MINERAL COMMODITY SUMMARIES 2008

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

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

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Molybdenum
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Peat
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CONTENTS

INSTANT INFORMATION

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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 foreign 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 2008 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 2007 mineral production data for the world. More than 90 individual minerals and materials are covered by two-page synopses.

National reserves and reserve base 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 and reserve base estimates compiled by countries for selected mineral commodities are a primary source of national reserves and reserve base information. Lacking national assessment information by governments, sources such as academic articles, company reports, common business practice, presentations by company representatives, and trade journal articles, or a combination of these, serve as the basis for national reserves and reserve base information reported in the mineral commodity sections of this publication.

A national estimate may be assembled from the following: historically reported reserves and reserve base information carried for years without alteration because no new information is available; historically reported reserves and reserve base reduced by the amount of historical production; and company reported reserves. International minerals availability studies conducted by the U.S. Bureau of Mines, before 1996, and estimates of identified resources by an international collaborative effort (the International Strategic Minerals Inventory) are the basis for some reserves and reserve base estimates.

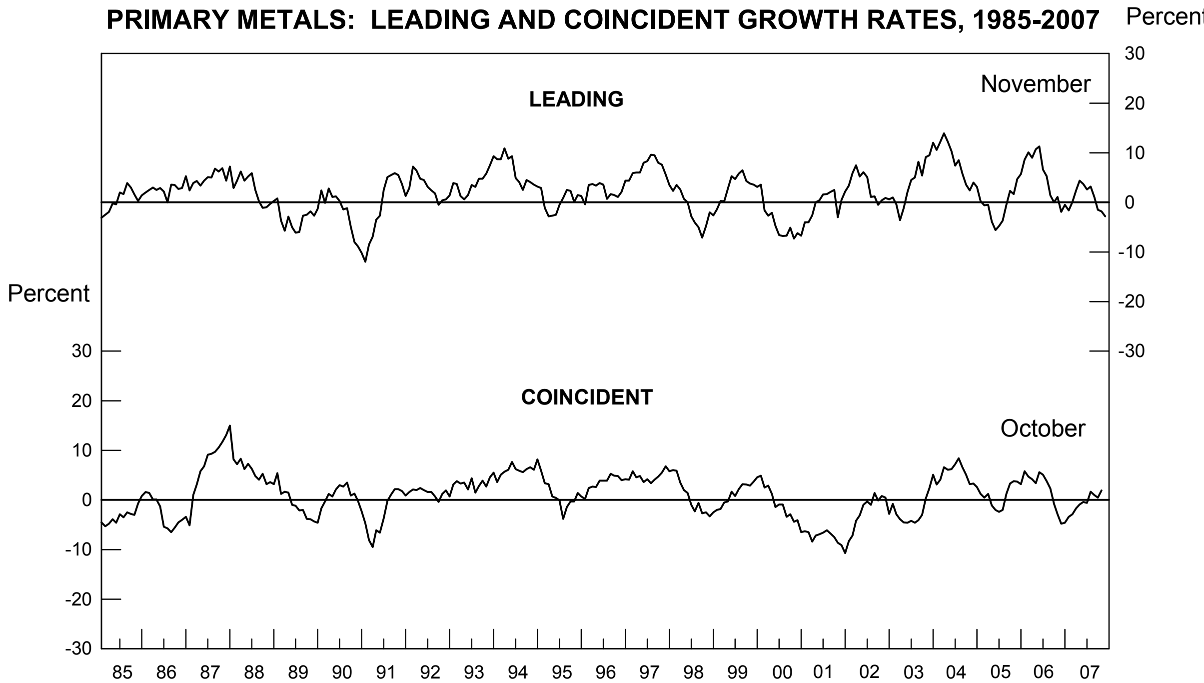
The USGS collects information about the quantity and quality of mineral resources but does not directly measure reserves, and companies or governments do not directly report reserves or reserve base to the USGS.

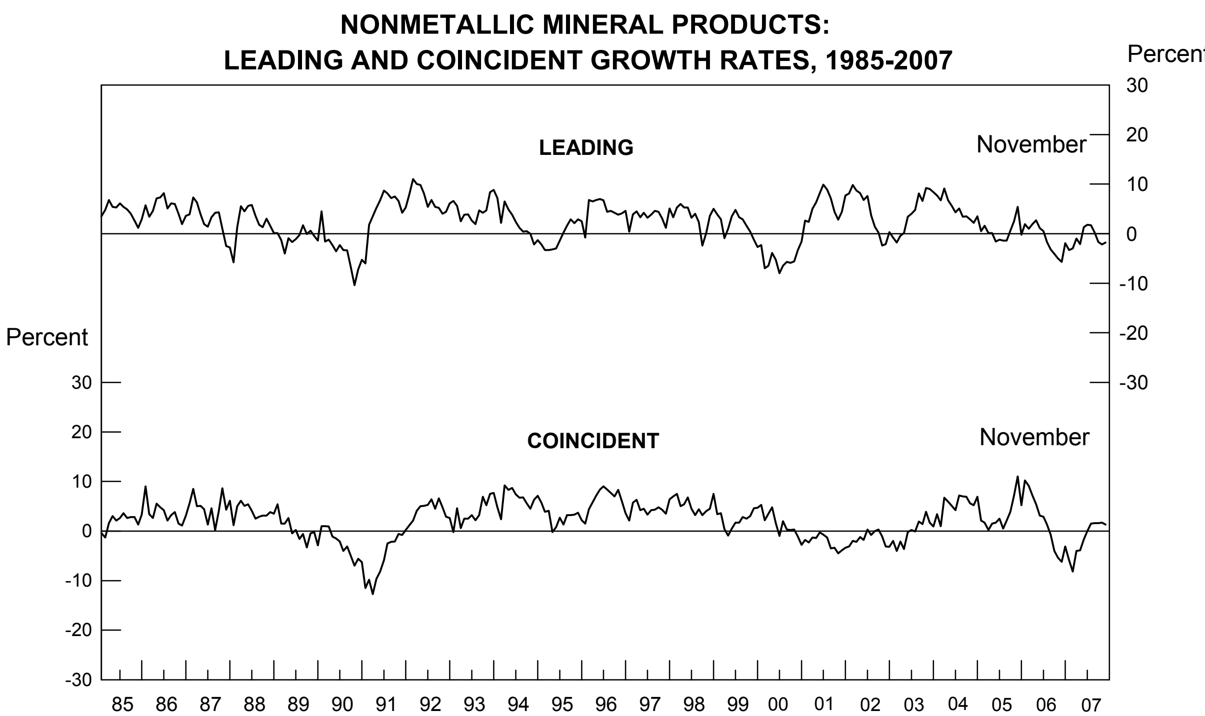
Reassessment of reserves and reserve base is a continuing process and the intensity of this process differs for mineral commodities, countries, and time period.

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 2008 are welcomed.

GROWTH RATES OF LEADING AND COINCIDENT INDEXES FOR MINERAL PRODUCTS



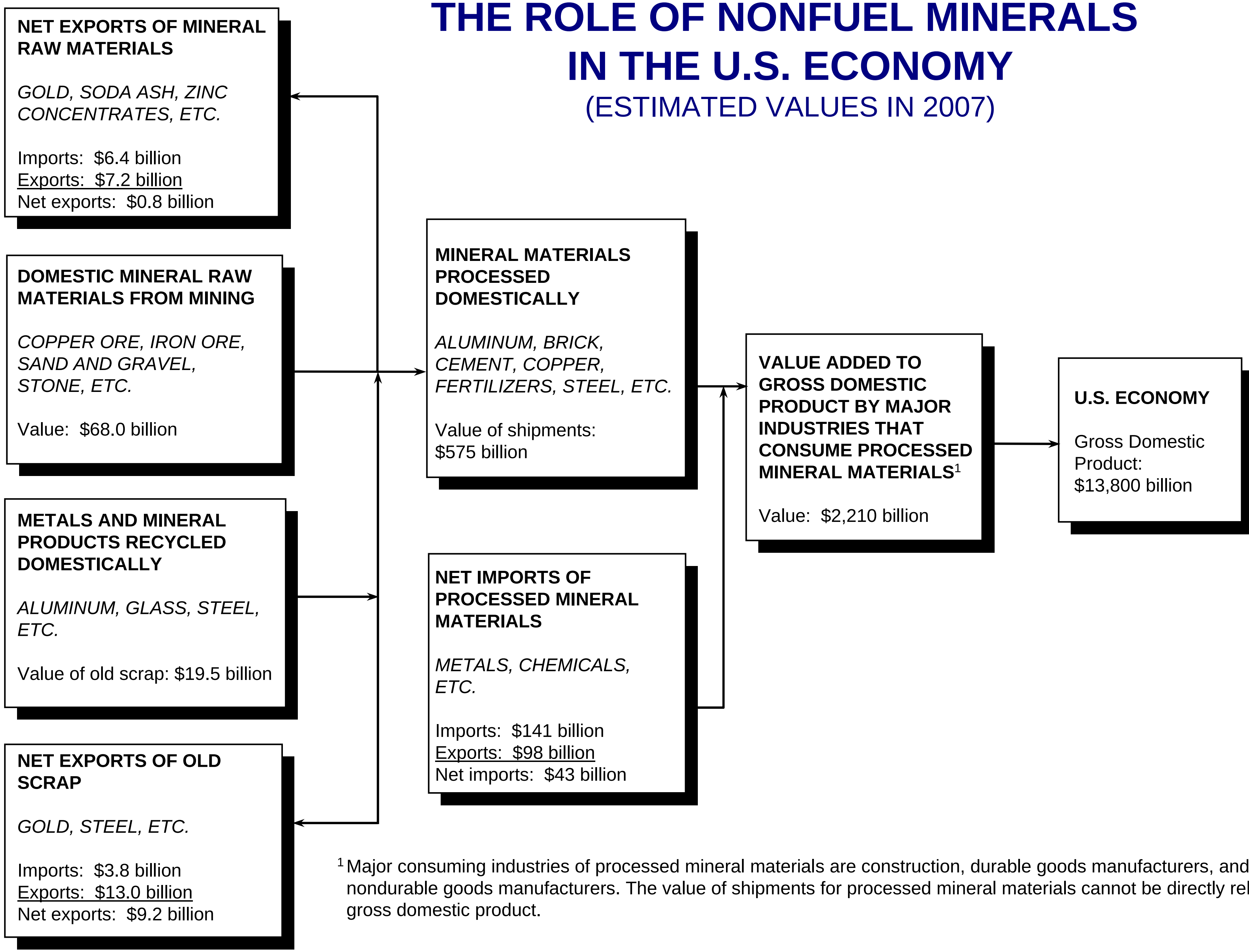


The leading indexes historically give signals several months in advance of major changes in the corresponding coincident index, which measures current industry activity. The growth rates, which can be viewed as trends, are expressed as compound annual rates based on the ratio of the current month's index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

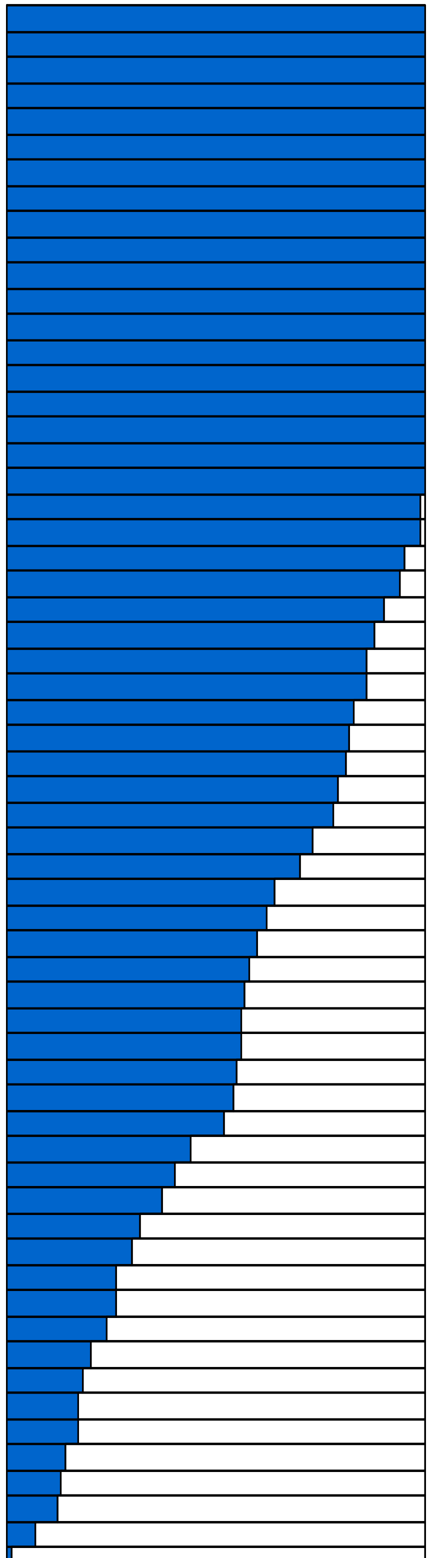
(ESTIMATED VALUES IN 2007)



[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.

2007 U.S. NET IMPORT RELIANCE FOR SELECTED NONFUEL MINERAL MATERIALS



Commodity	Percent	Major Import Sources (2003-06)[1]
ARSENIC (trioxide)	100	China, Morocco, Hong Kong, Chile
ASBESTOS	100	Canada
BAUXITE and ALUMINA	100	Guinea, Jamaica, Australia, Brazil
CESIUM	100	Canada
FLUORSPAR	100	China, Mexico, South Africa, Mongolia
GRAPHITE (natural)	100	China, Mexico, Canada, Brazil
INDIUM	100	China, Japan, Canada, Belgium
MANGANESE	100	South Africa, Gabon, Australia, China
MICA, sheet (natural)	100	India, Belgium, China, Brazil
NIOBIUM (columbium)	100	Brazil, Canada, Estonia, Germany
QUARTZ CRYSTAL (industrial)	100	Brazil, Germany, Madagascar, Canada
RARE EARTHS	100	China, France, Japan, Russia
RUBIDIUM	100	Canada
STRONTIUM	100	Mexico, Germany
TANTALUM	100	Australia, Brazil, China, Germany
THALLIUM	100	Russia, Netherlands, Belgium
THORIUM	100	United Kingdom, France
VANADIUM	100	Czech Republic, Swaziland, Canada, Austria
YTTRIUM	100	China, Japan, France, Austria
GALLIUM	99	China, Ukraine, Japan, Hungary
GEMSTONES	99	Israel, India, Belgium, South Africa
BISMUTH	95	Belgium, Mexico, China, United Kingdom
PLATINUM	94	South Africa, United Kingdom, Germany, Canada
STONE (dimension)	90	Italy, Turkey, China, Mexico
DIAMOND (natural industrial stone)	88	Botswana, Ireland, Namibia, South Africa
ANTIMONY	86	China, Mexico, Belgium
RHENIUM	86	Chile, Germany
BARITE	83	China, India
TITANIUM MINERAL CONCENTRATES	82	South Africa, Australia, Canada, Ukraine
POTASH	81	Canada, Belarus, Russia, Germany
TIN	79	Peru, Bolivia, China, Indonesia
COBALT	78	Norway, Russia, Finland, China
PALLADIUM	73	Russia, South Africa, United Kingdom, Norway
TUNGSTEN	70	China, Canada, Germany, Portugal
TITANIUM (sponge)	64	Kazakhstan, Japan, Russia, Ukraine
CHROMIUM	62	South Africa, Kazakhstan, Russia, Zimbabwe
PEAT	60	Canada
ZINC	58	Canada, Peru, Mexico, Australia
MAGNESIUM COMPOUNDS	57	China, Canada, Austria, Australia
GARNET (industrial)	56	Australia, India, China, Canada
SILICON (ferrosilicon)	56	China, Venezuela, Russia, Norway
SILVER	55	Mexico, Canada, Peru, Chile
MAGNESIUM METAL	54	Canada, Russia, Israel, China
DIAMOND (dust, grit and powder)	52	China, Ireland, Russia, Ukraine
NITROGEN (fixed), AMMONIA	44	Trinidad and Tobago, Canada, Russia, Ukraine
VERMICULITE	40	South Africa, China
COPPER	37	Chile, Canada, Peru, Mexico
MICA, scrap and flake (natural)	32	Canada, China, India, Finland
PERLITE	30	Greece
ALUMINUM	26	Canada, Russia, Brazil, Venezuela
GYPSUM	26	Canada, Mexico, Spain, Dominican Republic
SULFUR	24	Canada, Mexico, Venezuela
PUMICE	20	Greece, Italy, Turkey
SALT	18	Canada, Chile, The Bahamas, Mexico
CEMENT	17	Canada, China, Thailand, Republic of Korea
NICKEL	17	Canada, Russia, Norway, Australia
PHOSPHATE ROCK	14	Morocco
BROMINE	13	Israel, United Kingdom
IRON and STEEL	12	Canada, European Union, Mexico, Brazil
IRON and STEEL SLAG	7	Canada, Italy, France, Japan
LIME	1	Canada, Mexico

[1]In descending order of import share

SIGNIFICANT EVENTS, TRENDS, AND ISSUES[1]

The Mineral Sector of the U.S. Economy

Minerals are fundamental to the U.S. economy, contributing to the real gross domestic product (GDP) at several levels—mining, processing, and manufacturing finished products. The estimated growth rate for the real GDP of the United States was 2.1% and the nominal GDP was about $13.8 trillion in 2007. The prime interest rate decreased to 7.25% in December from 8.25% at the beginning of 2007, reflecting actions taken by the Federal Reserve Board to counter financial difficulties surrounding subprime mortgages. Delinquencies on subprime mortgages increased throughout the year, affecting not only the delinquent homeowners but also financial instruments invested in mortgage-backed securities. The average contract mortgage rate for the purchase of previously occupied homes in the United States was 6.35% in November, a slight decrease from 6.37% in January but still greater than 5.34% reported in July 2003, the lowest rate in the past 5 years. With the tightening of credit, the seasonally adjusted annualized rate for new privately owned housing starts declined 27% from December 2006 to November 2007. The loss in the residential market was balanced by a 9% increase in nonresidential construction between January and August 2007 in which slight increases occurred in nearly all nonresidential construction categories. Housing prices declined in many parts of the country, reducing State and municipal revenues from real estate and housing sales taxes that would have been used for construction projects.

