainder is derived from skimmings at lead refineries and from flue dusts and gases generated during the smelting of bismuth, copper, and lead ores. In copper production, tellurium is recovered only from the electrolytic refining of smelted copper. Growth in the global use of the leaching solvent extraction-electrowinning processes for copper extraction has limited the growth of tellurium supply.

Substitutes: Several materials can replace tellurium in most of its uses, but usually with losses in production efficiency or product characteristics. Bismuth, calcium, lead, phosphorus, selenium, and sulfur can be used in place of tellurium in many free-machining steels. Several of the chemical process reactions catalyzed by tellurium can be carried out with other catalysts or by means of noncatalyzed processes. In rubber compounding, sulfur and/or selenium can act as vulcanization agents in place of tellurium. The selenides of the refractory metals can function as high-temperature, high-vacuum lubricants in place of tellurides. The selenides and sulfides of niobium and tantalum can serve as electrically conducting solid lubricants in place of tellurides of those metals.

The selenium-tellurium photoreceptors used in some xerographic copiers and laser printers have been replaced by organic photoreceptors in newer machines. Amorphous silicon and copper indium diselenide are the two principal competitors to cadmium telluride in photovoltaic power cells.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Average price published by Mining Journal for United Kingdom lump and powder, 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 definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[4]In addition to the countries listed, Australia, Belgium, China, Germany, Kazakhstan, the Philippines, and Russia produce refined tellurium, but output is not reported, and available information is inadequate for formulation of reliable production estimates.

THALLIUM

(Data in kilograms of thallium content unless otherwise noted)

Domestic Production and Use: Thallium is a byproduct metal recovered in some countries from flue dusts and residues collected in the smelting of copper, zinc, and lead ores. Although thallium was contained in ores mined or processed in the United States, it has not been recovered domestically since 1981. Consumption of thallium metal and thallium compounds continued for most of its established end uses. These included the use of radioactive thallium isotope 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:	2005	2006	2007	2008	2009[e]
Production, mine	([1])	([1])	([1])	([1])	([1])
Imports for consumption (gross weight)					
Unwrought and powders	23	—	—	916	800
Other	212	530	901	—	300
Total	235	530	901	916	1,100
Exports (gross weight)					
Unwrought and powders	209	—	155	43	150
Waste and scrap	—	—	190	51	50
Other	43	229	258	153	150
Total	252	229	603	247	350
Consumption[e]	300	300	300	670	750
Price, metal, dollars per kilogram[2]	1,900	4,650	4,560	4,900	5,700
Net import reliance[e, 3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: None.

Import Sources (2005-08): Russia, 78%; Germany, 16%; Netherlands, 4%, and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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 2009 as the supply worldwide continued to be relatively tight. The average price for high-purity granules and rod increased by about 16% in 2009 and has tripled since 2005. China continued its policy of eliminating toll trading tax benefits on exports of thallium that began in 2006, thus contributing to the shortage on the world market. Higher internal demand for many metals, including thallium, has prompted China to begin importing greater quantities of thallium.

In June, the U.S. Trade Representative issued waivers to continue Generalized System of Preferences (GSP) benefits for 112 exports from 16 nations. Without receiving waivers, these particular exports would have been excluded from the program because their trade value exceeded statutory import ceilings. The Administration conducts an annual review of the countries covered under the GSP program and products that are eligible for duty-free treatment. Based on the conclusion of the 2008 review of countries covered by the program, articles of thallium imported from Russia that are classified under Harmonized Tariff Schedule code 8112.50.0000 continued to receive duty-free status in 2009.

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THALLIUM

One of the most significant events that affected the global thallium market in 2009 was the shortage of the medical isotope technetium-99, which had been widely used by physicians for medical imaging tests owing to its availability, cost, and the superior diagnostic quality of images produced. In mid-July, two of five isotope-producing nuclear reactors, in Canada and the Netherlands, were taken out of commission for repair work, and it was unclear how long this disruption was going to last. These reactors accounted for nearly 65% of the world's supply of technetium-99 in 2008. Technetium-99 has a very short half-life so it needs to be produced on a continual basis and cannot be stockpiled. Following the closure of these two plants, medical care facilities had a difficult time acquiring adequate supplies of technetium-99 and were forced to cancel scans or use alternative types of tests. The thallium isotope 201 was the most common alternative to technetium-99 for use in scans, such as the cardiac-stress test that monitors blood perfusion into heart tissue during rigorous exercise. It was estimated that before the shortage, thallium was used in about 25% of all cardiac-perfusion tests performed in the United States. In response to the shortage of technetium-99, some medical imaging equipment producers increased production of thallium isotope 201 in order to meet anticipated demand.

Thallium metal and its compounds are highly toxic materials and are strictly controlled to prevent a threat to humans and the environment. Thallium and its compounds can be absorbed into the human body by skin contact, ingestion, or inhalation of dust or fumes. Further information on thallium toxicity can be found in the U.S. Environmental Protection Agency (EPA) Integrated Risk Information System database. Under its national primary drinking water regulations, the EPA has set an enforceable Maximum Contaminant Level for thallium at 2 parts per billion. All public water supplies must abide by these regulations. The EPA continues to conduct studies at its National Risk Management Research Laboratory (NRMRL) to develop and promote technologies that protect and improve human health and the environment. Studies were conducted recently at NRMRL on methods to remove thallium from mine wastewaters.

World Mine Production and Reserves:[4]

	Mine production		Reserves[5]
	2008	2009[e]	
United States	([1])	([1])	32,000
Other countries	10,000	10,000	350,000
World total (rounded)	10,000	10,000	380,000

World Resources: World resources of thallium contained in zinc resources total about 17 million kilograms; most are in Canada, Europe, and the United States. An additional 630 million kilograms is in world coal resources. The average thallium content of the Earth's crust has been estimated to be 0.7 part per million.

Substitutes: The apparent leading potential demand for thallium could be in the area of HTS materials, but demand will be based on which HTS formulation has a combination of favorable electrical and physical qualities and is best suited for fabrication. A firm presently using a thallium HTS material in filters for wireless communications is considering using a nonthallium HTS. While research in HTS continues, and thallium is part of that research effort, it is not guaranteed that HTS products will be a large user of thallium in the future.

Although other materials and formulations can substitute for thallium in gamma radiation detection equipment and optics used for infrared detection and transmission, thallium materials are presently superior and more cost effective for these very specialized uses.

Nonpoisonous substitutes like tungsten compounds are being marketed as substitutes for thallium in high-density liquids for sink-float separation of minerals.

[e]Estimated. — Zero.
[1]No reported mine production; flue dust and residues from base-metal smelters, from which thallium metal and compounds may be recovered, are exported to Canada, France, the United Kingdom, and other countries.
[2]Estimated price of 99.999%-pure granules or rods in 100- to 250-gram or larger lots.
[3]Defined as imports – exports + adjustments for Government and industry stock changes. Consumption and exports of unwrought thallium were from imported material or from a drawdown in unreported inventories.
[4]Estimates are based on thallium content of zinc ores.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

THORIUM

(Data in metric tons of thorium oxide (ThO_2) equivalent unless otherwise noted)

Domestic Production and Use: The primary source of the world's thorium is the rare-earth and thorium phosphate mineral monazite. In the United States, thorium has been a byproduct of refining monazite for its rare-earth content. Monazite itself is recovered as a byproduct of processing heavy-mineral sands for titanium and zirconium minerals. In 2009, monazite was not recovered domestically as a salable product. Essentially all thorium compounds and alloys consumed by the domestic industry were derived from imports, stocks of previously imported materials, or materials previously shipped from U.S. Government stockpiles. About eight companies processed or fabricated various forms of thorium for nonenergy uses, such as catalysts, high-temperature ceramics, and welding electrodes. Thorium's use in most products has generally decreased because of its naturally occurring radioactivity. The value of thorium compounds used by the domestic industry was estimated to have increased to $350,000 from $121,000 in 2008.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production, refinery[1]	—	—	—	—	—
Imports for consumption:					
Thorium ore and concentrates (monazite), gross weight	—	10.0	—	—	24
Thorium ore and concentrates (monazite), ThO_2 content	—	0.70	—	—	1.68
Thorium compounds (oxide, nitrate, etc.), gross weight[2]	4.93	4.71	6.37	0.63	2.70
Thorium compounds (oxide, nitrate, etc.), ThO_2 content[2]	3.65	3.49	4.71	0.47	2.00
Exports:					
Thorium ore and concentrates (monazite), gross weight	—	—	1	61	16
Thorium ore and concentrates (monazite), ThO_2 content	—	—	0.07	4.27	1.12
Thorium compounds (oxide, nitrate, etc.), gross weight[2]	0.74	1.09	1.63	2.70	5.20
Thorium compounds (oxide, nitrate, etc.), ThO_2 content[2]	0.55	0.81	1.21	2.00	3.80
Consumption:					
Reported, (ThO_2 content)	NA	NA	NA	NA	NA
Apparent[2]	3.10	2.68	3.51	([3])	([3])
Price, yearend, dollars per kilogram:					
Nitrate, welding-grade[4]	5.46	5.46	5.46	5.46	5.46
Nitrate, mantle-grade[5]	27.00	27.00	27.00	27.00	27.00
Oxide, yearend:					
99.9% purity[6]	82.50	82.50	NA	NA	NA
99.99% purity[6]	107.25	175.00	200.00	200.00	300.00
Net import reliance[7] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2005-08): Monazite: Canada, 100%. Thorium compounds: United Kingdom, 72%; France, 26%; and Canada, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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, 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 2009. Domestic demand for thorium ores, compounds, metals, and alloys has exhibited a long-term declining trend. No thorium production or shipments were reported in the United States in 2008, according to the U.S. Geological Survey's canvass of mines and processors. In 2009, unreported thorium consumption was believed to be primarily in catalysts, microwave tubes, and optical equipment and was estimated to have increased. Increased costs to monitor and dispose of thorium have caused

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THORIUM

domestic processors to switch to thorium-free materials. Real and potential costs related to compliance with State and Federal regulations, proper disposal, and monitoring of thorium's radioactivity have limited its commercial value. It is likely that thorium's use will continue to decline unless a low-cost disposal process is developed or new technology, such as a nonproliferative nuclear fuel, creates renewed demand.

On the basis of data through July 2009, the average value of imported thorium compounds decreased to $149.39 per kilogram from the 2008 average of $174.61 per kilogram (gross weight). The average value of exported thorium compounds decreased to $73.37 per kilogram based on data through July 2009, compared with $96.55 for 2008.

World Refinery Production and Reserves:[8] U.S. reserves were increased based on new information from the Lemhi Pass area of Idaho-Montana. Thorium reserves related to the Fen Complex in Norway were deleted based on updated data from the Norges Geologiske Undersøkelse (Geological Survey of Norway).

	Refinery production		Reserves[9]
	2008	2009	
United States	—	—	440,000
Australia	—	—	[10]300,000
Brazil	NA	NA	16,000
Canada	NA	NA	100,000
India	NA	NA	290,000
Malaysia	—	—	4,500
South Africa	—	—	35,000
Other countries	NA	NA	90,000
World total	NA	NA	1,300,000

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, especially those in the Lemhi Pass area of Idaho. Lesser quantities of thorium-bearing monazite and thorite reserves occur in certain iron ore deposits and carbonatites. Thorium enrichment in iron ore is known in iron (Fe)-REE-thorium-apatite (FRETA) deposits, similar to the FRETA deposits in Mineville, NY, Pea Ridge, MO, and Scrub Oaks, NJ.

World Resources: Thorium resources occur in geologic provinces similar to those that contain reserves. The leading share is contained 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. E Net exporter. NA Not available. — Zero.
[1]All domestically consumed thorium was derived from imported materials.
[2]Thorium compound imports from the United Kingdom were believed to be material for nuclear fuel reprocessing or waste and were not used in calculating domestic apparent consumption. Thorium compound exports to Mexico were believed to be waste material shipped for disposal and were not used in calculating domestic apparent consumption. Apparent consumption calculation excludes ore and concentrates.
[3]Apparent consumption calculations in 2008 and 2009 result in negative numbers.
[4]Source: U.S. Department of Defense, Defense Logistics Agency. Based on sales from the National Defense Stockpile in 1997.
[5]Source: Rhodia Canada, Inc., and Rhodia Electronics and Catalysis, Inc., f.o.b. port of entry, duty paid, ThO_2 basis, 2005 to 2009.
[6]Source: Rhodia Electronics and Catalysis, Inc., 1- to 950-kilogram quantities, f.o.b. port of entry, duty paid. In 2007, Rhodia ceased sales of its 99.9% purity thorium oxide.
[7]Defined as imports – exports + adjustments for Government and industry stock changes.
[8]Estimates, based on thorium contents of rare-earth ores.
[9]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[10]Includes thorium contained in mineralized sands.

TIN

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

Domestic Production and Use: Tin has not been mined or smelted in the United States since 1993 and 1989, respectively. Twenty-five firms used about 84% of the primary tin consumed domestically in 2009. The major uses were as follows: cans and containers, 26%; electrical, 24%; construction, 11%; transportation, 11%; and other, 28%. On the basis of the average New York composite price, the estimated values of some critical items in 2009 were as follows: primary metal consumed, $769 million; imports for consumption, refined tin, $824 million; and secondary production (old scrap), $183 million.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production:					
Secondary (old scrap)	11,800	11,600	11,200	12,000	10,000
Secondary (new scrap)	2,280	2,340	2,800	2,600	2,100
Imports for consumption, refined tin	37,500	43,300	46,600	51,600	45,000
Exports, refined tin	4,330	5,490	5,100	4,700	4,060
Shipments from Government stockpile excesses	8,368	8,409	4,540	60	—
Consumption, reported:					
Primary	32,200	42,600	43,000	46,000	42,000
Secondary	9,170	11,900	11,000	10,000	8,000
Consumption, apparent	54,700	57,500	57,500	59,400	49,500
Price, average, cents per pound:					
New York market	361	419	680	865	636
New York composite	483	565	899	1,130	831
London	334	398	692	838	616
Kuala Lumpur	334	398	692	838	616
Stocks, consumer and dealer, yearend	8,270	9,000	8,700	8,200	9,600
Net import reliance[1] as a percentage of apparent consumption	78	79	81	80	80

Recycling: About 12,000 tons of tin from old and new scrap was recycled in 2009. Of this, about 10,000 tons was recovered from old scrap at 2 detinning plants and 84 secondary nonferrous metal processing plants.

Import Sources (2005-08): Peru, 47%; Bolivia, 15%; China, 14%; Indonesia, 10%; and other, 14%.

Tariff: Most major imports of tin, including unwrought metal, waste and scrap, and unwrought tin alloys, enter the United States duty free.

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

Government Stockpile: On June 4, 2008, the Office of the Undersecretary of Defense suspended tin sales pending further research as a result of the Defense National Stockpile Center (DNSC)'s reconfiguration. As a result of this suspension, the DNSC made no tin sales in calendar year 2009. As of September 30, 2009, DNSC held 4,020 tons of tin in inventory. The fiscal year 2009 Annual Materials Plan (AMP) for tin was set at 6,000 tons and the fiscal year 2010 AMP was set at 4,000 tons. The DNSC inventory was stored in the Hammond, IN, depot and was all "long horn" brand tin. When tin was last offered for sale, it was available via the basic ordering agreement and negotiated sales procedures.

Stockpile Status—9-30-09[2]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2009	Disposals FY 2009
Pig tin	4,020	4,020	6,000	—

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TIN

Events, Trends, and Issues: Apparent consumption of tin in the United States declined by 17% in 2009 compared with that of 2008. The average monthly composite price of tin generally rose during the year, but, overall, prices in 2009 were substantially lower than those in 2008. Lower prices in 2009 were attributed to decreased demand worldwide owing to the global economic slowdown.

Developments continued in major tin-consuming countries to move to new lead-free solders that usually contain greater amounts of tin then do leaded solders.

Despite the 2009 decline in prices, tin producers continued to respond to the higher tin prices of recent years with tin mine and tin smelter openings and expansions, including ones in Australia, Bolivia, Canada, and Thailand. Tin exploration activity increased, especially in Australia and Canada. In some countries, like Bolivia, old tin tailings were being evaluated for reclamation of tin.

China continued as the world's leading tin producer from both mine and smelter sources, but experienced sporadic difficulty in obtaining feedstock for its smelters. Indonesia, the world's second leading tin producer from both mine and smelter sources, continued to experience production difficulties, some related to a Government shutdown of possibly illegal production sites.

World Mine Production and Reserves:

	Mine production		Reserves[3]
	2008	2009[e]	
United States	—	—	—
Australia	1,800	2,000	150,000
Bolivia	17,000	16,000	450,000
Brazil	12,000	12,000	540,000
China	110,000	115,000	1,700,000
Congo (Kinshasa)	12,000	12,000	NA
Indonesia	96,000	100,000	800,000
Malaysia	2,200	2,000	500,000
Peru	39,000	38,000	710,000
Portugal	100	100	70,000
Russia	1,500	2,000	300,000
Thailand	100	100	170,000
Vietnam	3,500	3,500	NA
Other countries	4,000	4,000	180,000
World total (rounded)	299,000	307,000	5,600,000

World Resources: U.S. resources of tin, primarily in Alaska, were insignificant compared with those of the rest of the world. World resources, principally in western Africa, southeastern Asia, Australia, Bolivia, Brazil, China, and Russia, are sufficient to sustain recent annual production rates well into the future.

Substitutes: Aluminum, glass, paper, plastic, or tin-free steel substitute for tin in cans and containers. Other materials that substitute for tin are epoxy resins for solder; aluminum alloys, copper-base alloys, and plastics for bronze; plastics for bearing metals that contain tin; and compounds of lead and sodium for some tin chemicals.

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

[1]Defined as imports - exports + adjustments for Government and industry stock changes.

[2]See Appendix B for definitions.