The unemployment rate in the United States was 5.0% in December 2007, an increase from 4.4% in December 2006. However, employment increased in all sectors of the mining industry between January and November 2007. The Nation's international trade deficit in goods and services increased to $57.8 billion in October 2007 from $57.1 billion in September 2007, as imports increased at a slightly greater rate than exports. This is still less than the $58.2 billion deficit in October 2006.

Production of minerals in the United States in 2007 decreased slightly from that of 2006. The value, however, increased slightly to $68 billion from $66 billion because of increased unit prices for some metals—particularly copper, lead, tin, and other base metals—and increased energy costs passed along to customers by producers of industrial minerals. Infrastructure expansion and manufacturing in China and India continued to absorb a significant portion of world output. Domestic production decreased for several of the industrial mineral materials associated directly with housing construction, such as cement, construction sand and gravel, and crushed stone, and those associated with the manufacture of goods, such as ceramic tile, paint, sanitaryware, roofing, and wallboard, used by the housing industry.

The estimated value of U.S. metal mine production in 2007 was $24.8 billion, about 6% greater than that of 2006. Principal contributors to the total value of metal mine production in 2007 were copper (35%), gold (20%), molybdenum (14%), iron ore (11%), zinc (11%), and lead (4%). Metals with the largest increases in value of mine production were lead and silver (23% each), magnesium metal (20%), molybdenum (16%), zinc (11%), copper (6%), and palladium (4%).

The estimated value of U.S. nonmetal mine production in 2007 was $43.2 billion, slightly greater than that of 2006. Principal contributors to the total value of nonmetal mine production in 2007 were crushed stone (32%), cement (22%), and construction sand and gravel (19%).

Mine production of 13 mineral commodities was worth more than $1 billion each in the United States in 2007. These were crushed stone, cement, copper, construction sand and gravel, gold, molybdenum (concentrates), iron ore (shipped), zinc, clays (all varieties), lime, salt, soda ash, and phosphate rock, listed in decreasing order of value.

In 2007, 10 States each produced more than $2 billion worth of nonfuel mineral commodities. These States were, in descending order, Arizona, Nevada, California, Utah, Alaska, Florida, Texas, Minnesota, Missouri, and Georgia. The mineral production of these States accounted for 55% of the U.S. total output value (table 3).

The estimated value of all nonfuel mineral materials processed in the United States during 2007 totaled $575 billion, 1.5% more than that in 2006 (p. 5). The total value of U.S. raw nonfuel mineral production alone was $68 billion (p. 5), 3% more than that in 2006.

The United States continues to rely heavily on foreign sources for raw and processed mineral materials. In 2007, the United States supplied more than one-half of its apparent consumption of 44 mineral commodities through imports and was 100% import reliant for 19 of those (p. 6). The value of raw and processed mineral material exports increased by 42% to $105 billion. The value of exported ores and concentrates of metals and industrial minerals in 2007 was $7.2 billion. The value of raw and processed mineral material imports increased to $148 billion from $133 billion in 2006. The value of mineral raw material imports was $6.4 billion, an increase from $5.9 billion in 2006. The value of net imports of raw and processed mineral materials during 2007 decreased to $42 billion from $61 billion in 2006. As in recent years, aluminum, copper, and iron and steel were among the leading imports in terms of value (U.S. Census Bureau, 2007). The decline in value of the U.S. dollar relative to major world currencies probably

[1]Staff, U.S. Geological Survey

TABLE 1.—U.S. MINERAL INDUSTRY TRENDS

	2003	2004	2005	2006	2007[e]
Total mine production:[1]					
Metals	8,500	12,500	16,500	23,300	24,800
Industrial minerals	30,900	33,600	38,800	42,800	43,200
Coal	19,100	22,200	26,700	29,300	30,100
Employment:[2]					
Coal mining	59	59	61	68	71
Metal mining	20	20	22	26	29
Industrial minerals, except fuels	78	81	84	82	82
Chemicals and allied products	525	520	510	509	510
Stone, clay, and glass products	375	388	387	390	382
Primary metal industries	370	364	363	361	354
Average weekly earnings of production workers:[3]					
Coal mining	963	1,029	1,071	1,093	1,046
Metal mining	957	1,035	1,001	974	1,076
Industrial minerals, except fuels	771	791	830	863	875
Chemicals and allied products	784	820	832	834	820
Stone, clay, and glass products	665	688	701	713	722
Primary metal industries	768	800	816	843	842

[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

	2003	2004	2005	2006	2007[e]
Gross domestic product (billion dollars)	10,961	11,686	12,434	13,195	13,800
Industrial production (2002=100):					
Total index	101	104	107	111	113
Manufacturing:	101	104	108	113	115
Nonmetallic mineral products	101	104	108	113	110
Primary metals:	99	109	107	112	110
Iron and steel	101	116	110	117	114
Aluminum	96	96	102	99	96
Nonferrous metals (except aluminum)	101	104	103	107	109
Chemicals	101	106	108	110	111
Mining:	100	99	98	100	101
Coal	98	101	102	107	104
Oil and gas extraction	99	96	93	94	97
Metals	94	94	102	103	105
Nonmetallic minerals	101	106	107	104	91
Capacity utilization (percent):					
Total industry:	76	78	80	82	82
Mining:	88	88	88	91	91
Metals	72	72	79	79	81
Nonmetallic minerals	83	86	86	85	73
Housing starts (thousands)	1,850	1,950	2,070	1,810	1,360
Light vehicle sales (thousands)[1]	13,300	13,500	13,500	12,800	12,400
Highway construction, value, put in place (billion dollars)	57	59	64	72	76

[e]Estimated.

[1]Excludes imports.

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

helped to boost U.S. mineral exports in 2007 while at the same time making mineral imports more expensive.

In fiscal year 2007, the Defense Logistics Agency (DLA) sold $368 million of excess mineral materials from the 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 $1.24 billion remained in the stockpile.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2007[p, 1]

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$1,340,000	16	1.97	Cement (portland), stone (crushed), lime, sand and gravel (construction), salt.
Alaska	3,430,000	5	5.04	Zinc, gold, lead, silver, sand and gravel (construction).
Arizona	7,380,000	1	10.85	Copper, molybdenum concentrates, sand and gravel (construction), cement (portland), lime.
Arkansas	913,000	26	1.34	Bromine, stone (crushed), cement (portland), sand and gravel (construction), lime.
California	4,390,000	3	6.45	Sand and gravel (construction), cement (portland), boron minerals, stone (crushed), soda ash.
Colorado	1,940,000	11	2.85	Molybdenum concentrates, sand and gravel (construction), cement (portland), gold, stone (crushed).
Connecticut	181,000	43	0.27	Stone (crushed), sand and gravel (construction), stone (dimension), clays (common), gemstones (natural).
Delaware[2]	33,800	50	0.05	Sand and gravel (construction), magnesium compounds, stone (crushed), gemstones (natural).
Florida	3,190,000	6	4.69	Stone (crushed), phosphate rock, cement (portland), sand and gravel (construction), cement (masonry).
Georgia	2,110,000	10	3.10	Clays (kaolin), stone (crushed), cement (portland), clays (fuller's earth), sand and gravel (construction).
Hawaii	150,000	45	0.22	Stone (crushed), sand and gravel (construction), gemstones (natural).
Idaho	817,000	28	1.20	Molybdenum (concentrates), sand and gravel (construction), phosphate rock, silver, lead.
Illinois	1,220,000	20	1.79	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), lime.
Indiana	997,000	22	1.47	Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry).
Iowa	674,000	32	0.99	Stone (crushed), cement (portland), sand and gravel (construction), gypsum (crude), lime.
Kansas	967,000	24	1.42	Cement (portland), helium (Grade-A), stone (crushed), salt, sand and gravel (construction).
Kentucky	913,000	25	1.34	Stone (crushed), lime, cement (portland), sand and gravel (construction), clays (common).
Louisiana[2]	385,000	38	0.57	Sand and gravel (construction), salt, stone (crushed), clays (common), sand and gravel (industrial).
Maine	156,000	44	0.23	Cement (portland), sand and gravel (construction), stone (crushed), stone (dimension), peat.
Maryland	725,000	29	1.07	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry), stone (dimension).
Massachusetts	433,000	37	0.64	Stone (crushed), sand and gravel (construction), stone (dimension), lime, clays (common).
Michigan	1,910,000	12	2.81	Iron ore (usable shipped), cement (portland), sand and gravel (construction), stone (crushed), salt.
Minnesota	2,550,000	8	3.75	Iron ore (usable shipped), sand and gravel (construction), stone (crushed), sand and gravel (industrial), stone (dimension).
Mississippi	257,000	39	0.38	Sand and gravel (construction), stone (crushed), clays (fuller's earth), cement (portland), clays (ball).
Missouri	2,210,000	9	3.25	Stone (crushed), cement (portland), lead, lime, zinc.

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2007[p, 1]—Continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Montana	$1,290,000	18	1.90	Copper, molybdenum (concentrates), palladium metal, platinum metal, gold.
Nebraska	214,000	41	0.32	Cement (portland), sand and gravel (construction), stone (crushed), lime, clays (common).
Nevada	5,210,000	2	7.66	Gold, copper, sand and gravel (construction), silver, lime.
New Hampshire	115,000	46	0.17	Sand and gravel (construction), stone (crushed), stone (dimension), gemstones (natural).
New Jersey	582,000	33	0.86	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), greensand marl, peat.
New Mexico	1,520,000	15	2.23	Copper, potash, sand and gravel (construction), molybdenum (concentrates), cement (portland).
New York	1,330,000	17	1.96	Stone (crushed), cement (portland), sand and gravel (construction), salt, zinc.
North Carolina	986,000	23	1.45	Stone (crushed), phosphate rock, sand and gravel (construction), sand and gravel (industrial), clays (common).
North Dakota	55,700	48	0.08	Sand and gravel (construction), lime, sand and gravel (industrial), stone (crushed), clays (common).
Ohio	1,240,000	19	1.82	Stone (crushed), sand and gravel (construction), salt, lime, cement (portland).
Oklahoma	678,000	31	1.00	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), iodine (crude).
Oregon	505,000	36	0.74	Stone (crushed), sand and gravel (construction), cement (portland), diatomite, perlite (crude).
Pennsylvania	1,760,000	13	2.59	Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry).
Rhode Island	44,400	49	0.07	Sand and gravel (construction), stone (crushed), sand and gravel (industrial), gemstones (natural).
South Carolina	562,000	34	0.83	Cement (portland), stone (crushed), cement (masonry), sand and gravel (construction), sand and gravel (industrial).
South Dakota	227,000	40	0.33	Cement (portland), sand and gravel (construction), stone (crushed), stone (dimension), lime.
Tennessee	842,000	27	1.24	Stone (crushed), cement (portland), sand and gravel (construction), clays (ball), sand and gravel (industrial).
Texas	2,900,000	7	4.26	Cement (portland), stone (crushed), sand and gravel (construction), lime, salt.
Utah	3,940,000	4	5.79	Copper, molybdenum (concentrates), gold, sand and gravel (construction), cement (portland).
Vermont	92,800	47	0.14	Sand and gravel (construction), stone (dimension), stone (crushed), talc (crude), gemstones (natural).
Virginia	1,100,000	21	1.62	Stone (crushed), cement (portland), sand and gravel (construction), lime, zirconium (concentrates).
Washington	680,000	30	1.00	Sand and gravel (construction), stone (crushed), zinc, cement (portland), lime.
West Virginia	207,000	42	0.30	Stone (crushed), cement (portland), lime, sand and gravel (industrial), cement (masonry).
Wisconsin	552,000	35	0.81	Sand and gravel (construction), stone (crushed), lime, sand and gravel (industrial), stone (dimension).
Wyoming	1,670,000	14	2.45	Soda ash, clays (bentonite), helium (Grade-A), sand and gravel (construction), cement (portland).
Undistributed	435,000	XX	0.64	
Total	68,000,000	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."

Significant International Events

The year 2007 was characterized by a number of continuing trends—rapid economic growth in several populous developing countries, continuing high rates of increase of mineral consumption, and continued high levels of mineral prices. The most noteworthy developments in 2007 were the increasing concentration of ownership in the mineral industry (as already large companies combined through both friendly and hostile acquisitions) and the rise in economic nationalism (resource nationalism) as countries attempted to secure control over a larger portion of the economic rents (financial returns) from mineral production.

Economic Conditions

These trends were taking place in a world economy that was beset by growing economic difficulties. As 2007 began, much of the world was experiencing robust economic growth. This was especially true of four developing countries. China and India led the way with growth in the first quarter greater than 11% and 9%, respectively. Two other populous countries, Brazil and Russia, experienced significant but more moderate economic growth of 4.8% and 7.9%, respectively. Economic growth in the developed countries was moderate. In the United States, the rate of economic growth declined from 3.1% in the fourth quarter of 2006 to 2.1% in the first quarter of 2007. The rate of growth in the European Union (EU) also declined slightly from 3.3% to 3% during the same period. Japan's real gross domestic product (GDP) increased slightly in the first quarter of the year from 2.3% to 2.6%. Chinese growth remained above 11% through the first three quarters of the year, but was accompanied by rising inflation as consumer prices increased at a monthly rate of 2.2% in January to 6.9% in November (Economist, 2007b). To combat rising prices, the Chinese central bank raised interest rates three times in the first 6 months of the year (Metals Insider, 2007). However, interest rate increases barely kept up with the rate of inflation leading the central bank to announce a new "tight" monetary policy (Batson, 2007) and to raise interest rates for a sixth time (Areddy, 2007). India's rate of economic growth, which some analysts thought was unsustainable, cooled slightly to 8.9% in the third quarter (Economist, 2007c). India's monthly rate of increase in consumer prices, which was 6.7% in January, declined to 5.5% in October. Brazil's GDP grew at an estimated 5.3% for the entire year; however, Brazil, like China, faced increasing inflation worries. Russia's rate of economic growth slowed slightly to 7.6% and, like Brazil and China, Russia faced rising consumer prices and inflation worries. The EU and Japan experienced decreasing rates of economic growth in the second half of the year, and the EU also experienced moderate but rising consumer prices. The EU and Japan were dependent upon imports of mineral commodities as inputs to their manufacturing sectors and concerns about high prices were expressed at several conferences during the year.

In the United States, two factors threatened to reduce the rate of economic growth. The first factor was high oil prices. Rapid economic growth has led to increased consumption of petroleum in developing countries. Oil consumption in 2007 increased twice as fast as it had increased in 2006 (Bahree, 2007); however, a report by the International Energy Agency showed that when adjusted for inflation, investment in oil and natural gas development was essentially at the same levels as in 2000, notwithstanding a 9.3% increase in world oil consumption between 2000 and 2005 and a doubling of prices (Bahree, 2006). The second factor was a shortage of credit that resulted from the downturn in the housing market. This threatened the soundness of subprime loans that had been issued on residential real estate (Economist, 2007a). Problems with subprime loans in the United States had far-reaching effects, as these loans had been bundled with other loans and sold widely through global financial markets. In August, mining shares fell sharply on stock markets and base metal prices declined, as fears that a deepening credit crunch would curb demand growth (Cornish, 2007b). Stock prices recovered after central banks in the United States, Europe, and Japan injected hundreds of billions of dollars of liquidity into the market. Problems with the solvency of loans in the subprime credit market have begun to restrict access of the mining sector to finance according to bankers and analysts. Junior companies have been most affected (Dixon, 2007c).

Minerals Markets

Commodity analysts have expressed divergent views on the long-term outlook for metal prices. One group of analysts forecast prices to decline toward long-term average prices. A second group forecast prices to remain at or above current levels owing to continued rapid economic growth in developing countries such as China. The prices that mining companies are paying for mineral assets (mineral projects or other companies) indicates that mining companies expect metal prices to remain high (Hinde, 2007b).

Costs of mineral exploration and development have risen dramatically in 2007. In particular, the costs of assaying, drilling, fuel, and geoscientists have risen (Metals Economics Group, 2007). Production and shipping costs have also risen. An index of the cost of shipping bulk commodities has risen 169% over the last year. For example, cost of shipping iron ore from Brazil to China has tripled over the past year; the cost of shipping ($88 per metric ton) iron ore can sometimes exceed the price of the commodity ($60 per metric ton) (Matthews, 2007).

Copper projects have been particularly affected by rising development costs. Recently, the Galore Creek project in Canada was cancelled due to rising costs (Spicer, 2007). Costs at the nearly completed Cerro Corona and Magistral projects in Peru rose 25% and 55%, respectively, and costs at the Tenke Fungurume project in Congo (Kinshasa) have risen 38%. Costs at the large Oyu Tolgoi project in Mongolia have risen by an unstated amount (Dixon, 2007b; Mining Journal, 2007e, f, g).

The price of lump iron ore increased in 2007 as consumption of iron ore continued to increase due to rapidly rising steel production. World steel production increased 45% from 2000 to 2006; Chinese steel production increased more than three times in the same period and now represents 35% of world production. During the same period, iron ore prices have increased almost 2.8 times. Limits on access to transportation have affected iron ore production in Western Australia. Future production may be further limited by a recent ruling by the Western Australian Environmental Protection Authority, which has recommended that additional applications for iron ore mining permits in the Banded Ironstone Ranges in the Mount Manning Range be denied due to the presence of a rare species (Mining Journal, 2007u). High prices for iron ore are leading steelmakers to secure both supplies of coal and iron ore before they commit to building new plants (Dixon, 2007a; Parjia and Goswami, 2007). In addition, Tata Steel Ltd. and Arcelor Mittal have announced plans to invest in West African iron ore projects. Tata entered into an agreement to develop the Mt. Nimba project in Côte d'Ivoire, while ArcelorMittal will increase its investment in Liberia (Dixon, 2007d). High iron ore prices have led to a major reordering of country costs of production. Production costs of steelmakers in the United States, which have their own sources of iron ore, have dropped relative to production costs in the EU, Japan, and China (JPMorgan, 2007).