[3]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

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 2009 was about $460 million. Zircon was a coproduct of mining from ilmenite and rutile deposits. About 94% of titanium mineral concentrates was consumed by domestic titanium dioxide (TiO_2) pigment producers. The remaining 6% was used in welding rod coatings and for manufacturing carbides, chemicals, and metal.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production[2] (rounded)	300	300	300	200	200
Imports for consumption	1,000	1,030	1,220	1,110	810
Exports,[e] all forms	14	21	6	7	11
Consumption, estimated	1,390	1,510	1,600	1,420	1,100
Price, dollars per metric ton, yearend:					
Ilmenite, bulk, minimum 54% TiO_2, f.o.b. Australia	80	80	80	111	70
Rutile, bulk, minimum 95% TiO_2, f.o.b. Australia	470	475	488	525	530
Slag, 80%-95% TiO_2[3]	390-555	402-454	418-457	393-407	411-455
Stocks, mine, consumer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number[e]	286	246	225	144	182
Net import reliance[4] as a percentage of estimated consumption	71	67	76	78	73

Recycling: None.

Import Sources (2005-08): South Africa, 51%; Australia, 28%; Canada, 15%; Ukraine, 2%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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: In conjunction with production of TiO_2 pigment and metal, domestic consumption of titanium mineral concentrates was estimated to have decreased significantly. While mining continued at Starke, FL, and Stony Creek, VA, reprocessing mine tailings at Green Cove Springs, FL, ceased. At the Stony Creek mining operation, development of the Brink deposit was completed, and production began in the second quarter of 2009.

As a consequence of a global decline in construction and production of durable goods, consumption of titanium mineral concentrates was estimated to have decreased significantly compared with that of 2008.

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TITANIUM MINERAL CONCENTRATES

In Madagascar, production of ilmenite commenced at Fort Dauphin and was expected to increase to 750,000 tons per year when market conditions improved. Ilmenite was shipped from Madagascar to be used at the TiO_2 slag operations in Sorel, Quebec, Canada. In response to uncertain market conditions, mining and TiO_2 slag operations in Canada were temporarily idled for 3 months during the year. In the Eucla Basin, South Australia, production commenced at the Jacinth-Ambrosia Mine. Capacity at the Jacinth-Ambrosia Mine was expected to include 160,000 tons per year of ilmenite and 30,000 tons per year of rutile. In Victoria and New South Wales, Australia, mining and processing operations commenced at the Murray Basin Stage 2 project. In the first half of 2009, new Government policies were implemented in Vietnam to stop ilmenite exports, control illegal mining, and promote the development of upgraded products. In June, however, the export ban in Vietnam was temporarily lifted to support domestic mining companies hurt by global economic conditions.

World Mine Production and Reserves: The reserves estimate for Sierra Leone was revised based on information derived from industry reports.

	Mine production		Reserves[5]
	2008	2009[e]	
Ilmenite:			
United States[2]	[6]200	[6]200	6,000
Australia	1,320	1,210	130,000
Brazil	54	50	43,000
Canada[7]	850	600	31,000
China	600	600	200,000
India	432	380	85,000
Madagascar	—	60	40,000
Mozambique	197	200	16,000
Norway[7]	410	370	37,000
South Africa[7]	1,050	1,000	63,000
Ukraine	300	270	5,900
Vietnam	330	200	1,600
Other countries	55	50	26,000
World total (ilmenite, rounded)	5,800	5,190	680,000
Rutile:			
United States	([8])	([8])	400
Australia	309	293	22,000
Brazil	2	2	1,200
India	20	18	7,400
Mozambique	6	6	480
Sierra Leone	75	60	2,800
South Africa	121	100	8,300
Ukraine	57	50	2,500
Other countries	—	—	400
World total (rutile, rounded)	[9]590	[9]529	45,000
World total (ilmenite and rutile, rounded)	6,390	5,720	730,000

World Resources: Ilmenite accounts for about 91% 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. — Zero.
[1]See also Titanium and Titanium Dioxide.
[2]Rounded to one significant digit to avoid disclosing company proprietary data.
[3]Landed duty-paid value based on U.S. imports for consumption.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[6]Includes rutile.
[7]Mine production is primarily used to produce titaniferous slag.
[9]U.S. rutile production is included with ilmenite to avoid disclosing company proprietary data.

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, Oregon, and Utah. A fourth operation was expected to be commissioned in Rowley, UT, by yearend. Ingot was produced by 10 operations in 8 States. Numerous firms consumed ingot to produce wrought products and castings. In 2009, an estimated 76% of the titanium metal was used in aerospace applications. The remaining 24% was used in armor, chemical processing, marine, medical, power generation, sporting goods, and other nonaerospace applications. The value of sponge metal consumed was about $310 million, assuming an average selling price of $12.90 per kilogram.

In 2009, titanium dioxide (TiO_2) pigment, which was valued at about $2.7 billion, was produced by four companies at eight facilities in seven States. The estimated use of TiO_2 pigment by end use was paint (includes lacquers and varnishes), 59%; plastic, 25%; paper, 10%; and other, 6%. Other uses of TiO_2 included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Titanium sponge metal:					
Production	W	W	W	W	W
Imports for consumption	15,800	24,400	25,900	23,900	17,000
Exports	1,910	1,380	2,000	2,370	1,000
Shipments from Government stockpile excesses	2,510	—	—	—	—
Consumption, reported	26,100	28,400	33,700	W	24,000
Price, dollars per kilogram, yearend	17.28	20.62	14.76	15.64	12.90
Stocks, industry yearend[e]	4,330	8,240	7,820	14,200	14,000
Employment, number[e]	300	350	400	350	300
Net import reliance[2] as a percentage of reported consumption	73	67	72	W	67
Titanium dioxide:					
Production	1,310,000	1,370,000	1,440,000	1,350,000	1,150,000
Imports for consumption	341,000	288,000	221,000	183,000	170,000
Exports	524,000	581,000	682,000	733,000	630,000
Consumption, apparent	1,130,000	1,080,000	979,000	800,000	690,000
Producer price index, yearend	172	165	162	170	162
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, number[e]	4,300	4,300	4,300	4,200	3,800
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: New scrap metal recycled by the titanium industry totaled about 27,000 tons in 2009. Estimated use of titanium as scrap and ferrotitanium by the steel industry was about 9,000 tons; by the superalloy industry, 1,000 tons; and in other industries, 1,000 tons. Old scrap reclaimed totaled about 1,000 tons.

Import Sources (2005-08): Sponge metal: Kazakhstan, 52%; Japan, 34%; China, 5%; Ukraine, 5%; and other, 4%. Titanium dioxide pigment: Canada, 35%; China, 13%; Germany, 7%; United Kingdom, 5%; and other, 40%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
Titanium oxides (unfinished TiO_2 pigments)	2823.00.0000	5.5% ad val.
TiO_2 pigments, 80% or more TiO_2	3206.11.0000	6.0% ad val.
TiO_2 pigments, other	3206.19.0000	6.0% ad val.
Ferrotitanium and ferrosilicon titanium	7202.91.0000	3.7% ad val.
Unwrought titanium metal	8108.20.0000	15.0% ad val.
Titanium waste and scrap metal	8108.30.0000	Free.
Other titanium metal articles	8108.90.3000	5.5% ad val.
Wrought titanium metal	8108.90.6000	15.0% ad val.

Depletion Allowance: Not applicable.

Government Stockpile: None.

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TITANIUM AND TITANIUM DIOXIDE

Events, Trends, and Issues: Owing to greatly reduced demand from the construction and automotive industries, global production of titanium dioxide pigment decreased significantly compared with that in 2008. Domestic production of TiO_2 pigment was an estimated 1.2 million tons, a significant decrease compared with that of 2008. In 2009, numerous TiO_2 pigment plants were closed or temporarily idled. In Savannah, GA, a 110,000-ton-per-year TiO_2 pigment plant was idled. In Baltimore, MD, a 50,000-ton-per-year plant was closed. In the United Kingdom, the idle 40,000-ton-per-year Grimsby plant was permanently closed, and the Stallingborough plant was idled for 2 months. In Ukraine, TiO_2 pigment production was limited because fuel supplies were interrupted. In January, one of the leading global producers of TiO_2 pigment filed for bankruptcy protection. In August, a "stalking horse" asset and equity purchase agreement was made forming a floor bid to sell substantially all its assets to another leading producer. However, competitive bids were being pursued, and an auction was scheduled to be held by yearend. In China, TiO_2 pigment capacity was expected to increase to 2.7 million tons by the end of 2010.

Delays in aircraft construction and the global economic slowdown in 2009 resulted in a significant drop in titanium sponge metal production, lower prices, and delayed capacity expansions. In Albany, OR, a titanium sponge facility was temporarily idled in July to adjust production to market conditions. In Hamilton, MS, construction of a 9,070-ton-per-year sponge plant remained on hold. In Rowley, UT, construction of a new 10,900-ton-per-year sponge plant was completed. In Japan, the commissioning of a 12,000-ton-per-year sponge plant was delayed until April 2010. In Russia, an expansion of titanium metal production capacity to 44,000 tons per year was delayed until 2014. Work toward an alternative commercial process for the production of titanium metal was ongoing. In Illinois, a titanium powder plant using the Armstrong process was under construction.

World Sponge Metal Production and Sponge and Pigment Capacity: Capacity estimates were revised based on new information from industry reports.

	Sponge production		Capacity 2009[3]	
	2008	2009[e]	Sponge	Pigment
United States	W	W	24,000	1,480,000
Australia	—	—	—	241,000
Belgium	—	—	—	74,000
Canada	—	—	—	90,000
China[e]	49,600	35,000	78,000	1,100,000
Finland	—	—	—	130,000
France	—	—	—	125,000
Germany	—	—	—	440,000
Italy	—	—	—	80,000
Japan	40,900	30,000	46,400	309,000
Kazakhstan[e]	25,400	17,000	26,000	1,000
Mexico	—	—	—	130,000
Russia[e]	29,500	22,000	38,000	20,000
Spain	—	—	—	80,000
Ukraine[e]	9,930	6,400	10,000	120,000
United Kingdom	—	—	—	300,000
Other countries	—	—	—	900,000
World total (rounded)	[4]155,000	[4]110,000	222,000	5,620,000

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

Substitutes: There are few materials that possess titanium metal's strength-to-weight ratio and corrosion resistance. In high-strength applications, titanium competes with aluminum, composites, intermetallics, steel, and superalloys. Aluminum, nickel, specialty steels, and zirconium alloys may be substituted for titanium for applications that require corrosion resistance. Ground calcium carbonate, precipitated calcium carbonate, kaolin, and talc compete with titanium dioxide as a white pigment.

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]See also Titanium Mineral Concentrates.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]Yearend operating capacity.
[4]Excludes U.S. production.
[5]See Appendix C for definitions.

TUNGSTEN

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

Domestic Production and Use: A mine in California produced tungsten concentrates in 2009. 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. Nearly 60 industrial consumers were surveyed on a monthly or annual basis. Data reported by these consumers indicated that more than one-half of the tungsten consumed in the United States was used in cemented carbide parts for cutting and wear-resistant materials, primarily in the construction, metalworking, mining, and oil- and gas-drilling industries. The remaining tungsten was consumed to make tungsten heavy alloys for applications requiring high density; electrodes, filaments, wires, and other components for electrical, electronic, heating, lighting, and welding applications; steels, superalloys, and wear-resistant alloys; and chemicals for various applications. The estimated value of apparent consumption in 2009 was $400 million.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production:					
Mine	—	—	W	W	W
Secondary	4,670	4,490	4,330	4,790	4,000
Imports for consumption:					
Concentrate	2,080	2,290	3,880	3,990	3,800
Other forms	9,070	9,700	9,050	9,060	6,300
Exports:					
Concentrate	52	130	109	496	16
Other forms	5,890	6,310	5,950	5,480	2,600
Government stockpile shipments:					
Concentrate	2,310	3,120	1,740	1,470	250
Other forms	404	16	31	51	11
Consumption:					
Reported, concentrate	W	W	W	W	W
Apparent,[1] all forms	11,700	13,300	13,300	13,800	10,800
Price, concentrate, dollars per mtu WO_3,[2] average:					
U.S. spot market, Platts Metals Week	146	200	189	184	150
European market, Metal Bulletin	123	166	165	164	150
Stocks, industry, yearend:					
Concentrate	W	W	W	W	W
Other forms	2,300	2,110	1,980	2,200	2,750
Net import reliance[3] as a percentage of apparent consumption	68	67	68	60	63

Recycling: In 2009, the tungsten contained in scrap consumed by processors and end users represented approximately 37% of apparent consumption of tungsten in all forms.

Import Sources (2005-08): Tungsten contained in ores and concentrates, intermediate and primary products, wrought and unwrought tungsten, and waste and scrap: China, 43%; Germany, 10%; Canada, 9%; Bolivia, 7%; and other, 31%.

Tariff: Item	Number	Normal Trade Relations[4] 12-31-09
Ore	2611.00.3000	Free.
Concentrate	2611.00.6000	37.5¢/kg tungsten content.
Tungsten oxide	2825.90.3000	5.5% ad val.
Ammonium tungstate	2841.80.0010	5.5% ad val.
Tungsten carbide	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—9-30-09[5]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2009	Disposals FY 2009
Metal powder	172	172	136	11
Ores and concentrates	19,700	19,700	3,630	250

Events, Trends, and Issues: World tungsten supply was dominated by Chinese production and exports. China's Government limited the number of exploration and mining licenses for tungsten, restricted the amounts of tungsten that could be produced and exported, imposed constraints on mining and processing tungsten ores, continued to shift the balance of export quotas to favor value-added downstream tungsten materials and products, and adjusted export taxes on tungsten materials. The growth in China's economy during the past decade has resulted in China becoming the world's largest tungsten consumer. To conserve its resources and meet increasing domestic demand, the Chinese Government was expected to continue to limit tungsten production and exports and to increase imports of tungsten. In addition, the Chinese tungsten industry was investing in mine development projects outside China and developing technologies to increase the use of tungsten scrap and the processing of underutilized ores.

In late 2008, in response to global economic conditions, Chinese tungsten mines in Hunan and Jiangxi Provinces reportedly suspended production. In 2009, to help domestic producers, the Chinese Government decreased export taxes on some tungsten materials and encouraged local governments to offer loans to producers in exchange for tungsten concentrates and products. The sole Canadian tungsten mine was placed on care-and-maintenance status in October. Economic conditions were expected to delay the startup of some proposed new tungsten mine production. In recent years, the tungsten industry has increased its monitoring of proposed legislation and scientific research regarding the impact of tungsten on human health and the environment.

World Mine Production and Reserves: Production for Canada was revised downward to represent tungsten content of concentrates. Reserves for Canada were revised based on company data; reserves for Portugal were revised based on Government data.

	Mine production		Reserves[6]
	2008	2009[e]	
United States	W	W	140,000
Austria	1,100	1,000	10,000
Bolivia	1,100	900	53,000
Canada	2,300	2,000	110,000
China	43,500	47,000	1,800,000
Portugal	850	850	4,200
Russia	3,000	2,400	250,000
Other countries	4,100	3,700	400,000
World total (rounded)	[7]55,900	[7]58,000	2,800,000

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), diamond tools, 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 (LEDs) for lighting based on tungsten electrodes or filaments; depleted uranium for tungsten alloys or unalloyed tungsten in weights and counterweights; and depleted uranium alloys 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. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]The sum of U.S. net import reliance and secondary production, as estimated from scrap consumption.
[2]A metric ton unit (mtu) of tungsten trioxide (WO_3) contains 7.93 kilograms of tungsten.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]No tariff for Canada and Mexico. Tariffs for other countries for some items may be eliminated under special trade agreements.
[5]See Appendix B for definitions.
[6]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[7]Excludes U.S. production.

VANADIUM

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

Domestic Production and Use: Seven U.S. firms that comprise the majority of the domestic vanadium industry produced ferrovanadium, vanadium pentoxide, vanadium metal, and vanadium-bearing chemicals or specialty alloys by processing materials such as petroleum residues, spent catalysts, utility ash, and vanadium-bearing pig iron slag. Metallurgical use, primarily as an alloying agent for iron and steel, accounted for about 94% of the domestic vanadium consumption in 2009. 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:	2005	2006	2007	2008	2009[e]
Production, mine, mill[1]	—	—	—	—	—
Imports for consumption:					
Ash, ore, residues, slag	1,690	1,000	920	920	890
Vanadium pentoxide, anhydride	1,370	1,920	2,390	3,700	1,420
Oxides and hydroxides, other	186	129	42	144	37
Aluminum-vanadium master alloys (gross weight)	1	102	1,110	618	390
Ferrovanadium	11,900	2,140	2,220	2,800	780
Exports:					
Vanadium pentoxide, anhydride	254	341	327	249	360
Oxides and hydroxides, other	899	832	626	1,040	270
Aluminum-vanadium master alloys (gross weight)	1,500	1,930	1,700	1,389	380
Ferrovanadium	504	389	154	281	740
Consumption:					
Apparent	11,910	1,270	4,210	5,420	1,910
Reported	3,910	4,030	4,970	5,090	5,000
Price, average, dollars per pound V_2O_5	16.28	7.86	7.40	14.75	6.00
Stocks, consumer, yearend	371	330	323	310	320
Employment, mine and mill, number[1]	—	—	—	—	—
Net import reliance[2] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Some tool steel scrap was recycled primarily for its vanadium content, and vanadium was recycled from spent chemical process catalysts, but these two sources together accounted for only a very small percentage of total vanadium consumed. The vanadium content of other recycled steels was lost to slag during processing and was not recovered.

Import Sources (2005-08): Ferrovanadium: Czech Republic, 70%; Republic of Korea, 15%; Canada, 8%; Austria, 4%; and other, 3%. Vanadium pentoxide: South Africa, 42%; Russia, 30%; China, 27%; and other, 1%.

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

Item	Number	Normal Trade Relations 12-31-09
Vanadium pentoxide anhydride	2825.30.0010	5.5% ad val.
Vanadium oxides and hydroxides, other	2825.30.0050	5.5% ad val.
Vanadates	2841.90.1000	5.5% ad val.
Ferrovanadium	7202.92.0000	4.2% ad val.
Aluminum-vanadium master alloys	7601.20.9030	Free.