A recent report suggests that the Indonesian Government may reduce tin export quotas from 120,000 metric tons to 90,000 metric tons in 2008. Indonesia, the second leading tin-producing country, has had problems controlling tin smuggling (Dixon, 2007e). Higher tin prices have led to the reopening of two tin mines in the United Kingdom that were forced to close when tin prices plummeted in the mid-1980s (Chadwick, 2007).

Economic development in India increased India's gold consumption by 72% (or 221 metric tons) in the first half of 2007 relative to the same period in 2006 (O'Connell, 2007). The important causes for the rise in the gold prices were high oil prices and the dramatic drop in the value of the U.S. dollar relative to other convertible currencies. The drop in the value of the U.S. dollar relative to the Australian dollar led Newmont Mining Corp. to announce that it had begun a currency hedging program to protect it from the changing exchange rate between the Australian and U.S. dollars. Newmont sells its product for U.S. dollars but pays its costs in Australian dollars. The increase in value of the Australian dollar relative to the U.S. dollar has reduced company profits (Chandler, 2007b; Hinde, 2007c).

Uranium (U_3O_8) prices rose rapidly during the first half of the year and dropped during the second half of the year. Rapidly increasing demand for uranium and limited supply raised spot prices to new record levels several times during the year (Mining Journal, 2007o, r, s).

Mergers and Acquisitions

The leading story in the mining industry at the end of 2007 was the proposed $142 billion purchase of Rio Tinto by BHP Billiton the (BHPB) announced in early November. The combination of the leading (BHPB) and third leading (Rio Tinto) mining companies in terms of market capitalization would be the world's leading producer of aluminum and copper and the second leading iron ore producer, and potentially the leading uranium producer (Singer and Matthews, 2007). The company also would have significant coal and diamond reserves. The resulting entity could have a market capitalization of about $320 billion*. This would rank third behind Exxon Mobil Corp. ($499 billion) and Gazprom ($327 billion) among mining and oil companies. Traditionally, the mining industry has been considerably smaller than the oil industry. In proposing the merger, BHPB identified $3.7 billion of benefits that would result from the merger. Cost savings of $1.7 billion would result from improved efficiencies in transportation and $2 billion would result from increased production of mineral commodities over the next 7 years (Singer, 2007a). Rio Tinto's board of directors rejected the proposed offer (Hinde, 2007a) and later offered a plan to increase value for its shareholders (Chandler, 2007c; Singer, 2007b). The proposed merger has caused concern in Asia among Chinese, Japanese, and South Korean steel companies, which fear increased prices for iron ore (Hornby, 2007). Although BHPB has publicly announced its offer, it has not made a formal offer to Rio Tinto. As a result, Rio Tinto went to court and obtained an order that requires BHPB to either make a formal offer or to walk away (Reuters, 2007a).

In addition to the proposed purchase of Rio Tinto, a number of other noteworthy mergers and acquisitions were initiated in 2007, including Rio Tinto's purchase of Alcan, United Company Rusal's purchase of 25% of OAO Nori'lsk Nickel, Lafarge SA's purchase of Orascom Cement, Tata Steel's purchase of the Corus Group Plc, and OAO Nori'lsk Nickel's purchase of LionOre Mining International Ltd. There were a number of smaller mergers and acquisitions involving iron ore, nickel, and uranium assets, and a number of acquisitions involving copper assets in Congo (Kinshasa) and Peru, where Chinese companies obtained rights to two deposits through acquisitions.

Mergers and acquisitions have been proceeding at high levels for the last 3 years both in the economy at large and in the minerals sector (Berman, 2007). Among the factors cited for the recent spate of mergers in the minerals industry are the expected metals demand from China and other developing countries, the large amounts of cash that companies are holding as a result of high prices of commodities, and increased acquisitions by companies in developing countries, including Brazil, China, India, and Russia.

The consolidation that is taking place in the mining industry has been compared to the consolidation that took place in the oil industry in the 1990s (Barta and Matthews, 2007). Like the consolidation in the oil

*Correction posted March 26, 2008.

industry, consolidation in the mining industry is unlikely to result in increased mineral exploration, which is conducted largely by junior companies that are funded with speculative capital (Bahree, 2007).

BHPB's offer for Rio Tinto has raised concern that the offer may lead other big mining companies to propose additional mergers and acquisitions. As industry consolidation proceeds, policymakers and regulators may review the criteria that are appropriate for determining if and under what conditions proposed actions should take place.

Exploration

Global nonferrous mineral exploration budgets were expected to rise to $10.5 billion in 2007 from $7.1 billion in 2006. This is the highest level since the Metals Economic Group (MEG) began surveying companies about their intended expenditures in 1989. MEG estimated exploration spending at almost $940 million. Although exploration budgets have increased for companies of all sizes, those for small, or junior, exploration companies have increased the most (Metals Economics Group, 2007). Large companies typically expend only a small portion (1% to 2%) of their budgets on exploration, and one large company actually decreased exploration expenditures recently (Mining Journal, 2007b). Gold continued to attract the largest percentage of exploration budgets (41%), but this represented the smallest proportion since surveying began. Latin America continued to draw the largest expenditure of exploration funds.

Environment

Rapid economic development and rising mineral consumption were leading to growing environmental concern in countries such as China and India, as well as to renewed concerns about global environmental challenges such as the buildup of greenhouse gases in the atmosphere.

In China, rapid economic growth, especially the emphasis upon heavy industry and the use of coal as the country's main energy source, have led to increased water and air pollution. Although senior government officials have called for reduction in industrial pollution, the government was forced to shelve an attempt to account for the costs of such pollution in measuring the rate of economic growth due to complaints from provincial officials. An additional problem stems from the fact that many of China's new industrial plants and new commercial and residential buildings do not incorporate or use energy-efficient features (Kahn and Yardley, 2007); therefore, steel plants in China use more energy to produce a ton of steel than do steel plants in the EU, Japan, or the United States. This has led the world's leading steel producer, ArcelorMittal, to call for setting an allowable limit on each ton of steel, with credits being given to companies that produce below the limit and companies above the limit being forced to purchase credits (Blenkinsop, 2007). China's use of energy is now so great that it may have passed the United States as the leading emitter of carbon dioxide, one of the main greenhouse gases (Reuters, 2007b).

With the Kyoto Accords set to expire in 2012, and rising greenhouse gas emissions from developing countries such as China and India, both the EU and the United States have begun to discuss efforts to control emissions of greenhouse gases. In September, the United States convened a conference on global warming (Broder, 2007). Limits on carbon dioxide emissions are of special concern to the coal industry. Although an Australian court recently ruled against the plaintiff in a case that would have required Xstrata plc to "avoid, reduce or offset" greenhouse gas emissions from a new coal mining project, the company remains concerned about the possibility that another court might rule differently on a similar case (Giglio, 2007f).

Government Involvement

The high mineral prices and mining company profits during the last few years have lead host countries to want to capture a larger portion of the rents from minerals development for local and national economies. In some cases, this has resulted in direct expropriation of assets or of shares of companies. In other cases, it has involved the use of license revocation to accomplish the same purpose. Bolivia, China, Russia, and Venezuela have been cited as countries in which mineral exploration is particularly risky owing to threats of such actions (Mining Journal, 2007d).

Bolivia enacted a new bill to raise taxes on mining companies and announced it was "recovering" the Vinto smelter, which had been privatized by a previous government. The owner of the smelter, Glencore International AG, reportedly will fight the Bolivian government's expropriation of the Vento tin smelter (Mining Journal, 2007k).

In Russia, Rosprirodnadzor, a Russian environmental agency that has previously revoked environmental permits, began an examination of Highland Gold Mining Ltd.'s Mayskoye project. The announcement was enough to cause shares of the company to decline sharply (Mining Journal, 2007m).

In Venezuela, the Minister of Basic Industries and Mines, in reviewing the announced sale of assets of Gold Fields Ltd., stated that one of the assets, the Chaco 10 Mine, was not Gold Fields' asset to sell. Threats to nationalize the mining sector notwithstanding, Venezuela issued the final environmental approval for the Brisas project, and the Ministry of the Environment and Natural Resources of Venezuela approved the Environmental Impact Statement for Crystallex International Corporation's Las Cristinas project. Venezuela was expected to issue a new mining law at the end of 2007 that many feared would nationalize the mining industry (Mining Journal, 2007c, h, l).

Similar actions were also taken or proposed in Romania, where the Minister of the Environment stopped the licensing process for the Rosia Montana project for an indefinite period due to a permit dispute (Giglio, 2007d), and in Zimbabwe, where a proposed

Mines and Minerals Amendment Bill would give the government control of 51% of all mining companies. The proposed Zimbabwean bill requires companies to give the government 25% without effective compensation. A further 26% interest would be paid for with royalties earned from the first 25% (Giglio, 2007g).

Countries used a number of other tactics to increase rents on mineral production. For example, in Africa, reviews of mining deals were especially prevalent in 2007. Both Guinea and Tanzania began reviews of mining contracts, as did Congo (Kinshasa). The review in Congo (Kinshasa) was plagued by rumors, charges of conflict of interest on the part of western advisors, missed deadlines, and leaked documents, which resulted in share losses for companies rumored to be affected by the review (Giglio, 2007b, e). The review and a $5 billion loan from the Chinese Government lead miners to question the fairness of the Government's policies (Chandler, 2007a).

More traditional methods of increasing rents from mineral production were used by Ecuador and Zambia. Ecuador reintroduced mining royalties 5 years after it eliminated them. Zambia announced that mining royalties were being raised from 0.6% to 3.0%, and that it was raising income tax rates on mining companies (Dixon, 2007f; Mining Journal, 2007j).

In a number of countries, including Brazil, Ecuador, El Salvador, Honduras, India, and the Philippines, mining projects faced opposition from civil society groups.

Several governments rewrote or revised their mining laws. Australia ended a 25-year ban on uranium mining. Indonesia was in the process of revising its mining law and replacing it with a mining license that will be easier to alter and will be enforced for a shorter period. Nigeria passed new mining legislation and began to process exploration and mining permits. Finally, Peru passed a bill to speed up the rate at which 20 projects could proceed (Mining Journal, 2007a, i, q, r).

Afghanistan attempted to attract mineral investment by releasing a mineral-resource assessment that it had completed in cooperation with U.S. Geological Survey (USGS), and by auctioning the rights to develop the Aynak copper project (Peters and others, 2007). The China Metallurgical Group Corp (CMG) won the right to develop the project (Giglio, 2007c).

Outlook

The future of metal prices, which largely hinges on the level of consumption in developing countries and the level of metal production, continues to be a much-debated topic. USGS published outlooks for the production of a number of mineral commodities (Fong-Sam and others, 2007; Levine and others, 2007; Mobbs and others, 2007; Torres and others, 2007; and Yager and others, 2007). Based on these reports, it appears that mine capacity of bauxite, copper, iron ore, nickel, and zinc will increase by about 8%, 3%, 4%, 7%, and 2% per year, respectively.

An analysis by Credit Suisse (CS) reported that the increase of copper supply for 2008 could be as low as 2.3%, resulting in a significant spike in prices. Longer term, the report identifies 66 projects that could add 8 million metric tons per year to supply. Consumption has increased at 3.9% per year for the last 10 years. CS expects that projects beyond 2010 will be delayed by a year and will only reach 90% of planned capacity; this creates an increase of supply of only 3.6% per year. CS expects the increase in world demand, excluding China and India, to be no more than 1% per year. This would require consumption to increase by 9% in China and India to keep markets tight. For the past 7 years, copper demand has increased by 14.3% per year in China and 8% per year in India (Cornish, 2007a).

Demand from Chinese steelmakers is expected to result in at least a 30% increase in iron ore prices in 2008, according to CS. The CS report states that "30-40% looks possible" (Mining Journal, 2007n). Some consumers have worried that if the BHPB-Rio Tinto merger were to take place that prices could increase further. The high iron ore prices are causing steel companies to purchase iron ore resources. The International Nickel Study Group reported that world consumption of nickel could rise by 10% in 2008 owing to increasing demand for stainless steel in the United States and China. The group expects increasing consumption of nickel in China to decrease the current high level of stocks by 30,000 metric tons to 100,000 metric tons in 2008 (Mining Journal, 2007p).

Gold production is expected to continue to decline rapidly according to a number of large corporations. They note that higher prices could stimulate production (Giglio, 2007a).

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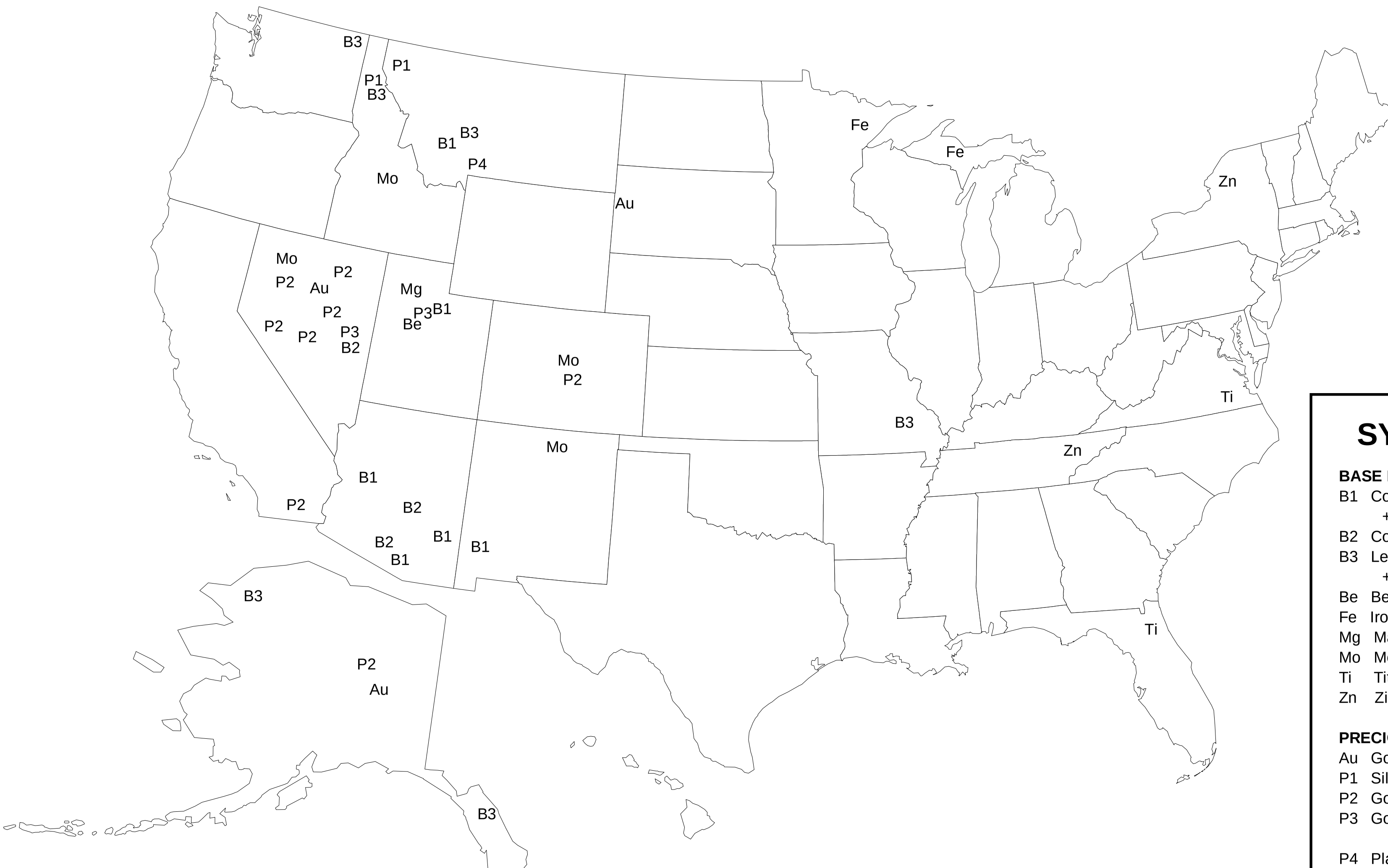
MAJOR METAL-PRODUCING AREAS



SYMBOLS

BASE METALS

B1 Copper and molybdenum +/- gold, silver
B2 Copper +/- gold, silver
B3 Lead, zinc +/- copper +/- gold +/- silver
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

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 $26.8 million. Bonded and coated abrasive products accounted for most abrasive uses of fused aluminum oxide and silicon carbide.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production,[1] United States and Canada (crude):					
Fused aluminum oxide, regular	20,000	20,000	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	164,000	232,000	244,000	209,000	237,000
Silicon carbide	169,000	209,000	201,000	186,000	155,000
Exports (U.S.):					
Fused aluminum oxide	11,800	13,900	13,900	15,300	17,700
Silicon carbide	13,200	13,900	15,600	20,300	19,100
Consumption, apparent (U.S.):					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	189,000	230,000	220,000	201,000	171,000
Price, dollars per ton, United States and Canada:					
Fused aluminum oxide, regular	279	323	144	152	165
Fused aluminum oxide, high-purity	514	544	656	652	671
Silicon carbide	529	614	603	693	749
Net import reliance[2] as a percentage of apparent consumption (U.S.):					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	82	85	84	83	80

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

Import Sources (2003-06): Fused aluminum oxide, crude: China, 78%; Venezuela, 13%; Canada, 8%; and other, 1%. Fused aluminum oxide, grain: Brazil, 22%; Germany, 22%; Austria, 13%; China, 10%; and other, 33%. Silicon carbide, crude: China, 71%; Venezuela, 9%; Netherlands, 7%; Romania, 6%; and other, 7%. Silicon carbide, grain: China, 36%; Brazil, 25%; Russia, 10%; Venezuela, 8%; and other, 21%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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: During fiscal year 2007, the Department of Defense sold 4,077 tons of fused aluminum oxide abrasive grain from the National Defense Stockpile for $1.73 million.