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

Government Stockpile: None.

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VANADIUM

Events, Trends, and Issues: U.S. vanadium consumption in 2009 decreased slightly from that of the previous year. Among the major uses for vanadium, production of carbon, full-alloy, and high-strength, low-alloy steels accounted for 13%, 41%, and 34% of domestic consumption, respectively. U.S. imports for consumption in 2009 were less than half that of the previous year. U.S. exports were approximately 40% less than that of the previous year. In 2009, U.S. steel production was expected to decrease from that of 2008.

Vanadium pentoxide (V_2O_5) prices continued to decrease to a low of $3.60 per pound of V_2O_5 in April 2009 before slowly increasing in May. In April 2008, V_2O_5 prices averaged $14.00 per lb of V_2O_5, almost four times that of April 2009. Ferrovanadium (FeV) prices followed a similar trend with a low of $7.40 in April. In April 2008, prices averaged $38.00 per pound of FeV, more than five times greater than that of the same month in 2009. The sharp decline in prices took place in the fourth quarter of 2008 and the first quarter of 2009 owing to the financial downturn and the decrease in demand from vanadium's dominant consumer, the steel industry.

World Mine Production and Reserves:

	Mine production		Reserves[3]
	2008	2009[e]	
United States	—	—	45,000
China	20,000	20,000	5,000,000
Russia	14,500	14,000	5,000,000
South Africa	20,000	19,000	3,000,000
Other countries	1,000	1,000	NA
World total (rounded)	55,500	54,000	13,000,000

World Resources: World resources of vanadium exceed 63 million tons. Vanadium occurs in deposits of phosphate rock, titaniferous magnetite, and uraniferous sandstone and siltstone, in which it constitutes less than 2% of the host rock. Significant amounts are also present in bauxite and carboniferous materials, such as coal, crude oil, oil shale, and tar sands. Because vanadium is usually recovered as a byproduct or coproduct, demonstrated world resources of the element are not fully indicative of available supplies. While domestic resources and secondary recovery are adequate to supply a large portion of domestic needs, a substantial part of U.S. demand is currently met by foreign material because it is currently uneconomic to mine vanadium in the United States.

Substitutes: Steels containing various combinations of other alloying elements can be substituted for steels containing vanadium. Certain metals, such as manganese, molybdenum, niobium (columbium), titanium, and tungsten, are to some degree interchangeable with vanadium as alloying elements in steel. Platinum and nickel can replace vanadium compounds as catalysts in some chemical processes. There is currently no acceptable substitute for vanadium in aerospace titanium alloys.

[e]Estimated. NA Not available. — Zero.
[1]Domestic vanadium mine and mill production stopped in 1999.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

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. Most of the vermiculite concentrate was shipped to 17 exfoliating plants in 11 States. The end uses for exfoliated vermiculite were estimated to be lightweight concrete aggregates (including cement premixes, concrete, and plaster), 36%; agriculture/horticulture, 43%; insulation, 7%; and other, 14%.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production[e, 1]	100	100	100	100	110
Imports for consumption[e]	91	65	51	73	75
Exports[e]	[2]5	[2]5	[2]5	[2]5	6
Consumption, apparent, concentrate[e]	185	160	145	170	180
Consumption, exfoliated[e]	85	90	85	82	93
Price, average, concentrate, dollars per ton, ex-plant	[3]143	[4]138	140	140	144
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, number[e]	90	95	100	100	80
Net import reliance[5] as a percentage of apparent consumption[e]	45	40	32	40	39

Recycling: Insignificant.

Import Sources (2005-08): China, 59%; South Africa, 39%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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.

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VERMICULITE

Events, Trends, and Issues: U.S. imports of vermiculite are not collected as a separate category by the U.S. Census Bureau. However, according to a nongovernmental source, U.S. imports, excluding any material from Canada and Mexico, were about 30,000 tons for the first 9 months of 2009. China provided 17% and South Africa, 82%.

The purchase of the East African Namekara deposit by an Australian company has led to a supply contract for selling 5,000 tons per year of vermiculite. The deposit has 54.9 million tons of inferred resource and is considered to be one of the world's largest deposits. Current investment will bring production to a sustained rate of 8,000 tons per year by 2010 with expansion plans to achieve 25,000 tons per year by 2012.

World Mine Production and Reserves:

	Mine production		Reserves[6]
	2008	2009[e]	
United States[e]	100	110	25,000
Australia	13	15	NA
Brazil	19	14	NA
China	120	130	NA
Russia	25	25	NA
South Africa	200	220	14,000
Zimbabwe	15	15	NA
Other countries	28	26	NA
World total	520	555	NA

World Resources: Marginal reserves of vermiculite that occur 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, reserves information comes from many sources, and in most cases it is not clear whether the numbers refer to vermiculite alone or vermiculite plus host rock and overburden.

Substitutes: Expanded perlite is a substitute for vermiculite in lightweight concrete and plaster. Other more dense but less costly material substitutes in these applications are expanded clay, shale, slag, and slate. Alternate materials for loosefill fireproofing insulation include fiberglass, perlite, and slag wool. In agriculture, substitutes include peat, perlite, sawdust, bark and other plant materials, and synthetic soil conditioners.

[e]Estimated. NA Not available.
[1]Concentrate sold and used by producers.
[2]Excludes Canada and Mexico.
[3]Moeller, Eric, 2006, Vermiculite: Mining Engineering, v. 58, no. 6, June, p. 61. (Average of prices from range of sized grades.)
[4]Moeller, Eric, 2007, Vermiculite: Mining Engineering, v. 59, no. 6, June, p. 61-62. (Average of prices from range of sized grades.)
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

YTTRIUM[1]

(Data in metric tons of yttrium oxide (Y_2O_3) content unless otherwise noted)

Domestic Production and Use: The rare-earth element yttrium was not mined in the United States in 2009. All yttrium metal and compounds used in the United States were imported. Principal uses were in phosphors for color televisions and computer monitors, temperature sensors, trichromatic fluorescent lights, and x-ray-intensifying screens. Yttria-stabilized zirconia was used in alumina-zirconia abrasives, bearings and seals, high-temperature refractories for continuous-casting nozzles, jet-engine coatings, oxygen sensors in automobile engines, simulant gemstones, and wear-resistant and corrosion-resistant cutting tools. In electronics, yttrium-iron garnets were components in microwave radar to control high-frequency signals. Yttrium was an important component in yttrium-aluminum-garnet laser crystals used in dental and medical surgical procedures, digital communications, distance and temperature sensing, industrial cutting and welding, nonlinear optics, photochemistry, and photoluminescence. Yttrium also was used in heating-element alloys, high-temperature superconductors, and superalloys. The approximate distribution in 2008 by end use was as follows: phosphors (all types), 87%; ceramics, 10%; metallurgy, 2%; and electronics and lasers, 1%.

Salient Statistics—United States:	**2005**	**2006**	**2007**	**2008**	**2009**[e]
Production, mine	—	—	—	—	—
Imports for consumption:					
In monazite	—	—	—	—	—
Yttrium, alloys, compounds, and metal[e, 2]	582	742	676	616	400
Exports, in ore and concentrate	NA	NA	NA	NA	NA
Consumption, estimated[3]	582	742	676	616	400
Price, dollars:					
Monazite concentrate, per metric ton[4]	300	300	300	300	300
Yttrium oxide, per kilogram, 99.9% to 99.99% purity[5]	10-85	10-85	10-85	10-85	10-85
Yttrium metal, per kilogram, 99.9% purity[5]	96	68-155	68-155	68-155	68-155
Stocks, processor, yearend	NA	NA	NA	NA	NA
Net import reliance[e, 6] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Small quantities, primarily from laser crystals and synthetic garnets.

Import Sources (2005-08):[e, 7] Yttrium compounds, greater than 19% to less than 85% weight percent yttrium oxide equivalent: China, 95%; Japan, 4%; France, less than one-half of 1%; and other, insignificant. Import sources based on Journal of Commerce data (2008 only): China, 90%; Austria, 8%; Japan, 1%; and United Kingdom, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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: Estimated yttrium consumption in the United States decreased in 2008 and was expected to decrease again in 2009. The United States required yttrium for use in phosphors and in electronics, especially those used in defense applications.

Yttrium production and marketing within China continued to be competitive, and the price range for yttrium has remained steady, although one domestic supplier lowered its oxide price from $50 to $44 per kilogram in 2009. China was the source of most of the world's supply of yttrium, from its weathered clay ion-adsorption ore deposits in the southern Provinces, primarily Fujian, Guangdong, and Jiangxi, with a lesser number of deposits in Guangxi and Hunan. Processing was primarily at facilities in Guangdong, Jiangsu, and Jiangxi Provinces. Yttrium was consumed mainly in the form of high-purity oxide compounds for phosphors. Smaller amounts were used in ceramics, electronic devices, lasers, and metallurgical applications.

China was the primary source of most of the yttrium consumed in the United States. About 90% of the imported yttrium compounds, metal, and alloys were sourced from China, with lesser amounts from Austria, Japan, and the United Kingdom.