Stockpile Status—9-30-07[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Fused aluminum oxide, grain	3,042	350	3,042	3,042	4,077

Prepared by **Donald W. Olson [(703) 648-7721, dolson@usgs.gov, fax: (703) 648-7975]**

ABRASIVES (MANUFACTURED)

Events, Trends, and Issues: Imports and higher operating costs continued to challenge producers in the United States and Canada. Foreign competition, particularly from China, is expected to persist and further curtail production in North America.

World Production Capacity:

	Fused aluminum oxide capacity		Silicon carbide capacity	
	2006	**2007[e]**	**2006**	**2007[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 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.
[3]See Appendix B for definitions.

ALUMINUM[1]

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

Domestic Production and Use: In 2007, 6 companies operated 14 primary aluminum smelters; 5 smelters were temporarily idled. Based upon published market prices, the value of primary metal production was $7.1 billion. Aluminum consumption was centered in the East Central United States. Transportation accounted for an estimated 38% of domestic consumption; the remainder was used in packaging, 22%; building, 16%; electrical, 7%; machinery, 7%; consumer durables, 7%; and other, 3%.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production:					
Primary	2,703	2,516	2,481	2,284	2,600
Secondary (from old scrap)	1,070	1,160	1,060	1,080	1,300
Imports for consumption	4,130	4,720	5,330	5,180	4,500
Exports	1,540	1,820	2,370	2,820	2,900
Consumption, apparent[2]	6,130	6,590	6,460	5,730	5,300
Price, ingot, average U.S. market (spot), cents per pound	68.1	84.0	91.0	121.4	125.2
Stocks:					
Aluminum industry, yearend	1,400	1,470	1,430	1,410	1,500
LME, U.S. warehouses, yearend[3]	207	116	209	239	350
Employment, number[4]	58,000	57,500	58,400	59,800	60,000
Net import reliance[5] as a percentage of apparent consumption	38	44	45	41	26

Recycling: In 2007, aluminum recovered from purchased scrap was about 3.5 million tons, of which about 63% came from new (manufacturing) scrap and 37% from old scrap (discarded aluminum products). Aluminum recovered from old scrap was equivalent to about 25% of apparent consumption.

Import Sources (2003-06): Canada, 55%; Russia, 17%; Brazil, 4%; Venezuela, 4%; and other, 20%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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.

Prepared by **E. Lee Bray [(703) 648-4979, lbray@usgs.gov, fax: (703) 648-7757]**

ALUMINUM

Events, Trends, and Issues: Domestic primary aluminum production increased substantially owing to smelter restarts after new power contracts were obtained by producers. Domestic smelters operated at about 69% of rated or engineered capacity.

Net import reliance as a percent of apparent consumption declined dramatically as domestic production increased while imports for consumption decreased. Canada and Russia accounted for almost three-fourths of total imports. U.S. exports increased slightly in 2007. China, Canada, and Mexico, in descending order, received approximately three-fourths of total U.S. exports. Most of the shipments to China (98%) were in the form of aluminum scrap.

The price of primary aluminum generally rose through July 2007 before declining significantly. In January, the average monthly U.S. market price for primary ingot quoted by Platts Metals Week was $1.295 per pound; it reached a high of $1.308 per pound in April but in September, the price was $1.115 per pound. Prices on the London Metal Exchange (LME) followed the trend of U.S. market prices. The monthly average LME cash price for September was $1.075 per pound.

World primary aluminum production continued to increase as capacity expansions outside the United States were brought onstream. Inventories of metal held by producers, as reported by the International Aluminium Institute, decreased through the end of July to about 2.8 million tons from 2.9 million tons at yearend 2006. Inventories of primary aluminum metal held by the LME increased during the year to 934,000 tons at the end of September from 698,000 tons at yearend 2006.

World Smelter Production and Capacity:

	Production		Yearend capacity	
	2006	2007[e]	2006	2007[e]
United States	2,284	2,600	3,700	3,700
Australia	1,930	1,900	1,950	1,950
Bahrain	872	870	830	830
Brazil	1,498	1,700	1,650	1,700
Canada	3,050	3,100	3,060	3,100
China	9,350	12,000	10,500	14,000
Germany	537	520	670	600
Iceland	320	400	400	790
India	1,100	1,400	1,200	1,500
Mozambique	564	560	570	570
Norway	1,330	1,100	1,350	1,190
Russia	3,720	4,200	3,800	4,400
South Africa	895	900	900	900
Tajikistan	414	500	515	515
United Arab Emirates, Dubai	730	900	860	920
Venezuela	610	630	675	675
Other countries	4,510	4,500	5,240	5,360
World total (rounded)	33,700	38,000	37,900	42,700

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 reserve base for bauxite is 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, and wood can substitute for aluminum in construction. Copper can replace aluminum in electrical applications.

[e]Estimated.
[1]See also Bauxite and Alumina.
[2]Domestic primary metal production + recovery from old aluminum scrap + net import reliance.
[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 domestic mine production of antimony in 2007. The only domestic source of antimony, a silver mine that produced antimony as a byproduct, closed early in 2001 with no output in that year. 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 other, 13%.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production:					
Mine (recoverable antimony)	—	—	—	—	—
Smelter:					
Primary	W	W	W	W	W
Secondary	5,600	3,650	3,030	3,480	3,240
Imports for consumption	26,700	33,500	22,700	23,000	22,700
Exports of metal, alloys, oxide, and waste and scrap[1]	3,680	3,810	2,140	2,140	3,060
Shipments from Government stockpile	2,070	—	—	—	—
Consumption, apparent[2]	29,400	36,800	31,400	24,300	22,900
Price, metal, average, cents per pound[3]	108	130	161	238	259
Stocks, yearend	6,320	2,830	2,110	2,110	2,160
Employment, plant, number[e]	30	30	10	10	10
Net import reliance[4] as a percentage of apparent consumption	81	90	88	86	86

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 (2003-06): Metal: China, 70%; Peru, 12%; Mexico, 11%; and other, 7%. Ore and concentrate: Bolivia, 88%; China, 10%; and other, 2%. Oxide: China, 46%; Mexico, 38%; Belgium, 7%; and other, 9%. Total: China, 51%; Mexico, 32%; Belgium, 7%; and other, 10%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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.

Prepared by **James F. Carlin, Jr. [(703) 648-4985, jcarlin@usgs.gov, fax: (703) 648-7757]**

ANTIMONY

Events, Trends, and Issues: In 2007, antimony production from domestic source materials was derived entirely from the recycling of lead-acid batteries. Recycling supplied only a minor portion of estimated domestic consumption. 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, continues to make antimony products.

The price of antimony started the year at about $2.55 per pound and remained in a narrow band most of the year, finishing August at $2.62 per pound.

During 2007, the world's leading antimony producer, China, continued experiencing production restraints. Around the world, several new antimony mine projects were being developed.

World Mine Production, Reserves, and Reserve Base: Production and reserve estimates were introduced for Thailand because of the emergence in 2006 of several new tin operations being worked by small-scale independent miners in the northern part of the country.

	Mine production		Reserves[5]	Reserve base[5]
	2006	2007[e]		
United States	—	—	—	90,000
Bolivia	6,600	7,000	310,000	320,000
China	110,000	110,000	790,000	2,400,000
Guatemala	1,000	1,000	NA	NA
Russia (recoverable)	3,500	4,000	350,000	370,000
South Africa	6,000	6,000	44,000	200,000
Tajikistan	2,000	2,000	50,000	150,000
Thailand	940	1,500	420,000	450,000
Other countries	4,000	4,000	150,000	330,000
World total (rounded)	134,000	135,000	2,100,000	4,300,000

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. NA Not available. 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.

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 over 20,000 tons annually during 2001-03 and were used mainly in the production of chromated copper arsenate (CCA) wood preservatives. The grids in lead-acid storage batteries were strengthened by the addition of arsenic metal, and small-arms ammunition used by the United States military was hardened by the addition of less than 1% arsenic metal. Other applications of arsenic metal include its use 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. The electronics industry used high-purity arsenic (99.9999%) 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 2007 was estimated to be about $9 million.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Imports for consumption:					
Metal	990	872	812	1,070	1,000
Trioxide	20,800	6,150	8,330	9,330	9,000
Exports, metal	173	220	3,270	3,060	5,500
Estimated consumption[1]	21,600	6,800	5,870	7,340	4,500
Value, cents per pound, average:[2]					
Metal (China)	87	88	95	160	130
Trioxide (China)	45	49	18	22	25
Trioxide (Mexico)	34	32	67	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 and 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. Approximately 7 tons of arsenic was 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 (2003-06): Metal: China, 86%; Japan, 13%; and other, 1%. Trioxide: China, 63%; Morocco, 25%; Hong Kong, 4%; Chile, 3%; and other, 5%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-07**
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.

Prepared by **William E. Brooks [(703) 648-7791, wbrooks@usgs.gov, fax: (703) 648-7757]**

ARSENIC

Events, Trends, and Issues: Exposure to arsenic may affect breathing, heart rhythm, and possibly increase the risk for bladder cancer. Therefore, in response to these 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. Arsenic trioxide imports, mainly from China, had dropped to 6,150 tons in 2004 compared with 20,800 tons in 2003. The 70% decline in arsenic trioxide imports was in response to this industry decision. Imports of arsenic trioxide have increased somewhat since 2004 but are still less than 10,000 tons per year. 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 metal export data for 2005 have been revised; exports rose sharply from 2004 levels. Export destinations for arsenic metal were the Republic of Korea (55%) and Taiwan (28%). Possible uses of the metal include electronics applications or in the production of small-arms ammunition. Imports of arsenic metal averaged 900 tons from 2002 to 2006.

Arsenic in ground water is another concern, and the U.S. Environmental Protection Agency has set the arsenic standard at 0.010 part per million. Water treatment systems were to meet this standard by January 23, 2006. Geologic sources and the effects of high levels of arsenic are the focus of global government and university research.

Rice grown in the United States may contain from one to five times the arsenic contained in rice from Bangladesh, Europe, and India. Arsenic was added to chicken feed in order to promote growth, kill parasites, and improve pigmentation of chicken meat; therefore, chicken manure may introduce arsenic to agricultural fields and ultimately to ground water. Arsenic was used as an embalming agent during the Civil War and now may be leached from Civil War-era cemeteries. Arsenic may also be released from coal-burning powerplant emissions and from buried World War I ammunition. Several contaminants, including arsenic, were found in sludge deposited across New Orleans in the aftermath of Hurricane Katrina. Arsenic trioxide may be used to treat leukemia.

World Production, Reserves, and Reserve Base:

	Production (arsenic trioxide)		Reserves and reserve base[4] (arsenic content)
	2006	2007[e]	
Belgium	1,000	1,000	World reserves and reserve base are thought to be about 20 and 30 times, respectively, annual world production. The reserve base for the United States is estimated to be 80,000 tons.
Chile	11,800	11,500	
China	30,000	30,000	
France	1,000	1,000	
Kazakhstan	1,500	1,500	
Mexico	1,750	1,400	
Morocco	6,900	6,900	
Peru	3,500	3,500	
Russia	1,500	1,500	
Other countries	800	1,000	
World total (rounded)	59,800	59,000	

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, and associated alteration products; 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 transport and 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.

ASBESTOS

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: There has been no asbestos mining in the United States since 2002, so the United States is totally dependent on imports to meet manufacturing needs. Asbestos consumption in the United States was estimated to be 84% for roofing products and 16% for other applications.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production (sales), mine	—	—	—	—	—
Imports for consumption	5	3	3	2	2
Exports[1]	3	2	2	3	1
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, estimated	5	3	3	2	2
Price, average value, dollars per ton[2]	220	255	255	NA	NA
Stocks, producer, yearend	—	—	—	—	—
Employment, mine and mill, number	2	—	—	—	—
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: None.

Import Sources (2003-06): Canada, 86%; and other, 14%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
Asbestos other than crocidolite	2524.90.0000	Free.
Crocidolite	2524.10.0000	Free.

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

Government Stockpile: None.

Prepared by **Robert L. Virta [(703) 648-7726, rvirta@usgs.gov, fax: (703) 648-7975]**

ASBESTOS

Events, Trends, and Issues: There was no production of asbestos in the United States. U.S. exports decreased to an estimated 1,089 tons in 2007 from 3,410 tons in 2006. Exports may include some nonasbestos materials and reexports, as U.S. production of asbestos ceased in 2002. Imports decreased to an estimated 1,820 tons in 2007 from 2,230 tons in 2006. Domestic use of asbestos declined to an estimated 1,820 tons in 2007 from 2,230 tons in 2006. 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 health risk posed by asbestos exposure in populated areas, such as housing developments, hiking trails, and school settings, remained a contentious topic of discussion, particularly in El Dorado County, CA.

The Ministry of Labor in the Republic of Korea announced that it will restrict the manufacture, import, and use of asbestos in stages through 2008, and a ban will be in force by 2009. The Government of New Caledonia imposed a ban on asbestos. Exemptions to the ban are effective through the end of 2011.

The companies controlling the production of asbestos in Canada filed for bankruptcy under the Bankruptcy and Insolvency Act of Canada. The companies will examine several scenarios to maximize the value of their assets, including selling land and equipment or forming a new partnership.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2006	2007[e]		
United States	—	—	Small	Large
Brazil	236	230	Moderate	Moderate
Canada	244	185	Large	Large
China	350	350	Large	Large
Kazakhstan	355	350	Large	Large
Russia	925	1,030	Large	Large
Zimbabwe	100	95	Moderate	Moderate
Other countries	90	45	Moderate	Large
World total (rounded)	2,300	2,290	Large	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. NA Not available. — Zero.
[1]Probably includes nonasbestos materials and reexports.
[2]Average price for Group 7 Canadian chrysotile, ex-mine.
[3]Defined as imports – exports + adjustments for Government and industry stock changes; however, imports account for all domestic consumption.
[4]See Appendix C for definitions.

BARITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Barite sales by domestic producers were estimated to be about 540,000 tons in 2007 valued at about $23 million, a decrease in production of about 8% from that of 2006. The majority of production came from three major mines in Nevada followed by a significantly smaller sales volume from a single mine in Georgia. In 2007, about 3.2 million tons of barite (from domestic production and imports) was sold by crushers and grinders in five 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 imports to the Louisiana and Texas ports went primarily to offshore drilling operations in the Gulf of Mexico and to onshore operations in Texas, Louisiana, New Mexico, and Oklahoma. 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:	2003	2004	2005	2006	2007[e]
Sold or used, mine	468	532	489	589	540
Imports for consumption:					
Crude barite	1,620	1,960	2,570	2,530	2,720
Ground barite	([1])	5	84	1	6
Other	33	34	29	22	14
Exports	44	70	93	72	20
Consumption, apparent[2] (crude and ground)	2,080	2,460	3,080	3,070	3,260
Consumption[3] (ground and crushed)	2,230	2,440	2,720	3,040	3,240
Price, average value, dollars per ton, f.o.b. mine	29.70	35.10	35.90	40.00	40.00
Employment, mine and mill, number[e]	340	340	340	330	330
Net import reliance[4] as a percentage of apparent consumption	77	78	84	81	83

Recycling: None.

Import Sources (2003-06): China, 90%; India, 8%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Crude barite	2511.10.5000	$1.25/t.
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	2833.27.0000	0.6% ad val.
Carbonate	2836.60.0000	2.3% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **M. Michael Miller [(703) 648-7716, mmiller1@usgs.gov, fax: (703) 648-7757]**

BARITE

Events, Trends, and Issues: Increasing exploration for natural gas in Colorado, Utah, and Wyoming has fueled increased demand for drilling mud and, consequently, barite. This demand has resulted in two developments—sales of 4.1 specific gravity barite to extend reserves at existing mines in Nevada, and exploration in Montana and Nevada of previously explored or mined barite deposits in order to initiate new mining operations.

Prices of ground barite for the oil and gas market remain high. Almost all barite consumed for drilling in the major U.S. oil and gas producing regions (excluding the Rocky Mountain region) is supplied by imports from China and India. Ocean freight rates remain high, and port congestion remains a problem in Chinese ports causing delays and higher costs. Other factors have adversely affected barite prices, including higher prices for natural gas, which is used to dry barite before grinding, and transportation problems ranging from poor barge availability to higher diesel prices (barges are needed to transport barite from ships to grinding mills).

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for the United States were revised based on data from a recent paper presented by one of the major Nevada barite producers. Reserve base estimate for Kazakhstan was revised based on a recent Russian Mining Journal article.

	Mine production		Reserves[5]	Reserve base[5]
	2006	2007[e]		
United States	589	540	15,000	45,000
Algeria	53	60	9,000	15,000
Brazil	50	50	2,100	5,000
Bulgaria	80	80	NA	NA
China	4,400	4,400	62,000	360,000
France	30	—	2,000	2,500
Germany	90	85	1,000	1,500
India	950	1,000	53,000	80,000
Iran	290	250	NA	NA
Kazakhstan	[6]120	[6]120	NA	150,000
Mexico	206	250	7,000	8,500
Morocco	350	600	10,000	11,000
Russia	63	65	2,000	3,000
Thailand	120	5	9,000	15,000
Turkey	180	160	4,000	20,000
United Kingdom	50	50	100	600
Vietnam	120	120	NA	NA
Other countries	220	210	14,000	160,000
World total (rounded)	7,960	8,000	190,000	880,000

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. — Zero.
[1]Less than ½ unit.
[2]Sold or used by domestic mines – exports + imports.
[3]Domestic and imported crude barite sold or used by domestic grinding establishments.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.
[6]Estimated marketable barite; however, reported production figures are significantly higher.

BAUXITE AND ALUMINA[1]

(Data in thousand metric dry tons unless otherwise noted)

Domestic Production and Use: Nearly all bauxite consumed in the United States was imported; of the total, more than 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 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:	2003	2004	2005	2006	2007[e]
Production, bauxite, mine	NA	NA	NA	NA	NA
Imports of bauxite for consumption[2]	8,860	10,500	10,400	13,000	10,000
Imports of alumina[3]	2,310	1,650	1,860	1,860	2,300
Exports of bauxite[2]	89	75	62	43	29
Exports of alumina[3]	1,090	1,230	1,210	1,540	1,200
Shipments of bauxite from Government stockpile excesses[2]	1,710	66	—	—	—
Consumption, apparent, bauxite and alumina (in aluminum equivalents)[4]	2,580	2,810	2,940	3,230	3,000
Price, bauxite, average value U.S. imports (f.a.s.) dollars per ton	19	22	26	28	27
Stocks, bauxite, industry, yearend[2]	3,830	3,120	W	W	W
Net import reliance,[5] bauxite and alumina, as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2003-06):[6] Bauxite: Guinea, 29%; Jamaica, 23%; Brazil, 20%; Guyana, 12%; and other, 16%. Alumina: Australia, 47%; Suriname, 29%; Jamaica, 9%; and other, 15%. Total: Guinea, 20%; Jamaica, 19%; Australia, 17%; Brazil, 15%; and other, 29%.

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 8 months of 2007 had normal-trade-relations status.

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

Government Stockpile:

Stockpile Status—9-30-07[7]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Bauxite, metal grade:					
Jamaica-type	—	—	—	2,030	—
Suriname-type	—	—	—	406	—
Bauxite, refractory-grade	—	—	—	44	—

Prepared by **E. Lee Bray [(703) 648-4979, lbray@usgs.gov, fax: (703) 648-7757]**

BAUXITE AND ALUMINA

Events, Trends, and Issues: Spot prices for metallurgical-grade alumina, as published by Metal Bulletin, rebounded in January and remained in a narrow range through the third quarter as a result of increased aluminum production and slightly lower alumina production. The published price range began the year at $200 to $210 per ton of alumina. By the end of January, the price range had reached $350 to $370 per ton. The price range remained at $350 to $370 per ton until mid-July when a gradual decline began. The price range was $330 to $350 per ton at the end of September.

World production of alumina declined slightly compared with that of 2006. Based on production data from the International Aluminium Institute, world alumina production during the first two quarters of 2007 decreased less than 1% compared with that for the same period in 2006. Expansions of bauxite mines in China, Brazil, and Guyana accounted for most of the 6% increase in worldwide production of bauxite, offsetting declines caused by a strike in Guinea and reduced production from Russia.

World Bauxite Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[8]	Reserve base[8]
	2006	2007[e]		
United States	NA	NA	20,000	40,000
Australia	62,300	64,000	5,800,000	7,900,000
Brazil	21,000	24,000	1,900,000	2,500,000
China	21,000	32,000	700,000	2,300,000
Greece	2,450	2,400	600,000	650,000
Guinea	14,500	14,000	7,400,000	8,600,000
Guyana	1,400	2,000	700,000	900,000
India	12,700	13,000	770,000	1,400,000
Jamaica	14,900	14,000	2,000,000	2,500,000
Kazakhstan	4,800	4,900	360,000	450,000
Russia	6,600	6,000	200,000	250,000
Suriname	4,920	5,000	580,000	600,000
Venezuela	5,500	5,500	320,000	350,000
Other countries	5,460	6,800	3,400,000	4,000,000
World total (rounded)	178,000	190,000	25,000,000	32,000,000

World Resources: Bauxite resources are estimated to be 55 to 75 billion tons, located in Africa (33%), Oceania (24%), South America and the Caribbean (22%), Asia (15%), 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. A company acquisition in 2007 resulted in the withholding of data, including revisions to data from 2005.
[3]Calcined equivalent weights.
[4]The sum of U.S. bauxite production and net import reliance.
[5]Defined as imports – exports + adjustments for Government and industry stock changes (all in aluminum equivalents). Treated as separate commodities, the net import reliance equaled 100% for bauxite and 16% for alumina in 2007. For the years 2003-06, the net import reliance was 100% for bauxite and ranged from 5% to 29% for alumina.
[6]Aluminum equivalents.
[7]See Appendix B for definitions.
[8]See Appendix C for definitions.

BERYLLIUM

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

Domestic Production and Use: A 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, and some was sold. Estimated beryllium consumption of 91 tons was valued at about $28 million, based on the estimated unit value for beryllium in imported beryllium-copper master alloy. Based on sales revenues, nearly one-half of beryllium use was estimated to be in computer and telecommunications products, and the remainder was in aerospace and defense applications, appliances, automotive electronics, industrial components, and other applications.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production, mine shipments[e]	85	90	110	155	100
Imports for consumption[1]	163	85	93	62	80
Exports[2]	269	217	201	135	90
Government stockpile releases[3]	33	106	79	158	1
Consumption:					
Apparent[4]	57	69	84	226	91
Reported, ore	140	130	160	180	NA
Unit value, average annual, beryllium-copper master alloy, dollars per pound contained beryllium[5]	113	125	99	128	141
Stocks, ore, consumer, yearend	45	40	35	50	NA
Net import reliance[6] as a percentage of apparent consumption	E	E	E	[7]31	E

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 (2003-06):[1] Kazakhstan, 42%; Germany, 24%; United Kingdom, 6%; and other, 28%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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 2008 Annual Materials Plan are as follows: beryl ore, 109 tons of contained beryllium; beryllium-copper master alloy, 11 tons of contained beryllium; and beryllium metal, 36 tons.

Stockpile Status—9-30-07[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Beryl ore (11% BeO)	—	—	—	[9]145	—
Beryllium-copper master alloy	3	—	3	[10]44	—
Beryllium metal:					
Hot-pressed powder	155	—	110	—	—
Vacuum-cast	40	—	40	[10]36	—

Prepared by **Kim B. Shedd [(703) 648-4974, kshedd@usgs.gov, fax: (703) 648-7757]**

BERYLLIUM

Events, Trends, and Issues: During the first half of 2007, the leading U.S. beryllium producer sold a lower volume of bulk and strip beryllium-copper alloy products than it did during the first half of 2006. Sales of beryllium products for defense applications and medical and industrial x-ray equipment were higher than those during the first half of 2006; sales of beryllium blanks to an experimental nuclear fusion reactor in Europe continued in 2007. Sales of beryllium-aluminum products were higher than those during the first half of 2006, while sales of beryllium oxide ceramics were the same during the two periods.

The leading U.S. beryllium producer began work on opening a new bertrandite mine in Utah. The mine was expected to begin ore production in 2008. The company also planned to build a new primary beryllium facility at its operations in Ohio. The engineering and design of the new facility was being funded by the Department of Defense's Defense Production Act Title III Program, and was expected to be completed before the end of 2007. Construction and startup of the facility was expected to take 2 to 3 years; funding would require additional Title III approval. Primary beryllium is the feedstock used to make beryllium metal products. The only primary beryllium facility in the United States was closed in 2000.

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 maintain careful control over the quantity of beryllium dust, fumes, and mists in the workplace. Control of potential health hazards adds to the final cost of beryllium products.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e] 2006	Mine production[e] 2007
United States	155	100
China	20	20
Mozambique	6	6
Other countries	([12])	([12])
World total (rounded)	180	130

Reserves and reserve base[11]

The United States has very little beryl that can be economically handsorted from pegmatite deposits. The Spor Mountain area, Utah, an epithermal deposit, contains a large reserve base of bertrandite, which was being mined. Proven bertrandite reserves in Utah total about 15,900 tons of contained beryllium. World beryllium reserves and reserve base are not sufficiently well delineated to report consistent figures for all countries.

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 Spor Mountain and Gold Hill 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. NA Not available. — 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; includes committed and uncommitted inventories.
[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]Represents inventory sold, but not yet shipped.
[11]See Appendix C for definitions.
[12]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 $64 million. About 47% of the bismuth was used for metallurgical additives; 34% in fusible alloys, solders, and ammunition cartridges; 18% in pharmaceuticals and chemicals; and 1% 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:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production, refinery	—	—	—	—	—
Imports for consumption, metal	2,320	1,980	2,530	2,300	2,700
Exports, metal, alloys, and scrap	108	109	142	311	670
Consumption:					
Reported	2,120	2,420	2,340	2,050	2,100
Apparent	2,040	2,130	2,490	2,070	2,125
Price, average, domestic dealer, dollars per pound	2.87	3.35	3.91	5.04	13.75
Stocks, yearend, consumer	279	134	136	155	160
Net import reliance[1] as a percentage of apparent consumption	95	95	96	95	95

Recycling: All types of bismuth-containing alloy scrap were recycled and contributed about 10% of U.S. bismuth consumption, or 250 tons.

Import Sources (2003-06): Belgium, 38%; Mexico, 23%; China, 19%; United Kingdom, 12%; and other, 8%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
Bismuth and articles thereof, including waste and scrap	8106.00.0000	Free.

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

Government Stockpile: None.

Prepared by **James F. Carlin, Jr. [(703) 648-4985, jcarlin@usgs.gov, fax: (703) 648-7757]**

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 nontoxic replacements 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 for the use of bismuth in lead-free solders. Researchers are looking at 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 2007 at $7.30 per pound and slowly rose throughout the first quarter. In early April, the price rise accelerated from $10.50 per pound to $15.00 per pound in late April, to $18.00 per pound in late May, and reached a peak of $18.50 per pound in late June. Then by early July, the price began to subside gradually, reaching $14.50 per pound in mid-October. The estimated average price for 2007 was about 173% above that for 2006. Industry sources attributed the substantial price increases to a moderate increase in world demand combined with flat world production and speculative investing activity.

Around the world, there were a couple of bismuth exploration activities that seemed promising. In Canada, an exploration firm announced that its cobalt-gold-bismuth deposit in the Northwest Territories was undergoing a feasibility study and that an agreement was reached to sell all of its eventual bismuth production to a European bismuth refiner. Another Canadian exploration firm announced increased expenditures to develop its property in Vietnam that contains bismuth, fluorspar, and tungsten.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[2]	Reserve base[2]
	2006	2007[e]		
United States	—	—	—	14,000
Bolivia	70	70	10,000	20,000
Canada	190	190	5,000	30,000
China	3,000	3,000	240,000	470,000
Kazakhstan	140	140	5,000	10,000
Mexico	1,180	1,200	10,000	20,000
Peru	950	960	11,000	42,000
Other countries	170	160	39,000	74,000
World total (rounded)	5,700	5,700	320,000	680,000

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 has been on standby status since the mid-1990s awaiting a significant and sustained rise in the metal price. 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.

BORON

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

Domestic Production and Use: The estimated value of boric oxide contained in minerals and compounds produced in 2007 was withheld to prevent disclosure of individual company proprietary data. Boron minerals, primarily as sodium borates, were produced domestically by two companies in southern California. The leading producer operated an open pit tincal and kernite mine and associated compound plants. A second company produced borax and boric acid using saline brines as the raw material. A third company that previously processed calcium and calcium sodium borates became a trader and sold from inventory and imported products. A fourth company has been idle since 2003. 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 2006 was glass and ceramics, 72%; soaps, detergents, and bleaches, 4%; agriculture, 3%; enamels and glazes, 3%; and other, 18%.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production[1]	605	637	612	W	W
Imports for consumption, gross weight:					
Borax	([2])	([2])	1	2	1
Boric acid	47	49	52	85	90
Colemanite	24	21	31	25	30
Ulexite	80	110	103	131	140
Exports, gross weight:					
Boric acid	70	61	183	221	200
Colemanite	23	18	—	—	—
Refined sodium borates	131	135	308	393	390
Consumption:					
Apparent	532	509	439	W	W
Reported	366	385	W	W	W
Price, dollars per ton, granulated pentahydrate borax in bulk, carload, works[3]	400-425	400-425	400-425	400-425	NA
Stocks, yearend[4]	NA	NA	NA	NA	NA
Employment, number[e]	1,300	1,300	1,300	1,300	1,300
Net import reliance[5] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2003-06): Boric acid: Turkey, 45%; Chile, 30%; Bolivia, 7%; Peru, 7%; and other, 11%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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.
Boric acids	2810.00.0000	1.5% ad val.
Natural borates:		
Sodium	2528.10.0000	Free.
Calcium	2528.90.0010	Free.
Other	2528.90.0050	Free.

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

Government Stockpile: None.

Prepared by **Dennis S. Kostick [(703) 648-7715, dkostick@usgs.gov, fax: (703) 648-7757]**

BORON

Events, Trends, and Issues: Although production data were withheld, the United States was a major world producer of refined boron compounds during 2007. U.S. processed products had fewer impurities and were produced with lower emissions than in other countries. The U.S. industry produced boron minerals with a higher productivity per worker hour than those produced in other countries. It was reported that a leading indicator for demand for refined borates was a strong housing market. The demand for housing decreased at yearend 2006 and remained depressed through 2007. Borate-based wood preservatives have been shown to have a lower environmental impact than other wood-treatment liquids.

Exported U.S. borate materials competed with borax, boric acid, colemanite, and ulexite, primarily from Turkey, the leading producer of boron ore in the world. China, Eastern Europe, and India are favorable areas for increased borates consumption because of their growing economies. Significant strides in industrialization, urbanization, foreign investment, and free trade should increase the demand for borates over the next several years.

World Production, Reserves, and Reserve Base:[6]

	Production—All forms		Reserves[7]	Reserve base[7]
	2006	2007[e]		
United States	W	W	40,000	80,000
Argentina	650	650	2,000	9,000
Bolivia	60	60	NA	NA
Chile	460	460	NA	NA
China	145	150	25,000	47,000
Iran	3	3	1,000	1,000
Kazakhstan	30	30	NA	NA
Peru	10	10	4,000	22,000
Russia	400	400	40,000	100,000
Turkey	2,500	2,500	60,000	150,000
World total (rounded)	4,260	4,300	170,000	410,000

World Resources: Large domestic reserves of boron materials occur in California, chiefly in sediments and their contained brines. Extensive resources also occur in Turkey. 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 soaps, detergents, enamel, and insulation. In soaps, sodium and potassium salts of fatty acids are the usual cleaning and emulsion agents. Borates in detergents can be replaced by chlorine bleach or enzymes. Some enamels can use other glass-producing substances, such as phosphates. Insulation substitutes include cellulose, foams, and mineral wools.

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Minerals and compounds sold or used by producers; includes both actual mine production and marketable products.
[2]Less than ½ unit.
[3]Chemical Market Reporter 2003-05; ICIS Chemical Business (Americas) thereafter.
[4]Stocks data are not available and are assumed to be zero for net import reliance and apparent consumption calculations.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]Gross weight of ore in thousand metric tons.
[7]See Appendix C for definitions.

BROMINE

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

Domestic Production and Use: Bromine was recovered from underground brines by two companies in Arkansas. The total estimated value of bromine sold or used in the United States in 2007 was $470 million. Bromine was the leading mineral commodity, in terms of value, produced in Arkansas. The United States accounted for 42% of world bromine production.

Bromine is used in the manufacture of dyes, fire retardants, insect repellents, oilfield completion fluids, perfumes, pharmaceuticals, photographic chemicals, water-treatment chemicals, and other chemicals. Other products included intermediate chemicals for the manufacture of products and bromide solutions used alone or in combination with other chemicals.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production[1]	216	222	226	243	235
Imports for consumption, elemental bromine and compounds[2]	48	62	60	44	45
Exports, elemental bromine and compounds	8	9	10	12	10
Consumption, apparent[3]	256	274	277	275	270
Price, cents per kilogram, bulk, purified bromine	71.7	86.0	74.0	139.2	200.0
Employment, number	1,700	1,500	1,200	1,100	1,000
Net import reliance[4] as a percentage of apparent consumption	15	19	18	12	13

Recycling: Some bromide solutions were recycled to obtain elemental bromine and prevent the solutions from being disposed of as hazardous waste. This recycled bromine is not included in the virgin bromine production reported by the companies, but is included in data collected by the U.S. Census Bureau.

Import Sources (2003-06): Israel, 94%; United Kingdom, 2%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Ammonium, calcium, or zinc bromide	2827.59.2500	Free.
Bromides and bromide oxides	2827.59.5100	3.6% ad val.
Bromine	2801.30.2000	5.5% ad val.
Bromochloromethane	2903.49.1000	Free.
Decabromodiphenyl and octabromodiphenyl oxide	2909.30.0700	5.5% ad val.
Ethylene dibromide	2903.31.0000	5.4% ad val.
Hydrobromic acid	2811.19.3000	Free.
Methyl bromide	2903.90.1520	Free.
Potassium bromate	2829.90.0500	Free.
Potassium or sodium bromide	2827.51.0000	Free.
Sodium bromate	2829.90.2500	Free.
Tetrabromobisphenol A	2908.19.2500	5.5% ad val.

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

Government Stockpile: None.

Prepared by **Stephen M. Jasinski [(703) 648-7711, sjasinsk@usgs.gov, fax: (703) 648-7757]**

BROMINE

Events, Trends, and Issues: Israel and the United States were the leading producers of bromine in the world. Approximately 90% of Israel's production was for export, accounting for about 80% of international trade in bromine and bromine compounds to more than 100 countries.

Bromine and bromine compound prices increased in 2007, reflecting the rising market value of bromine and major increases in the costs of energy, raw materials, regulatory compliance, and transportation.