World Mine Production and Reserves:

	Mine production[e, 8]		Reserves[9]
	2008	2009	
United States	—	—	120,000
Australia	—	—	100,000
Brazil	15	15	2,200
China	8,800	8,800	220,000
India	55	55	72,000
Malaysia	4	4	13,000
Sri Lanka	—	—	240
Other countries	—	—	17,000
World total (rounded)	8,900	8,900	540,000

World Resources: 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 ancient and recent placer deposits, carbonatites, uranium ores, and weathered clay deposits (ion-adsorption ore). Additional large subeconomic resources of yttrium occur in apatite-magnetite-bearing rocks, deposits of niobium-tantalum minerals, non-placer monazite-bearing deposits, sedimentary phosphate deposits, and uranium ores, especially those of the Blind River District near Elliot Lake, Ontario, Canada, which contain yttrium in brannerite, monazite, and uraninite. Additional resources in Canada are contained in allanite, apatite, and britholite at Eden Lake, Manitoba; allanite and apatite at Hoidas Lake, Saskatchewan; and fergusonite and xenotime at Thor Lake, Northwest Territories. 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.

Substitutes: Substitutes for yttrium are available for some applications but generally are much less effective. In most uses, especially in electronics, lasers, and phosphors, yttrium is not subject to substitution by other elements. As a stabilizer in zirconia ceramics, yttria (yttrium oxide) may be substituted with calcia (calcium oxide) or magnesia (magnesium oxide), but they generally impart lower toughness.

[e]Estimated. NA Not available. — Zero.
[1]See also Rare Earths.
[2]Imports based on data from the Port Import/Export Reporting Service (PIERS), Journal of Commerce.
[3]Essentially, all yttrium consumed domestically was imported or refined from imported ores and concentrates.
[4]Monazite price based on monazite exports from Malaysia for 2005 and estimated for 2006 through 2009.
[5]Yttrium oxide and metal prices for 5-kilogram to 1-metric-ton quantities from Rhodia Rare Earths, Inc., Shelton, CT; the China Rare Earth Information Center, Baotou, China; Hefa Rare Earth Canada Co., Ltd., Vancouver, Canada; and Stanford Materials Corp., Aliso Viejo, CA.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]May not add to 100% due to rounding.
[8]Includes yttrium contained in rare-earth ores.
[9]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

ZINC

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

Domestic Production and Use: The value of zinc mined in 2009, based on zinc contained in concentrate, was about $1.18 billion. It was produced in 6 States at 13 mines operated by 6 companies. Two facilities—one primary and the other secondary—produced the bulk of refined zinc metal of commercial grade in 2009. Of the total zinc consumed, about 55% was used in galvanizing, 21% in zinc-based alloys, 16% in brass and bronze, and 8% in other uses. Zinc compounds and dust were used principally by the agriculture, chemical, paint, and rubber industries. Major coproducts of zinc mining and smelting were lead, sulfuric acid, cadmium, silver, gold, and germanium.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production:					
Mine, zinc in ore and concentrate	748	727	803	778	690
Primary slab zinc	195	113	121	125	100
Secondary slab zinc	156	156	157	161	115
Imports for consumption:					
Zinc in ore and concentrate	156	383	271	63	75
Refined zinc	700	895	758	725	700
Exports:					
Zinc in ore and concentrate	786	825	816	725	850
Refined zinc	1	3	8	3	3
Shipments from Government stockpile	27	30	10	([1])	([1])
Consumption, apparent, refined zinc	1,080	1,190	1,040	998	920
Price, average, cents per pound:					
North American[2]	67.1	158.9	154.4	88.9	78.0
London Metal Exchange (LME), cash	62.7	148.5	147.0	85.0	75.0
Producer and consumer stocks, slab zinc, yearend	71	70	68	78	70
Employment:					
Mine and mill, number[3]	1,620	1,680	2,290	2,520	1,540
Smelter primary, number	600	246	264	250	230
Net import reliance[4] as a percentage of apparent consumption (refined zinc)	67	77	73	71	76

Recycling: In 2009, about 54% (117,000 tons) of the slab zinc produced in the United States was recovered from secondary materials—mainly electric arc furnace dust, as well as galvanizing residues.

Import Sources (2005-08): Ore and concentrate: Peru, 68%; Ireland, 15%; Mexico, 14%; Canada, 2%; and other, 1%. Metal: Canada, 70%; Mexico, 15%; Kazakhstan, 3%; Republic of Korea, 3%; and other, 9%. Waste and scrap: Canada, 69%; Mexico, 19%; Italy, 4%; Thailand, 3%; and other, 5%. Combined total: Canada, 55%; Peru, 15%; Mexico, 15%; Ireland, 3%; and other, 12%.

Tariff: Item	Number	Normal Trade Relations[5] 12-31-09
Zinc ores and concentrates,		
Zn content	2608.00.0030	Free.
Hard zinc spelter	2620.11.0000	Free.
Zinc oxide and zinc peroxide	2817.00.0000	Free.
Unwrought zinc, not alloyed:		
Containing 99.99% or more zinc	7901.11.0000	1.5% ad val.
Containing less than 99.99% zinc:		
Casting-grade	7901.12.1000	3% ad val.
Other	7901.12.5000	1.5% ad val.
Zinc alloys	7901.20.0000	3% ad val.
Zinc waste and scrap	7902.00.0000	Free.

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

Government Stockpile:

Stockpile Status—9-30-09[6, 7]

Material	Uncommitted inventory	Authorized for disposal	Disposal plan FY 2009	Disposals FY 2009
Zinc	7	7	[8]27	([1])

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ZINC

Events, Trends, and Issues: According to the International Lead and Zinc Study Group's October 2009 forecast, global zinc mine production fell 5.4% to 11.1 million metric tons as a result of mine closures and cutbacks during late 2008 and early 2009. Refined metal production fell 4.7% to 11.1 million metric tons, while world consumption fell 5.6% to 10.8 million metric tons, resulting in a surplus of 380,000 tons of metal on the market. Another surplus is anticipated in 2010.

Global economic activity continued to contract during the first half of 2009, with the notable exception of China and India. As global economic activity began recovering during the third quarter, global demand for zinc began to increase. By yearend, however, China (by 17%) and India (by 6%) were the only two countries where zinc consumption increased year over year. China's rise in consumption is thought to have been supported partly by its fiscal stimulus package, which directed investment into infrastructure.

Domestically, several U.S. zinc-producing mines closed in early 2009 owing to low metal prices, including mines in Montana and Washington and a zinc-complex in Tennessee. Zinc smelters in Pennsylvania and Tennessee reduced production during this time in response to the downturn in the zinc market. As market conditions improved, a zinc mine in Tennessee restarted during the third quarter, but at a low production rate. The zinc smelters either returned to full production or increased production.

Despite the zinc metal market being in surplus during 2009, average monthly zinc prices increased over the course of the year, possibly owing to speculative investment. The LME cash price for Special High Grade zinc averaged 54 cents per pound in January and had risen to 94 cents per pound by October.

World Mine Production and Reserves: Reserves estimates were revised, excluding Australia and China, based on a commercially available database of reserves and resources of mines and potential mines.

	Mine production[9]		Reserves[10]
	2008	2009[e]	
United States	778	690	14,000
Australia	1,480	1,300	21,000
Canada	750	730	8,000
China	3,200	2,800	33,000
India	610	650	10,000
Ireland	400	380	2,000
Kazakhstan	460	490	17,000
Mexico	400	520	14,000
Peru	1,600	1,470	19,000
Other countries	1,920	2,090	62,000
World total (rounded)	11,600	11,100	200,000

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.
[1]Less than ½ unit.
[2]Platts Metals Week price for North American Special High Grade zinc. Based on the London Metal Exchange cash price plus premiums or discounts, depending on market conditions.
[3]Includes mine and mill employment at all zinc-producing mines. Source: Mine Safety and Health Administration.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]No tariff for Canada and Mexico for items shown.
[6]See Appendix B for definitions.
[7]Sales of zinc under Basic Ordering Agreement DLA-ZINC-004 were suspended on August 6, 2008.
[8]Actual quantity will be limited to remaining inventory.
[9]Zinc content of concentrate and direct shipping ore.
[10]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.

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. Two firms produced zircon from surface-mining operations in Florida and Virginia. Zirconium and hafnium metal were produced from zircon by two domestic producers, one in Oregon and the other in Utah. Typically, both elements are in the ore in a zirconium-to-hafnium ratio of about 50:1. Zirconium chemicals were produced by the metal producer in Oregon and by at least 10 other companies. Zirconia (ZrO_2) was produced from zircon at plants in Alabama, New Hampshire, New Jersey, New York, Ohio, Tennessee, and by the metal producer in Oregon. Ceramics, foundry applications, opacifiers, and refractories are the leading end uses for zircon. Other end uses of zircon include abrasives, chemicals, metal alloys, welding rod coatings, and sandblasting. The leading consumers of zirconium and hafnium metal are the nuclear energy and chemical process industries.