A bromine recovery facility in Michigan was closed at the end of 2006. The recovered bromine was used by a company in Arkansas to produce bromine chemicals. The company signed an agreement to buy elemental bromine from one of the two producers in Arkansas to ensure its supply or bromine.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	2006	2007[e]		
United States[1]	243	235	11,000	11,000
Azerbaijan	2	2	300	300
China	43	43	130	3,500
France	2	—	1,600	1,600
Germany	([6])	([6])	([7])	([7])
India	1.5	1.5	([8])	([8])
Israel	179	200	([9])	([9])
Italy	([6])	([6])	([8])	([8])
Japan	20	20	([10])	([10])
Jordan	50	50	([9])	([9])
Spain	([6])	([6])	1,400	1,400
Turkmenistan	([6])	([6])	700	700
Ukraine	3	3	400	400
World total (rounded)	545	556	Large	Large

World Resources: Resources of bromine are virtually unlimited. Bromine is found principally in seawater, salt lakes, and underground brines associated with oil. The Dead Sea, in the Middle East, 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 with other materials are used as fire retardants in plastics, such as those found in electronics.

[e]Estimated. — Zero.
[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.
[6]Less than ½ unit.
[7]From waste bitterns associated with potash production.
[8]From waste bitterns associated with solar salt.
[9]From the Dead Sea.
[10]From seawater.

CADMIUM

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

Domestic Production and Use: Two companies in the United States produced cadmium metal in 2007. One company, operating in Tennessee, recovered cadmium as a byproduct of zinc leaching from roasted sulfide concentrates. The other company, located in Pennsylvania, thermally recovered cadmium metal from spent nickel-cadmium (NiCd) batteries and other cadmium-bearing scrap. A third company located in Illinois, which historically recovered byproduct cadmium from zinc concentrates, shuttered in 2006 owing to recent mine closures and the increasing cash price of zinc concentrate. As a result of the closure, U.S. refinery production in 2007 was withheld in order to protect the company proprietary data of the remaining two operations. Based on the average New York dealer price, U.S. cadmium metal consumption was valued at about $3.62 million in 2007. Cadmium use in batteries amounted to an estimated 83% of apparent consumption. The remaining 17% was distributed as follows: pigments, 8%; coatings and plating, 7%; stabilizers for plastics, 1.2%; and nonferrous alloys, photovoltaic devices, and other, 0.8%.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production, refinery[1]	1,450	1,480	1,470	700	W
Imports for consumption, metal only	74	102	207	179	172
Imports for consumption, metal, alloys, scrap	112	263	288	180	174
Exports of metal, alloys, scrap	615	154	686	483	304
Shipments from Government stockpile excesses	146	—	—	—	—
Consumption of metal, apparent	1,020	1,840	699	561	441
Price, metal, average annual[2]					
Dollars per kilogram	1.31	1.20	3.30	2.98	8.21
Dollars per pound	0.59	0.55	1.50	1.35	3.72
Stocks, yearend, producer and distributor[3]	1,430	1,170	1,540	1,380	W
Net import reliance[4] as a percentage of apparent consumption	E	20	E	E	E

Recycling: Cadmium is recovered from spent consumer and industrial NiCd batteries, 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 (2003-06): Metal:[5] Australia, 41%; Canada, 20%; China, 10%; Peru, 9%; and other, 20%.

Tariff: Item	Number	Normal Trade Relations[6] 12-31-07
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.
Cadmium other	8107.90.0000	4.4% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: Most of the world's primary cadmium (approximately 50%) was produced in Asia and the Pacific—specifically China, Japan, and the Republic of Korea—followed by North America (20%), Central Eurasia (16%), and Europe (12.5%). Global primary cadmium production may increase in 2007 as the International Lead and Zinc Study Group forecast zinc concentrate production to increase by 9.4%. However, primary producers may opt to voluntarily cut back primary cadmium production. High zinc prices have recently allowed smelters to discard byproduct cadmium as hazardous waste rather than process it. Global secondary cadmium production accounts for approximately 19% of all refined cadmium production, and this percentage is expected to increase in the future.

Prepared by **Amy C. Tolcin [(703) 648-4940, atolcin@usgs.gov, fax: (703) 648-7757]**

CADMIUM

NiCd battery production was the leading end use of cadmium, accounting for approximately 83% of global cadmium consumption. 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. Approximately 85% of the global NiCd battery market was concentrated in Asia. Japan alone constituted 35% of global NiCd battery sales. However, the percentage share of NiCd batteries in the rechargeable battery market has been on the decline since the mid-1990s. In 1996, NiCd batteries accounted for 56% of the rechargeable battery market. By 2006, that percentage had decreased to 18%. Global sales of NiCd batteries also decreased during 2006 by approximately 16% from that of 2005. However, demand for cadmium may increase owing to several new market opportunities for NiCd batteries, particularly in industrial applications. NiCd batteries currently power approximately 80% of battery electric vehicles in circulation and are also used as a source of power in a limited number of hybrid electric vehicles.

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, Reserves, and Reserve Base:

	Refinery production		Reserves[7]	Reserve base[7]
	2006	2007[e]		
United States	700	W	43,000	67,000
Australia	400	390	66,000	260,000
Canada	1,710	2,100	23,000	84,000
China	3,000	3,400	99,000	280,000
Germany	640	640	—	8,000
India	450	500	21,000	49,000
Japan	2,290	2,100	—	—
Kazakhstan	2,000	2,000	41,000	89,000
Korea, Republic of	3,250	3,600	—	—
Mexico	1,400	1,600	21,000	39,000
Netherlands	570	570	—	—
Peru	420	420	54,000	87,000
Russia	1,100	1,210	12,000	37,000
Other countries	1,370	1,370	110,000	200,000
World total (rounded)	19,300	[8]19,900	490,000	1,200,000

World Resources: The bulk of the cadmium being recovered is associated with ores of sphalerite (ZnS). Estimated world identified resources of cadmium were about 6 million tons, based on identified zinc resources of 1.9 billion tons containing about 0.3% cadmium. 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. W Withheld to avoid disclosing company proprietary data. — Zero.

[1]Cadmium metal and oxide produced as a byproduct of lead-zinc refining plus metal from recycling. Refinery production was revised based on new data from company surveys.

[2]Average New York dealer price for 99.95% purity in 5-short-ton lots. Source: Platts Metals Week.

[3]Yearend stocks were revised based on new data from company surveys.

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

[5]Imports only 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.

[8]Excludes U.S. refinery production.

CEMENT

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2007, about 91 million tons of portland cement and about 4 million tons of masonry cement were produced at 113 plants in 37 States; total cement production capacity was about 127 million tons. Cement also was produced at two plants in Puerto Rico. Sales prices were similar or slightly higher than those in 2006 and implied a value of cement production, excluding that of Puerto Rico, of about $9.7 billion. The value of total sales, including imported cement, was about $11.8 billion. Most of the cement was used to make concrete, worth at least $60 billion. About 75% of cement sales went to ready-mixed concrete producers, 13% to concrete product manufacturers, 6% to contractors (mainly road paving), 3% to building materials dealers, and 3% to other users. Lower overall sales volumes, as in the second half of 2006, reflected declines in the housing market. The bulk of the decline in demand in 2007 was at the expense of import volumes, which dropped sharply. California, Texas, Pennsylvania, Florida, Alabama, and Michigan, in descending order, were the six leading cement-producing States and accounted for about 48% of U.S. production.

Salient Statistics—United States:[1]	**2003**	**2004**	**2005**	**2006**	**2007**[e]
Production:					
Portland and masonry cement[2]	92,843	97,434	99,319	98,167	95,500
Clinker	81,882	86,658	87,405	88,555	87,200
Shipments to final customers, includes exports	112,929	120,731	127,361	127,898	116,000
Imports of hydraulic cement for consumption	21,015	25,396	30,403	32,141	21,300
Imports of clinker for consumption	1,808	1,630	2,858	3,425	900
Exports of hydraulic cement and clinker	837	749	766	1,510	1,850
Consumption, apparent[3]	114,090	121,980	128,280	126,810	115,000
Price, average mill value, dollars per ton	75.00	79.50	91.00	101.50	102.00
Stocks, cement, yearend	6,610	6,710	7,390	9,380	8,900
Employment, mine and mill, number[e]	16,500	16,200	16,300	16,300	16,000
Net import reliance[4] as a percentage of apparent consumption	20	21	23	23	17

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 recycling of some concrete for use as aggregate.

Import Sources (2003-06):[5] Canada, 18%; China, 16%; Thailand, 11%; Republic of Korea, 7%; and other, 48%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-07**
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 during the year was a major decline in residential construction related to the combined effect of the severe decline in the housing market (especially in speculative purchasing of homes), escalating mortgage rates on subprime loans and related increases in foreclosures, and tighter credit overall. Nonresidential buildings and public sector construction were less affected. Spending on transportation infrastructure remained strong, funded in part by the $244.1 billion SAFETEA-LU bill. Notwithstanding the virtual elimination in early 2006 of antidumping duties on imported Mexican cement, imports from that country fell in 2007, although to a lesser degree than from most other countries.

A number of environmental issues, especially carbon dioxide emissions, affect the cement industry. 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 noncarbonate sources of calcium oxide in the kiln raw materials, and partial substitution of supplementary

Prepared by **Hendrik G. van Oss [(703) 648-7712, hvanoss@usgs.gov, fax: (703) 648-7757]**

cementitious materials (SCM), such as pozzolans, for portland cement in the finished cement products and in concrete. The United States lags behind many foreign countries in the use of SCM. Because SCM do not require the energy-intensive clinker manufacturing (kiln) phase of cement production, their use, or the use of inert additives or extenders, reduces the unit monetary and environmental costs of the cement component of concrete. A recent revision of the major portland cement standard ASTM-C150 allows for the incorporation of up to 5% ground limestone as an inert extender, but has yet to lead to widespread adoption of this practice, mainly because the limestone addition has yet to be adopted into the otherwise similar AASHTO standard that governs most cement and concrete specifications for public transportation sector construction projects.

Fossil fuel cost increases were of continued concern to the cement industry; even in times of cement shortages, the industry has found it difficult to fully pass on energy cost increases to customers. Some cement companies burn waste materials in their kilns as a low-cost substitute for fossil fuels. Cement kilns can be an effective and benign way of destroying such wastes. The viability of the practice and the type of waste burned hinge on current and future environmental regulations and their associated costs. The trend appears to be toward increased use of waste fuels.

World Production and Capacity:

	Cement production		Yearend clinker capacity[e]	
	2006	**2007[e]**	**2006**	**2007**
United States (includes Puerto Rico)	99,700	96,400	101,000	102,000
Brazil	39,500	40,000	45,000	45,000
China	1,200,000	1,300,000	1,000,000	1,100,000
Egypt	[e]29,000	29,000	35,000	35,000
France	[e]21,000	21,000	22,000	22,000
Germany	33,400	34,000	31,000	31,000
India	[e]155,000	160,000	150,000	160,000
Indonesia	[e]34,000	35,000	42,000	42,000
Iran	[e]33,000	34,000	35,000	35,000
Italy	43,200	44,000	46,000	46,000
Japan	69,900	70,000	70,000	70,000
Korea, Republic of	55,000	55,000	62,000	62,000
Mexico	40,600	41,000	40,000	40,000
Russia	54,700	59,000	65,000	65,000
Saudi Arabia	27,100	28,000	29,000	29,000
Spain	[e]54,000	50,000	42,000	42,000
Thailand	39,400	40,000	50,000	50,000
Turkey	47,500	48,000	41,000	43,000
Vietnam	32,000	32,000	20,000	20,000
Other countries (rounded)	[e]442,000	390,000	470,000	470,000
World total (rounded)	2,550,000	2,600,000	2,400,000	2,500,000

World Resources: Although individual company 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 some 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 – changes in stocks.
[4]Defined as imports (revised to include clinker) – exports + adjustments for Government (nil) and industry stock changes.
[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, may be found in zoned pegmatites worldwide. There are occurrences of cesium-bearing pollucite in pegmatites in Maine and South Dakota; however, these occurrences are not mined. Canada is the leading producer and supplier of pollucite concentrate, which is imported for processing by one corporation in the United States. Cesium is an important component of cesium formate, a specialty, high-density drilling fluid used for completing high-temperature, high-pressure oil and gas wells in Argentina and in the North Sea. Cesium formate is especially useful for this application because of its density; it has a specific gravity of 2.3, which is more than twice the specific gravity of water. Vibrations of cesium are used to maintain the accuracy of the atomic clocks at the U.S. Naval Observatory, Washington, DC. The master clock there provides a reference time, available to the public at (202) 762-1401. Atomic clocks that use cesium are accurate to a few hundred trillionths of a second and help synchronize the positions of the jets that track returning U.S. space shuttles. Global positioning satellites, Internet and cell phone transmissions, and missile guidance systems are all dependent on the accuracy of cesium atomic clocks. Other applications of cesium include DNA separation techniques, infrared detectors, night vision devices, photoelectric cells, and traffic controls. Cesium-131 and cesium-137 are reactor-produced isotopes of cesium. These may be used, respectively, to treat prostate cancer or as brachytherapy where the radioactive source is placed within the cancerous area. Cesium-137 is also widely used in industrial gauges, mining and geophysical instruments, and for sterilization of food, sewage, and surgical equipment.

Salient Statistics—United States: Production, consumption, import, and export data for cesium have not been available since the late 1980s. U.S. consumption and world mine production are unavailable. There is no trading of cesium, and therefore no market price is available. Consumption of cesium in the United States is small and is estimated to amount to only a few thousand kilograms per year. In 2007, one company offered 1-gram ampoules of 99.8% (metals basis) cesium for $42.50 each and 99.98% (metals basis) cesium for $55.90. The price for 50 grams of 99.8% (metals basis) cesium was $558.00, and 100 grams of 99.98% (metals basis) cesium was priced at $1,534.00. These prices are unchanged from those of 2006.

Recycling: Cesium formate fluids are rented to oil and gas clients, and after completion of the well, the used cesium formate fluids are 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 (2003-06): 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 12-31-07
Alkali metals, other	2805.19.9000	5.5% ad val.
Chlorides, other	2827.39.5000	3.7% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **William E. Brooks [(703) 648-7791, wbrooks@usgs.gov, fax: (703) 648-7757]**

CESIUM

Events, Trends, and Issues: Domestic cesium occurrences will remain uneconomic unless there is a change in the market, such as new or increased end uses. The United States is reliant on imports of pollucite concentrate from Canada for its cesium supply. Cost and reactivity of the metal point to continued limited applications. There are no known human health issues associated with cesium, and its use has minimal environmental impact. Nonradioactive cesium is mainly used as a component of specialty, high-density drilling muds that are used for oil and gas exploration. Reactor-produced cesium-131 and cesium-137, respectively, have applications in cancer treatment and industrial applications, such as sterilization of food, sewage, and surgical equipment. 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."

World Mine Production, Reserves, and Reserve Base: Pollucite is a hydrated aluminosilicate mineral that may form in association with lithium-rich, lepidolite-bearing or petalite-bearing zoned pegmatites, which are a type of granite with exceptionally large crystals. Cesium reserves and reserve base are therefore estimated based on the occurrence of pollucite, which is mined as a byproduct with the lithium mineral lepidolite. Concentrates of pollucite may contain about 20% cesium by weight; however, cesium resource and mine production data are either limited or not available. The deposit at Lac du Bonnet, Canada, contains approximately 300,000 tons of pollucite that grades 24% Cs_2O and also contains tantalum. The next largest occurrence that may be potentially economic is in Zimbabwe.

	Reserves[1]	Reserve base[1]
Canada	70,000,000	73,000,000
Namibia	—	9,000,000
Zimbabwe	—	23,000,000
Other countries	NA	NA
World total (rounded)	70,000,000	110,000,000

World Resources: 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.

Substitutes: Because of similar physical properties, proximity on the Periodic Table, and similar atomic radii, cesium and rubidium may be used interchangeably in many applications.

NA Not available. — Zero.
[1]See Appendix C for definitions.

CHROMIUM

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

Domestic Production and Use: In 2007, the United States consumed about 11% 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 was about $408 million as measured by the value of net imports excluding stainless steel.

Salient Statistics—United States:[1]	2003	2004	2005	2006	2007[e]
Production:					
Primary	—	—	—	W	W
Secondary	250	233	255	235	240
Imports for consumption	441	489	503	520	510
Exports	188	171	220	212	210
Government stockpile releases	83	94	91	103	90
Consumption:					
Reported (includes scrap)	424	444	431	437	440
Apparent[2] (includes scrap)	585	647	629	645	630
Unit value, average annual import (dollars per metric ton):					
Chromite ore (gross weight)	54	114	140	141	175
Ferrochromium (chromium content)	835	1,322	1,425	1,290	1,555
Chromium metal (gross weight)	5,271	5,823	8,007	8,181	7,859
Stocks, yearend, held by U.S consumers	10	8	9	10	10
Net import reliance[3] as a percentage of apparent consumption	57	64	59	64	62

Recycling: In 2007, recycled chromium (that contained in reported stainless steel scrap receipts adjusted for stainless steel and chromium metal scrap trade) accounted for 38% of apparent consumption.

Import Sources (2003-06): Chromium contained in chromite ore and chromium ferroalloys and metal: South Africa, 34%; Kazakhstan, 18%; Russia, 7%; Zimbabwe, 6%; and other, 35%.

Tariff:[4] Item	Number	Normal Trade Relations 12-31-07
Ore and concentrate	2610.00.0000	Free.
Ferrochromium:		
Carbon more than 4%	7202.41.0000	1.9% ad val.
Carbon more than 3%	7202.49.1000	1.9% ad val.
Other:		
Carbon more than 0.5%	7202.49.5010	3.1% ad val.
Other	7202.49.5090	3.1% ad val.
Ferrochromium silicon	7202.50.0000	10% ad val.
Chromium metal:		
Unwrought powder	8112.21.0000	3% ad val.
Waste and scrap	8112.22.0000	Free.
Other	8112.29.0000	3% ad val.

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

Government Stockpile: In fiscal year (FY) 2007, which ended on September 30, 2007, the Defense Logistics Agency, Defense National Stockpile Center (DNSC), disposed of 152,000 tons of high-carbon ferrochromium, 72,500 tons of low-carbon ferrochromium, and 139 tons of chromium metal. Metallurgical-grade chromite ore stocks were exhausted in FY 2002; chemical- and refractory-grade chromite ore stocks were exhausted in FY 2004; ferrochromium silicon stocks were exhausted in FY 2002. The DNSC announced maximum disposal limits for FY 2008 of about 45,000 tons of refractory-grade chromite ore, 136,000 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, and chromium metal in FY 2013.

Prepared by **John F. Papp [(703) 648-4963, jpapp@usgs.gov, fax: (703) 648-7757]**

CHROMIUM

Stockpile Status—9-30-07[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007	Average chromium content
Chromite ore:						
Chemical-grade	—	—	—	4.54	—	28.6%
Refractory-grade	—	—	—	84.4	—	[e]23.9%
Ferrochromium:						
High-carbon	113	—	265	[6]136	152	71.4%
Low-carbon	61	—	134	([6])	72.5	71.4%
Chromium metal	5.15	—	5.28	0.907	0.139	100%

Events, Trends, and Issues: The price of ferrochromium reached historically high levels in 2007. China's role as a chromium consumer grew along with its stainless steel production industry. China's importance as a consumer of raw materials increased owing to its strong economic growth and the expansion of its stainless steel production. China's growth was generally recognized as the leading cause of increased chromium demand. Chinese stainless steel production exceeded that of the United States beginning in 2004 and by 2007 was 142% greater than that of the United States.

World Mine Production, Reserves, and Reserve Base:

	Mine production[7] 2006	Mine production[7] 2007[e]	Reserves[8] (shipping grade)[9]	Reserve base[8] (shipping grade)[9]
United States	W	W	110	120
India	3,600	3,600	25,000	57,000
Kazakhstan	3,600	3,600	290,000	470,000
South Africa	7,418	7,500	160,000	270,000
Other countries	4,970	5,000	NA	NA
World total (rounded)	19,600	20,000	NA	NA

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 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. Revisions (to 2003-06 production, trade, and apparent consumption) principally based on the reevaluation of import and export data by adding stainless steel mill products, which account for an increasing amount of chromium introduced to the U.S. economy, and on accounting for the role of stainless steel scrap trade in secondary production.

[2]Calculated consumption of chromium; equal to production (from mines and scrap) + imports – exports + stock adjustments.

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

[4]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.

[5]See Appendix B for definitions.

[6]Disposal plan for ferrochromium without distinction between high-carbon and low-carbon ferrochromium; total included in high-carbon.

[7]Mine production units are thousand metric tons, gross weight, of marketable chromite ore.

[8]See Appendix C for definitions.

[9]Reserves and reserve base 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 2007, clay and shale production was reported in 42 States. About 200 companies operated approximately 800 clay pits or quarries. The leading 20 firms supplied about 50% of the tonnage and 75% of the value for all types of clay sold or used in the United States. In 2007, domestic producers estimated that sales or use will be 40.6 million tons valued at $1.80 billion. Major uses for specific clays were estimated to be as follows: ball clay—41% floor and wall tile, 31% sanitaryware, and 28% other uses; bentonite—26% absorbents, 23% drilling mud, 19% foundry sand bond, 15% iron ore pelletizing, and 17% other uses; common clay—57% brick, 18% cement, 17% lightweight aggregate, and 8% other uses; fire clay—72% heavy clay products, 22% refractory products, and 6% other uses; fuller's earth—70% absorbent uses and 30% other uses; and kaolin—62% paper and 38% other uses.

Salient Statistics—United States:[1]	**2003**	**2004**	**2005**	**2006**	**2007**[e]
Production, mine:					
Ball clay	1,310	1,220	1,210	1,190	1,110
Bentonite	3,770	4,550	4,710	4,940	5,070
Common clay	23,100	24,600	24,300	24,200	23,600
Fire clay	345	307	353	848	830
Fuller's earth	3,610	3,260	2,730	2,540	2,670
Kaolin	7,680	7,760	7,800	7,470	7,330
Total[2]	39,800	41,700	41,200	41,200	40,600
Imports for consumption:					
Artificially activated clay and earth	21	25	17	21	15
Kaolin	224	205	262	303	225
Other	34	21	23	22	25
Total[2]	279	251	301	346	265
Exports:					
Ball clay	139	107	141	140	95
Bentonite	721	915	847	1,270	1,460
Fire clay[3]	285	332	368	348	430
Fuller's earth	48	49	55	69	110
Kaolin	3,520	3,640	3,580	3,540	3,400
Clays, not elsewhere classified	416	586	634	607	550
Total[2]	5,130	5,630	5,620	5,980	6,050
Consumption, apparent	34,900	36,300	35,900	35,600	34,800
Price, average, dollars per ton:					
Ball clay	43	44	44	45	48
Bentonite	44	45	46	47	48
Common clay	6	7	7	10	10
Fire clay	28	28	30	22	22
Fuller's earth	96	101	100	96	99
Kaolin	122	121	110	131	139
Employment, number:[e]					
Mine	1,320	1,250	1,270	1,250	1,220
Mill	5,000	4,980	5,000	5,050	5,000
Net import reliance[4] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2003-06): Brazil, 79%; Mexico, 5%; United Kingdom, 5%; Canada, 3%; and other, 8%.

Prepared by **Robert L. Virta [(703) 648-7726, rvirta@usgs.gov, fax: (703) 648-7975]**

CLAYS

Tariff: Item	Number	Normal Trade Relations 12-31-07
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); and clay used for alumina and aluminum compounds, 22% (Domestic).

Government Stockpile: None.

Events, Trends, and Issues: Total sales or use of clays declined as the U.S. economy slowed and housing starts declined in 2007. However, bentonite sales increased, helped by a strong drilling mud market. Fuller's earth sales rebounded slightly after a large decline in absorbent sales in 2006. A declining U.S. dollar probably contributed to the slight increase in exports and a decline in imports in 2007. The major sources of imported clay were Brazil (kaolin), Greece (bentonite), Mexico (activated clay), and the United Kingdom (kaolin). Major markets for exported clays, by descending order of tonnage, were Canada (bentonite and kaolin), Japan (bentonite and kaolin), Mexico (kaolin), Finland (kaolin), the Netherlands (bentonite and kaolin), China (kaolin), and Taiwan (kaolin).

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

	Mine production					
	Bentonite		Fuller's earth		Kaolin	
	2006	2007[e]	2006	2007[e]	2006	2007[e]
United States (sales)	4,940	5,070	2,540	2,670	7,470	7,330
Brazil (beneficiated)	221	240	—	—	2,410	2,500
Commonwealth of Independent States (crude)	750	750	—	—	6,020	6,000
Czech Republic (crude)	220	220	—	—	3,770	3,700
Germany (sales)	350	360	—	—	3,770	3,800
Greece (crude)	950	1,100	—	—	60	50
Italy (kaolinitic earth)	470	470	30	30	470	470
Korea, Republic of (crude)	—	—	—	—	2,400	2,400
Mexico	450	450	110	110	875	900
Spain	110	110	870	870	450	460
Turkey	950	1,000	—	—	580	450
United Kingdom	—	—	140	70	2,500	2,100
Other countries	2,290	1,990	290	265	6,730	7,630
World total (rounded)	11,700	11,800	3,980	4,020	37,500	37,800

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.

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 2007; 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. One of two U.S. producers of extra-fine cobalt powder ceased operations in late 2006. The remaining U.S. powder producer used cemented carbide scrap as feed. Seven companies were known to produce cobalt compounds. Sixty-five industrial consumers were surveyed on a monthly or annual basis. Data reported by these consumers indicate that 45% of the cobalt consumed in the United States was for use in superalloys, which are used mainly in aircraft gas turbine engines; 9% was for use in cemented carbides for cutting and wear-resistant applications; 14%, for various other metallic applications; and 32%, for a variety of chemical applications. The total estimated value of cobalt consumed in 2007 was $600 million.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production:					
Mine	—	—	—	—	—
Secondary	2,130	2,300	2,030	2,010	2,000
Imports for consumption	8,080	8,720	11,100	11,600	9,700
Exports	2,710	2,500	2,440	2,850	3,100
Shipments from Government stockpile excesses	2,380	1,630	1,110	260	600
Consumption:					
Reported (includes secondary)	8,030	8,990	9,150	9,270	9,300
Apparent[1] (includes secondary)	10,000	9,950	11,800	11,100	9,200
Price, average annual spot for cathodes, dollars per pound	10.60	23.93	15.96	17.22	30.20
Stocks, industry, yearend	1,010	1,210	1,190	1,150	1,150
Net import reliance[2] as a percentage of apparent consumption	79	77	83	82	78

Recycling: In 2007, cobalt contained in purchased scrap represented an estimated 22% of cobalt reported consumption.

Import Sources (2003-06): Cobalt contained in metal, oxide, and salts: Norway, 21%; Russia, 19%; Finland, 10%; China, 9%; and other, 41%.

Tariff: **Item**	**Number**	**Normal Trade Relations[3] 12-31-07**
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.
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.
Cobalt ores and concentrates	2605.00.0000	Free.

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

Government Stockpile: Sales of National Defense Stockpile cobalt began in March 1993. The disposal limit for cobalt in the fiscal year 2008 Annual Materials Plan was unchanged from that of fiscal year 2007.

Stockpile Status—9-30-07[4]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2007**	**Disposals FY 2007**
Cobalt	989	26	989	1,590	388

Prepared by **Kim B. Shedd [(703) 648-4974, kshedd@usgs.gov, fax: (703) 648-7757]**

COBALT

Events, Trends, and Issues: The worldwide availability of refined cobalt during the first half of 2007 was nearly equal to that of the first half of 2006. World demand for cobalt reportedly was slightly higher during the first half of 2007 than that of the first half of 2006. By late November 2007, the price of cobalt cathode increased to nearly $40 per pound. Work progressed on numerous brownfield and greenfield projects that will add to future world cobalt supply. In 2008, new cobalt production is expected from Australia, Congo (Kinshasa), Finland, and Zambia.

In recent years, China has become the world's leading producer of refined cobalt, and much of its production has been from cobalt-rich ores imported from Congo (Kinshasa). In 2006, the Government of Congo (Kinshasa) began to enforce a ban on exports of unprocessed cobalt. As a result, Chinese imports of ores declined and its imports of cobalt intermediates from Congo (Kinshasa) increased. In 2007, estimated cobalt mine production from Congo (Kinshasa) decreased for the first time in more than a decade. The Chinese cobalt industry was expected to develop more domestic and foreign sources of cobalt supply, to invest in African cobalt projects, to increase the recycling of cobalt scrap, to continue to shift its consumption towards more downstream materials, and to consolidate into fewer larger companies. U.S. imports of cobalt from China increased steadily over the 2003-06 time period.

Health, safety, and environmental issues are becoming increasingly significant with respect to such metals as cobalt. The European Commission's new chemicals policy became effective June 1, 2007. This legislation affects suppliers of cobalt materials to the European market by requiring them to collect and submit risk assessment data on each material produced in or imported into the European Union.

World Mine Production, Reserves, and Reserve Base: U.S. reserves were estimated based on reports from two companies.

	Mine production		Reserves[5]	Reserve base[5]
	2006	2007[e]		
United States	—	—	33,000	860,000
Australia	7,400	7,500	1,400,000	1,700,000
Brazil	1,200	1,200	29,000	40,000
Canada	7,000	8,000	120,000	350,000
China	2,300	2,300	72,000	470,000
Congo (Kinshasa)	28,000	22,500	3,400,000	4,700,000
Cuba	3,800	4,000	1,000,000	1,800,000
Morocco	1,500	1,500	20,000	NA
New Caledonia[6]	1,900	2,000	230,000	860,000
Russia	5,100	5,000	250,000	350,000
Zambia	8,000	7,000	270,000	680,000
Other countries	1,300	1,300	130,000	1,100,000
World total (rounded)	67,500	62,300	7,000,000	13,000,000

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, millions of tons of hypothetical and speculative cobalt resources exist in manganese nodules and crusts on the ocean floor.

Substitutes: In most 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; iron-cobalt-nickel, nickel, cermets, or ceramics in cutting and wear-resistant materials; nickel-base alloys or ceramics in jet engines; nickel in petroleum catalysts; rhodium in hydroformylation catalysts; cobalt-manganese-nickel in lithium-ion batteries; and cerium, iron, lead, manganese, or vanadium in paints.

[e]Estimated. NA Not available. — 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.
[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 2007 declined nominally to 1.19 million tons, but its value rose slightly to about $8.8 billion. The principal mining States, in descending order of production—Arizona, Utah, New Mexico, Nevada, and Montana—accounted for 99% of domestic production; copper was also recovered at mines in two other States. Although copper was recovered at 26 mines operating in the United States, 17 mines accounted for about 99% of production. Three primary smelters, 4 electrolytic and 3 fire refineries, and 14 solvent extraction-electrowinning facilities operated during the year. Refined copper and direct-melt scrap were consumed at about 30 brass mills; 16 rod mills; and 500 foundries, chemical plants, and miscellaneous consumers. Copper and copper alloy products were used in building construction, 51%; electric and electronic products, 19%; transportation equipment, 10%; consumer and general products, 11%; and industrial machinery and equipment, 9%.[1]

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production:					
Mine	1,120	1,160	1,140	1,200	1,190
Refinery:					
Primary	1,250	1,260	1,210	1,210	1,300
Secondary	53	51	47	45	50
Copper from all old scrap	207	191	182	141	150
Imports for consumption:					
Ores and concentrates	27	23	([2])	([2])	([2])
Refined	882	807	1,000	1,070	830
Unmanufactured	1,140	1,060	1,230	1,320	1,010
General imports, refined	687	704	977	1,070	830
Exports:					
Ores and concentrates	9	24	137	108	80
Refined	93	118	40	106	55
Unmanufactured	703	789	815	990	800
Consumption:					
Reported, refined	2,290	2,410	2,270	2,130	2,120
Apparent, unmanufactured[3]	2,430	2,550	2,400	2,180	2,300
Price, average, cents per pound:					
Domestic producer, cathode	85.2	133.9	173.5	314.8	335
London Metal Exchange, high-grade	80.7	130.0	166.8	304.9	329
Stocks, yearend, refined, held by U.S. producers, consumers, and metal exchanges	656	134	66	196	120
Employment, mine and mill, thousands[e]	6.8	7.0	7.0	7.2	7.3
Net import reliance[4] as a percentage of apparent consumption	40	43	42	38	37

Recycling: Old scrap, converted to refined metal and alloys, provided 150,000 tons of copper, equivalent to 7% of apparent consumption. Purchased new scrap, derived from fabricating operations, yielded 800,000 tons of contained copper; about 88% 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 75%; miscellaneous manufacturers, foundries, and chemical plants, 11%; ingot makers, 9%; and copper smelters and refiners, 5%. Copper in all old and new, refined or remelted scrap contributed about 32% of the U.S. copper supply.

Import Sources (2003-06): Unmanufactured: Chile, 39%; Canada, 32%; Peru, 15%; Mexico, 6%; and other, 8%. Refined copper accounted for 79% of unwrought copper imports.

Tariff: Item	Number	Normal Trade Relations[5] 12-31-07
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.

Prepared by **Daniel L. Edelstein [(703) 648-4978, dedelste@usgs.gov, fax: (703) 648-7757]**

COPPER

Events, Trends, and Issues: Copper prices, which had risen to record-high levels of more than $4.00 per pound at mid-year 2006, fell below $3.00 per pound during the first quarter of 2007, but rose sharply again in April, with the producer price averaging $3.53 per pound during the second and third quarters of the year. A decline in commodity exchange inventories during the second quarter and a dramatic rise in imports of refined copper by China, the world's leading copper consumer, gave rise to concern over supply adequacy. Year-on-year apparent consumption of copper in China for the first 6 months of 2007 (excluding changes in unreported Government and industry stocks) rose by 37%. Labor strikes in Canada, Chile, Mexico, and Peru, and lower than anticipated production in Africa, Indonesia, and the United States, led to lower copper supply. According to the International Copper Study Group,[6] the production deficit during the first half of the year would reverse, and a modest production surplus was anticipated by yearend.

In the United States, mine production declined slightly owing to lower ore grades at a major mine, and continued labor and equipment shortages. In March, Freeport-McMoran Copper & Gold Inc. (New Orleans, LA) acquired Phelps Dodge Corp.[7] Production by domestic brass mills was lower during the first half of the year and was anticipated to decline sharply during the fourth quarter owing to substitution and a weak housing market. Despite lower demand, domestic production of wire rod declined only slightly during the first half of the year as the weak dollar led to a sharp reduction in imports. One copper tube producer announced it was closing one of its casting facilities, and ownership changes were announced at a major brass mill and wire and cable manufacturer. In addition to a major new mine-for-leach project in Arizona due onstream in 2008, several companies announced progress toward the startup of new projects in Arizona, Minnesota, and Montana that would add 240,000 tons per year of new mine capacity by 2009.

World Mine Production, Reserves, and Reserve Base: Official reserves reported by Poland include properties being considered for future development.

	Mine production		Reserves[8]	Reserve base[8]
	2006	2007[e]		
United States	1,200	1,190	35,000	70,000
Australia	859	860	24,000	43,000
Canada	607	585	9,000	20,000
Chile	5,360	5,700	150,000	360,000
China	890	920	26,000	63,000
Indonesia	816	780	35,000	38,000
Kazakhstan	457	460	14,000	20,000
Mexico	338	400	30,000	40,000
Peru	1,049	1,200	30,000	60,000
Poland	512	470	30,000	48,000
Russia	725	730	20,000	30,000
Zambia	476	530	19,000	35,000
Other countries	1,835	1,800	65,000	110,000
World total (rounded)	15,100	15,600	490,000	940,000

World Resources: A recent assessment of U.S. copper resources indicated 550 million tons of copper in identified (260 million tons) and undiscovered resources (290 million tons).[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 some 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 2006 by the Copper Development Association, Inc., 2007.
[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, 2007, Forecast 2007-2008: Lisbon, Portugal, International Copper Study Group press release, October 2, 1 p.
[7]Freeport-McMoRan Copper & Gold Inc., 2007, Freeport-McMoRan Copper & Gold Inc. completes acquisition of Phelps Dodge Corp.: New Orleans, LA, Freeport-McMoRan Copper & Gold Inc. press release, March 19, 1 p.
[8]See Appendix C for definitions.
[9]U.S. Geological Survey National Mineral Resource Assessment Team, 2000, 1998 assessment of undiscovered deposits of gold, silver, copper, lead, and zinc in the United States: U.S. Geological Survey Circular 1178, 21 p.