Salient Statistics—United States:	2005	2006	2007	2008	2009[e]
Production, zircon (ZrO_2 content)	W	W	W	W	W
Imports:					
Zirconium, ores and concentrates (ZrO_2 content)	24,800	23,500	13,000	22,300	20,300
Zirconium, unwrought, powder, and waste and scrap	283	256	299	318	690
Zirconium, wrought	741	492	485	715	930
Zirconium oxide[1]	3,160	2,820	3,740	5,060	3,100
Hafnium, unwrought, waste and scrap	4	4	4	12	5
Exports:					
Zirconium ores and concentrates (ZrO_2 content)	65,600	49,600	43,000	27,400	22,000
Zirconium, unwrought, powder, and waste and scrap	321	271	328	591	210
Zirconium, wrought	1,650	1,610	1,830	2,080	2,300
Zirconium oxide[1]	2,260	3,340	2,400	2,970	1,700
Consumption, zirconium ores and concentrates, apparent (ZrO_2 content)	W	W	W	W	W
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic[2]	570	785	763	788	830
Imported, f.o.b.[3]	674	791	872	773	890
Zirconium, unwrought, dollars per kilogram[3]	22	23	24	26	58
Hafnium, unwrought, dollars per kilogram[3]	235	194	250	343	648
Net import reliance[4] as a percentage of apparent consumption:					
Zirconium	E	E	E	E	E
Hafnium	NA	NA	NA	NA	NA

Recycling: In-plant recycled zirconium came from scrap generated during metal production and fabrication and was recycled by companies in Oregon and Utah. 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. Recycling of hafnium metal was insignificant.

Import Sources (2005-08): Zirconium mineral concentrates: Australia, 49%; South Africa, 46%; China, 3%; Russia, 1%; and other, 1%. Zirconium, unwrought, including powder: France, 50%; Germany, 23%; Japan, 12%; Australia, 8%; and other, 7%. Hafnium, unwrought: France, 60%; Germany, 21%; Canada, 8%; United Kingdom, 6%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12-31-09
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, zirconium powders	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, hafnium powders	8112.92.2000	Free.

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

Government Stockpile: None.

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ZIRCONIUM AND HAFNIUM

Events, Trends, and Issues: Domestic consumption of zirconium mineral concentrates decreased significantly compared with that of 2008. Domestic mining of heavy minerals continued near Stony Creek, VA, and Starke, FL. Development of the Brink deposit in Virginia was completed in the first quarter and was expected to extend the economic life of the Virginia operations beyond 2015. In Green Cove Springs, FL, the reprocessing of mine tailings to recover zircon ended in April. In 2009, global financial difficulties led to decreased demand for ceramic, foundry, opacifier, and refractory products. Consequently, the global consumption of zirconium concentrates decreased significantly. In the longer term, however, consumption of zircon was expected to recover with average growth of 3% per year through 2015. Global production of zirconium concentrates (excluding the United States) decreased by 4% compared with that of 2008. Heavy mineral exploration and mining projects were underway in Australia, Canada, India, Kenya, Madagascar, Mozambique, Russia, Senegal, South Africa, and the United States. The availability of hafnium, produced as a byproduct during zirconium metal processing, continued to exceed demand.

Zirconium metal producers were beginning to increase capacity in anticipation of a resurgence of nuclear energy plants. In China, a U.S. zirconium producer formed a joint venture with a Chinese metal producer to build and operate a plant to produce nuclear-grade sponge at Nantong, Jiangsu Province. Production at the Nantong plant was scheduled to begin in 2012, and zirconium sponge was expected to be shipped to China and the United States. Another U.S. zirconium producer was expanding sponge capacity in Albany, OR, to an unspecified level.

World Mine Production and Reserves: World primary hafnium production statistics are not available. Hafnium occurs with zirconium in the minerals zircon and baddeleyite. The reserves estimates for Australia have been revised based on new information from Government and company reports.

	Zirconium			Hafnium
	Mine production (thousand metric tons)		Reserves[5] (million metric tons, ZrO_2)	Reserves[5] (thousand metric tons, HfO_2)
	2008	2009[e]		
United States	W	W	3.4	68
Australia	550	510	25	230
Brazil	27	27	2.2	44
China	140	140	0.5	NA
India	30	30	3.4	42
Indonesia	42	42	NA	NA
South Africa	400	395	14	280
Ukraine	35	35	4.0	NA
Other countries	58	48	3.5	NA
World total (rounded)	[6]1,280	[6]1,230	56	660

World Resources: Resources of zircon in the United States included about 14 million tons associated with titanium resources in heavy-mineral sand deposits. Phosphate and sand and gravel deposits have the potential to yield substantial amounts of zircon as a future byproduct. Eudialyte and gittinsite are zirconium silicate minerals that have a potential for zirconia production. Identified world resources of zircon exceed 60 million tons.

Resources of hafnium in the United States are estimated to be about 130,000 tons, available in the 14-million-ton domestic resources of zircon. World resources of hafnium are associated with those of zircon and baddeleyite and exceed 1 million tons.

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 plant uses.

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; in others, only hafnium produces the desired or required grain boundary refinement.

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Includes germanium oxides and zirconium oxides.
[2]Yearend average price.
[3]Unit value based on U.S. imports for consumption.
[4]Defined as imports – exports.
[5]See Appendix C for definitions. Reserve base estimates were discontinued in 2009; see Introduction.
[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
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
1 short dry ton (sdt)	= 2,000 pounds, avoirdupois, excluding moisture content
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 2009 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 2009 (fiscal year 2009) is the period October 1, 2008, through September 30, 2009. 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 2009 refers to material sold or traded from the stockpile in FY 2009.

Depletion Allowance

The depletion allowance is a business tax deduction analogous to depreciation, but 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

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 U.S. Geological Survey (USGS) collects information about the quantity and quality of all mineral resources. In 1976, the USGS and the U.S. Bureau of Mines developed a common classification and nomenclature, which was published as USGS Bulletin 1450-A—*"Principles of the Mineral Resource Classification System of the U.S. Bureau of Mines and U.S. Geological Survey."* Experience with this resource classification system showed that some changes were necessary in order to make it more workable in practice and more useful in long-term planning. Therefore, representatives of the USGS and the U.S. Bureau of Mines collaborated to revise Bulletin 1450-A. Their work was published in 1980 as USGS Circular 831—*"Principles of a Resource/Reserve Classification for Minerals."*

Long-term public and commercial planning must be based on the probability of discovering new deposits, on developing economic extraction processes for currently unworkable deposits, and on knowing which resources are immediately available. Thus, resources must be continuously reassessed in the light of new geologic knowledge, of progress in science and technology, and of shifts in economic and political conditions. To best serve these planning needs, known resources should be classified from two standpoints: (1) purely geologic or physical/chemical characteristics—such as grade, quality, tonnage, thickness, and depth—of the material in place; and (2) profitability analyses based on costs of extracting and marketing the material in a given economy at a given time. The former constitutes important objective scientific information of the resource and a relatively unchanging foundation upon which the latter more valuable economic delineation can be based.

The revised classification system, designed generally for all mineral materials, is shown graphically in figures 1 and 2; its components and their usage are described in the text. The classification of mineral and energy resources is necessarily arbitrary, because definitional criteria do not always coincide with natural boundaries. The system can be used to report the status of mineral and energy-fuel resources for the Nation or for specific areas.

RESOURCE/RESERVE DEFINITIONS

A dictionary definition of resource, "something in reserve or ready if needed," has been adapted for mineral and energy resources to comprise all materials, including those only surmised to exist, that have present or anticipated future value.

Resource.—A concentration of naturally occurring solid, liquid, or gaseous material in or on the Earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible.

Original Resource.—The amount of a resource before production.

Identified Resources.—Resources whose location, grade, quality, and quantity are known or estimated from specific geologic evidence. Identified resources include economic, marginally economic, and sub-economic components. To reflect varying degrees of geologic certainty, these economic divisions can be subdivided into measured, indicated, and inferred.

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.

[1]Based on U.S. Geological Survey Circular 831, 1980.

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*

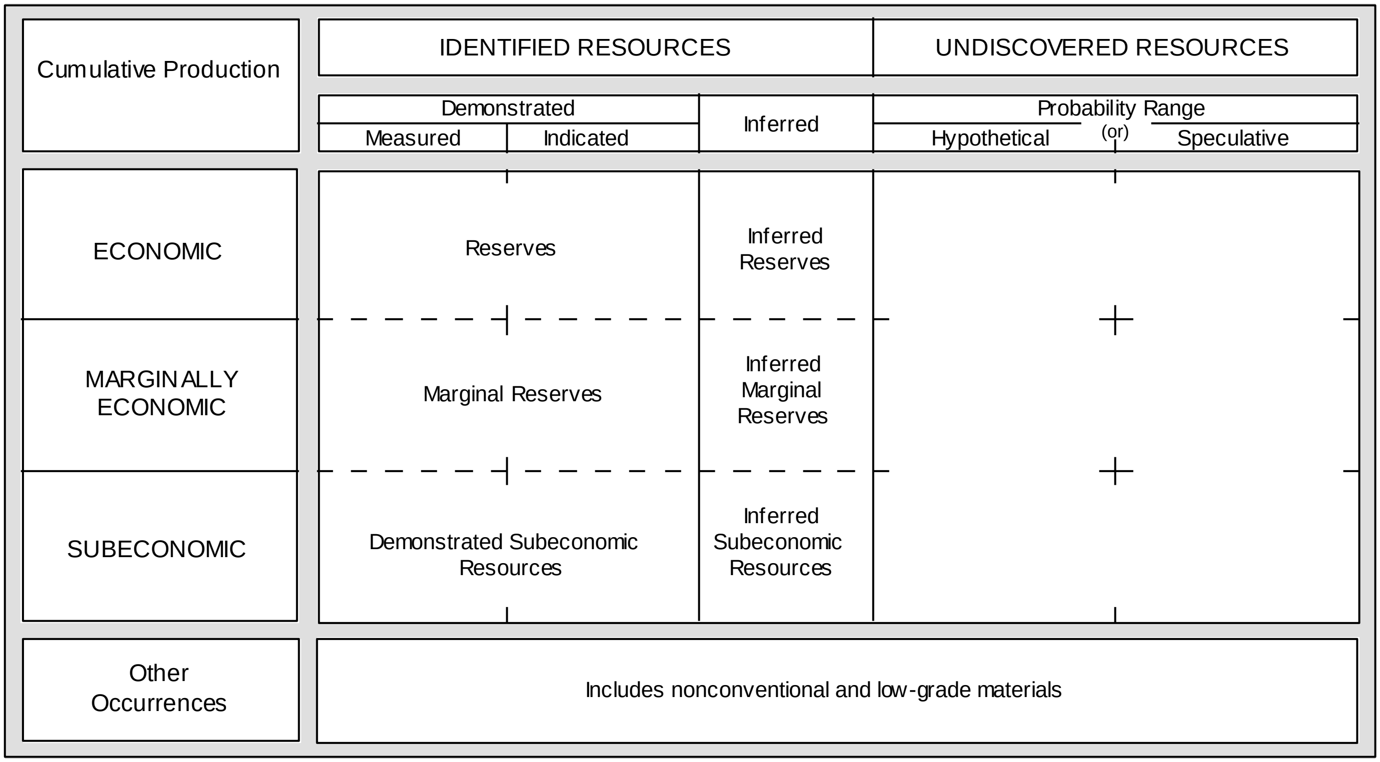
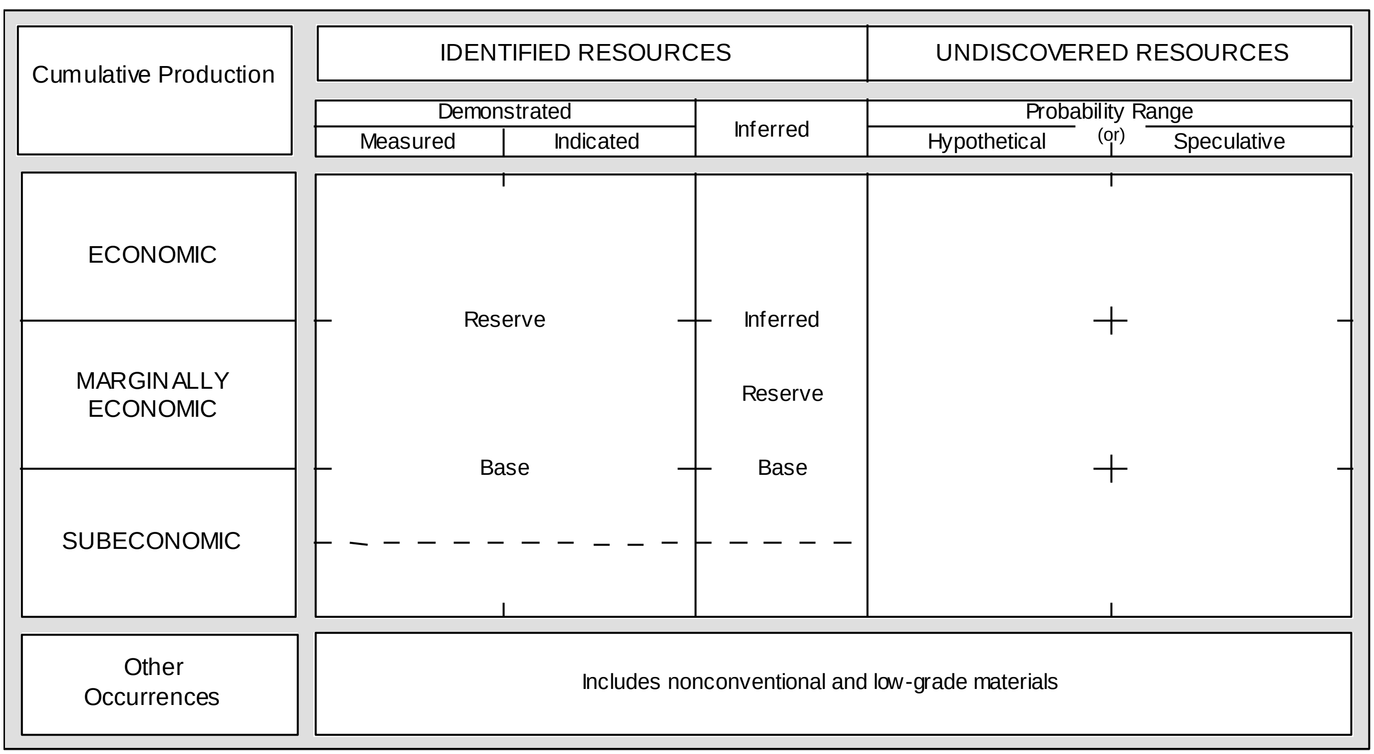


FIGURE 2.—*Reserve Base* and *Inferred Reserve Base* Classification Categories



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
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	Yolanda Fong-Sam
Cambodia	Yolanda Fong-Sam
China	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 G. Wacaster
Nauru	Pui-Kwan Tse
Nepal	Lin Shi
New Caledonia	Susan G. Wacaster
New Zealand	Pui-Kwan Tse
Pakistan	Chin S. Kuo
Papua New Guinea	Susan G. 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
Timor, East	Pui-Kwan Tse
Tonga	Chin S. Kuo
Vanuatu	Chin S. Kuo
Vietnam	Yolanda Fong-Sam

Europe and Central Eurasia

Albania	Mark Brininstool
Armenia[1]	Richard M. Levine
Austria[2]	Steven T. Anderson
Azerbaijan[1]	Richard M. Levine
Belarus[1]	Richard M. Levine

Europe and Central Eurasia—continued

Belgium[2]	Alberto A. Perez
Bosnia and Herzegovina	Mark Brininstool
Bulgaria[2]	Mark Brininstool
Croatia	Mark Brininstool
Cyprus[2]	Harold R. Newman
Czech Republic[2]	Mark Brininstool
Denmark, Faroe Islands, and Greenland[2]	Harold R. Newman
Estonia[2]	Richard M. Levine
Finland[2]	Harold R. Newman
France[2]	Alberto A. Perez
Georgia[1]	Richard M. Levine
Germany[2]	Steven T. Anderson
Greece[2]	Harold R. Newman
Hungary[2]	Richard M. Levine
Iceland	Harold R. Newman
Ireland[2]	Harold R. Newman
Italy[2]	Alberto A. Perez
Kazakhstan[1]	Richard M. Levine
Kyrgyzstan[1]	Richard M. Levine
Latvia[2]	Richard M. Levine
Lithuania[2]	Richard M. Levine
Luxembourg[2]	Alberto A. Perez
Macedonia	Mark Brininstool
Malta[2]	Harold R. Newman
Moldova[1]	Richard M. Levine
Montenegro	Mark Brininstool
Netherlands[2]	Alberto A. Perez
Norway	Harold R. Newman
Poland[2]	Mark Brininstool
Portugal[2]	Alfredo C. Gurmendi
Romania[2]	Mark Brininstool
Russia[1]	Richard M. Levine
Serbia	Mark Brininstool
Slovakia[2]	Mark Brininstool
Slovenia[2]	Mark Brininstool
Spain[2]	Alfredo C. Gurmendi
Sweden[2]	Harold R. Newman
Switzerland	Harold R. Newman
Tajikistan[1]	Richard M. Levine
Turkmenistan[1]	Richard M. Levine
Ukraine[1]	Richard M. Levine
United Kingdom[2]	Alberto A. Perez
Uzbekistan[1]	Richard M. Levine

North America, Central America, and the Caribbean

Belize	Susan G. Wacaster
Canada	Philip M. Mobbs
Costa Rica	Susan G. Wacaster
Cuba	Omayra Bermúdez-Lugo
Dominican Republic	Susan G. Wacaster
El Salvador	Susan G. Wacaster
Guatemala	Steven T. Anderson
Haiti	Susan G. Wacaster
Honduras	Susan G. Wacaster
Jamaica	Susan G. Wacaster
Mexico	Alberto A. Perez
Nicaragua	Susan G. Wacaster
Panama	Susan G. Wacaster
Trinidad and Tobago	Susan G. Wacaster

South America

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Bolivia	Steven T. Anderson
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