DIAMOND (INDUSTRIAL)

(Data in million carats unless otherwise noted)

Domestic Production and Use: In 2007, domestic production of industrial diamond was estimated to be approximately 260 million carats, and the United States remained the world's leading market. All domestic output was synthetic grit and powder. Two firms, one in Pennsylvania and the other in Ohio, accounted for all of the production. Nine firms produced polycrystalline diamond from diamond powder. Four 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 99% 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:	**2003**	**2004**	**2005**	**2006**	**2007**[e]
Bort, grit, and dust and powder; natural and synthetic:					
Production:					
Manufactured diamond[e]	236	252	256	258	260
Secondary	4.7	4.6	4.6	34.2	34.3
Imports for consumption	250	240	284	371	423
Exports[1]	74	86	92	99	104
Sales from Government stockpile excesses	—	—	—	—	—
Consumption, apparent	417	411	453	564	613
Price, value of imports, dollars per carat	0.26	0.25	0.27	0.22	0.19
Net import reliance[2] as a percentage of apparent consumption	42	38	42	48	52
Stones, natural:					
Production:					
Mine	—	—	—	—	—
Secondary	([3])	([3])	0.53	0.56	0.43
Imports for consumption[4]	1.8	1.8	2.1	2.2	3.1
Exports[1]	([3])	0.5	([3])	1.6	—
Sales from Government stockpile excesses	0.4	0.4	—	0.1	([3])
Consumption, apparent	2.1	2.1	2.2	1.3	3.5
Price, value of imports, dollars per carat	3.09	7.77	13.91	12.61	10.83
Net import reliance[2] as a percentage of apparent consumption	91	80	77	57	88

Recycling: In 2007, the amount of diamond bort, grit, and dust and powder recycled was estimated to be 34.3 million carats. Lower prices of newly produced industrial diamond appear to be reducing the number and scale of diamond stone recycling operations. In 2007, it was estimated that 425,000 carats of diamond stone were recycled.

Import Sources (2003-06): Bort, grit, and dust and powder; natural and synthetic: China, 42%; Ireland, 29%; Russia, 7%; Ukraine, 7%; and other, 15%. Stones, primarily natural: Botswana, 23%; Ireland, 22%; Namibia, 10%; South Africa, 10%; and other, 35%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-07**
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).

Prepared by **Donald W. Olson [(703) 648-7721, dolson@usgs.gov, fax: (703) 648-7975]**

DIAMOND (INDUSTRIAL)

Government Stockpile:

Stockpile Status—9-30-07[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Industrial stones	0.473	—	0.473	0.473	0.036

Events, Trends, and Issues: The United States will continue to be the world's leading market for industrial diamond into the next decade and will remain a significant producer and exporter of industrial diamond as well. Increase in U.S. demand for industrial diamond is likely to continue in the construction sector as the United States builds and repairs the Nation's highway system. Industrial diamond coats the cutting edge of saws used to cut cement in highway construction and repair work. One U.S. company has developed a chemical vapor deposition (CVD) method of growing nearly 100%-pure diamond. One research group has developed a CVD method which is even faster and uses microwave plasma technology. The greatest potential for CVD diamond will be in computing, where it will be able to function as a semiconductor at much higher speeds and temperatures than silicon.

World demand for diamond grit and powder will continue growing. 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 increasing.

World Mine Production, Reserves, and Reserve Base:[6]

	Mine production		Reserves[7]	Reserve base[7]
	2006	2007[e]		
United States	—	—	NA	NA
Australia	22	16	90	230
Botswana	8	8	130	230
China	1	1	10	20
Congo (Kinshasa)	22	23	150	350
Russia	15	15	40	65
South Africa	9	9	70	150
Other countries	3	3	85	210
World total (rounded)	80	75	580	1,300

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]Less than ½ unit.
[4]May include synthetic miners' diamond.
[5]See Appendix B for definitions.
[6]Natural industrial diamond only. Note, however, that synthetic diamond production far exceeds natural industrial diamond output. Worldwide production of manufactured industrial diamond totaled at least 568 million carats in 2007; the leading producers included Ireland, Japan, Russia, South Africa, and the United States.
[7]See Appendix C for definitions.

DIATOMITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2007, domestic production of diatomite was estimated at 830,000 tons with an estimated processed value of $183 million, f.o.b. plant. Production was from 7 diatomite-producing companies with 11 mining areas and 9 processing facilities in California, Nevada, Oregon, and Washington. Estimated end uses of diatomite were filter aids, 60%; ingredients in cement, 20%,fillers, 10%; absorbents, 5%; and other (mostly cement manufacture and thermal insulation), 5%. The unit value of diatomite varied widely in 2007 from less than $3.00 per ton for cement manufacture to over $1,000 per ton for some limited market specialty uses, such as art supplies and cosmetics. The average unit value for filter-grade diatomite was $265 per ton.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production[1]	599	620	653	799	830
Imports for consumption	([2])	1	4	4	4
Exports	136	143	142	150	175
Consumption, apparent	463	478	507	653	659
Price, average value, dollars per ton, f.o.b. plant	255	258	274	220	220
Stocks, producer, year end[e]	36	36	40	40	40
Employment, mine and plant, number[e]	1,000	1,000	1,000	1,020	1,020
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: None.

Import Sources (2003-06): Mexico, 35%; France, 34%; Italy, 12%; Germany, 11%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Siliceous fossil meals, including diatomite	2512.00.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Thomas P. Dolley [(703) 648-7710, tdolley@usgs.gov, fax: (703) 648-7975]**

DIATOMITE

Events, Trends, and Issues: The amount of domestically produced diatomite sold or used in 2007 increased by about 4% compared with that of 2006. 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 (D.E.). Domestically, production of diatomite used as an ingredient for 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 an insecticide that is nontoxic to humans.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2006	2007[e]		
United States[1]	799	830	250,000	500,000
Chile	30	27	NA	NA
China	420	420	110,000	410,000
Commonwealth of Independent States	80	80	NA	13,000
Costa Rica	26	26	NA	NA
Czech Republic	40	40	4,500	4,800
Denmark[5] (processed)	235	240	NA	NA
France	75	75	NA	2,000
Germany	54	55	NA	NA
Iceland	28	28	NA	NA
Italy	25	25	NA	NA
Japan	130	130	NA	NA
Mexico	60	60	NA	2,000
Peru	35	35	2,000	5,000
Spain	35	35	NA	NA
Other countries	88	88	550,000	NA
World total (rounded)	2,160	2,200	920,000	Large

World Resources: World resources of crude diatomite are adequate for the foreseeable future, but the need for diatomite to be near markets because of transportation costs encourages development of new sources for the material.

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 also 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]Less than ½ unit.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions.
[5]Includes sales of moler production.

FELDSPAR

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: U.S. feldspar production in 2007 had an estimated value of about $45 million. The three leading producers accounted for about two-thirds of the production, with six other companies supplying the remainder. Operations in North Carolina provided about 45% of the output; facilities in Virginia, California, Oklahoma, Georgia, Idaho, and South Dakota, in descending order of estimated production, produced the remainder. 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 2007 end-use distribution of domestic feldspar was glass, 63%, and pottery and other, 37%.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production, marketable[e]	800	770	750	760	760
Imports for consumption	8	21	26	5	4
Exports	9	10	15	10	11
Consumption, apparent[e]	799	781	761	755	753
Price, average value, marketable production, dollars per ton[e]	54	57	57	59	59
Stocks, producer, yearend[1]	NA	NA	NA	NA	NA
Employment, mine, preparation plant, and office, number[e]	400	400	400	400	400
Net import reliance[2] as a percentage of apparent consumption	E	1	1	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 (2003-06): Turkey, 61%; Mexico, 38%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Feldspar	2529.10.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Michael J. Potter [(703) 648-7723, mpotter@usgs.gov, fax: (703) 648-7757]**

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. U.S. shipments of glass containers in the first 9 months of 2007 were slightly higher than in the comparable period of 2006, according to the U.S. Census Bureau.

Feldspar use in tile and vitreous sanitaryware reflected housing construction. U.S. housing starts for the first 9 months were about 25% lower than in the same period of 2006, according to the U.S Census Bureau. In 2006 (latest data), 80% of ceramic tiles and 50% of the plumbing fixtures sold in the United States were imported.[3]

China reportedly was the leading producing country of ceramics, including sanitaryware, tableware, and tile. The world sanitaryware market in 2006 (latest data) was an estimated 265 million pieces. Of this total, China produced 98 million pieces, or 36%. In recent years, price increases of energy, labor, natural minerals, power, and transportation have resulted in significant production cost increases in Chinese sanitaryware manufacturing.[4]

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	2006	2007[e]		
United States[e]	760	760	NA	NA
Argentina	150	160	NA	NA
Brazil	123	130	NA	NA
China	1,900	2,000	NA	NA
Colombia	100	100	NA	NA
Czech Republic	475	480	25,000	68,000
Egypt	350	350	NA	NA
France	650	650	NA	NA
Germany	167	170	NA	NA
India	160	160	NA	NA
Iran	250	250	NA	21,000
Italy	3,000	4,000	NA	NA
Japan	1,000	900	NA	NA
Korea, Republic of	500	450	NA	NA
Mexico	450	450	NA	NA
Poland	300	300	11,000	87,000
Portugal	134	130	NA	NA
Spain	580	580	NA	NA
Thailand	1,000	1,100	NA	NA
Turkey	2,300	2,300	NA	NA
Venezuela	200	210	NA	NA
Other countries	851	850	NA	NA
World total (rounded)	15,400	16,000	Large	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]Rogers, W.Z., 2007, Feldspar and nepheline syenite: Mining Engineering, v. 59, no. 6, June, p. 29-30.
[4]Wilson, Ian, 2007, Chinese sanitaryware: Industrial Minerals, no. 476, May, p. 30-39.
[5]See Appendix C for definitions.

FLUORSPAR

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: A small amount of fluorspar was recovered as a byproduct of limestone quarrying in Illinois and stockpiled for future processing. Some byproduct calcium fluoride was recovered from industrial waste streams, although data are not available on exact quantities. Material purchased from the National Defense Stockpile or imported was screened and dried for resale to customers. Domestically, about 85% of reported fluorspar consumption went into the production of hydrofluoric acid (HF) in Louisiana and Texas and aluminum fluoride in Texas. HF is the primary feedstock for the manufacture of virtually all organic and inorganic 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 47,000 tons of fluorosilicic acid (equivalent to about 83,000 tons of 92% fluorspar) was recovered from phosphoric acid plants processing phosphate rock. Fluorosilicic acid was used primarily in water fluoridation, either directly or after processing into sodium silicofluoride.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production:					
Finished, all grades	—	—	—	—	—
Fluorspar equivalent from phosphate rock	94	90	86	70	83
Imports for consumption:					
Acid grade	533	546	586	490	556
Metallurgical grade	34	53	43	62	47
Total fluorspar imports	567	599	629	553	603
Fluorspar equivalent from hydrofluoric acid plus cryolite	180	197	209	233	246
Exports[1]	31	21	36	13	13
Shipments from Government stockpile	75	62	28	66	17
Consumption:					
Apparent[2]	589	691	616	608	601
Reported	616	618	582	523	550
Price, average value, dollars per ton, c.i.f. U.S. port					
Acid grade	138	167	202	217	NA
Metallurgical grade	85	83	93	101	111
Stocks, yearend, consumer and dealer[3]	206	105	131	90	85
Employment, mine and mill, number	—	—	—	—	—
Net import reliance[4] 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 recycled HF and fluorides from smelting operations. HF is recycled in the petroleum alkylation process.

Import Sources (2003-06): China, 62%; Mexico, 18%; South Africa, 14%; Mongolia, 5%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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: During fiscal year 2007, the Defense National Stockpile Center (DNSC), Defense Logistics Agency, sold about 9,070 tons (10,000 short dry tons) of metallurgical-grade fluorspar and 2,020 tons (2,230 short dry tons) of acid-grade fluorspar from the National Defense Stockpile.

Stockpile Status—9-30-07[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Acid grade	—	—	—	11	2
Metallurgical grade	1	([6])	—	54	9

Prepared by **M. Michael Miller [(703) 648-7716, mmiller1@usgs.gov, fax: (703) 648-7757]**

FLUORSPAR

Events, Trends, and Issues: In 2007, Hastie Mining Co. and Moodie Mineral Co. continued their drilling program for fluorspar in Livingston County, KY. Drilling on the vein deposit during 2006 and 2007 had resulted in reserves in excess of 1 million metric tons with an average ore grade of 55% calcium fluoride. Additional drilling was planned for the fourth quarter of 2007. Mine development was scheduled to begin in 2008 with production expected in the latter part of the year. Hastie Mining installed a briqueting machine to manufacture fluorspar briquets for the metallurgical market. The company planned to install a heavy-media plant in 2008 to process stockpiled fluorspar ore produced as a byproduct at its limestone quarry in Hardin County, IL. Work on restarting an idle flotation plant at Salem, KY, also was planned for 2008.[7]

Effective June 1, 2007, China raised the export tax on fluorspar to 15% from the previous rate of 10%, which had only been introduced in the fourth quarter of 2006. This move was part of a policy intended to conserve important resources for domestic use. This and other actions by the Chinese Government in recent years have resulted in significant price increases for Chinese acid-grade fluorspar. By the second quarter of 2007, export prices for acid-grade fluorspar reportedly were at $230 per metric ton, free on board, China. Including insurance and freight costs, delivered prices to U.S. Gulf of Mexico ports were $280 per ton or higher.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[8, 9]	Reserve base[8, 9]
	2006	2007[e]		
United States	—	—	NA	6,000
China	2,750	2,750	21,000	110,000
France	40	—	10,000	14,000
Kenya	83	90	2,000	3,000
Mexico	938	900	32,000	40,000
Mongolia	388	400	12,000	16,000
Morocco	95	95	NA	NA
Namibia	[10]130	[10]130	3,000	5,000
Russia	210	210	Moderate	18,000
South Africa	270	295	41,000	80,000
Spain	132	140	6,000	8,000
Other countries	294	300	110,000	180,000
World total (rounded)	5,330	5,310	240,000	480,000

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: Olivine and/or dolomitic limestone have been used as substitutes for fluorspar. Byproduct fluorosilicic acid from phosphoric acid production 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]Exports are all general imports reexported or National Defense Stockpile material exported.
[2]Excludes fluorspar equivalent of fluorosilicic acid, hydrofluoric acid, and cryolite.
[3]Industry stocks for three leading consumers, fluorspar distributors, and National Defense Stockpile material committed for sale pending shipment.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix B for definitions.
[6]Less than ½ unit.
[7]D. Hastie, Owner, Hastie Mining Co., oral commun., October 2007.
[8]See Appendix C for definitions.
[9]Measured as 100% calcium fluoride.
[10]Data are in wet tons.

GALLIUM

(Data in kilograms of gallium content unless otherwise noted)

Domestic Production and Use: No domestic primary gallium recovery was reported in 2007. 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 $11 million. Gallium arsenide (GaAs) and gallium nitride (GaN) electronic components represented about 98% of domestic gallium consumption. About 66% of the gallium consumed was used in integrated circuits (ICs). Optoelectronic devices, which include light-emitting diodes (LEDs), laser diodes, photodetectors, and solar cells, represented 20% of gallium demand. The remaining 14% 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:	2003	2004	2005	2006	2007[e]
Production, primary	—	—	—	—	—
Imports for consumption	14,300	19,400	15,800	26,900	31,700
Exports	NA	NA	NA	NA	NA
Consumption:					
Reported	20,100	21,500	18,700	20,300	22,000
Apparent	NA	NA	NA	NA	NA
Price, yearend, dollars per kilogram, 99.99999%-pure[1]	411	550	538	443	460
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, refinery, number[e]	20	20	20	20	20
Net import reliance[2] as a percentage of reported consumption[e]	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 (2003-06): China, 23%; Ukraine, 17%; Japan, 16%; Hungary, 10%; and other, 34%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Gallium arsenide wafers, undoped	2853.00.0010	2.8% ad val.
Gallium arsenide wafers, doped	3818.00.0010	Free.
Gallium metal	8112.92.1000	3.0% ad val.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: Imports of gallium and GaAs wafers continued to supply almost all U.S. demand for gallium. Gallium metal imports were higher than those in 2006, but the estimated consumption did not increase significantly. This was because of some imports, particularly those from China and Germany, that were imported into the United States and then re-exported. After the gallium recycler-refiner in Utah and a gallium recycler in the United Kingdom jointly purchased the gallium production facility in Stade, Germany, in 2006, gallium that used to be refined in France was refined in China and the United States. The refinery in France, which was owned by the previous owner of the Stade facility, was closed.

A United States firm that manufactured GaAs substrates in China entered into an agreement with the Utah gallium recycler-refiner to supply 1,000 kilograms per month of 99.99999%-pure gallium to its China subsidiary beginning in July 2007. The 18-month agreement was estimated to be worth $7.3 million. The GaAs manufacturing firm also had majority ownership in a gallium production facility and a gallium refining facility in China. Presumably, gallium from the production facility would be refined in Utah and returned to China.

Prices for low-grade (99.99%-pure) gallium increased in the first half of 2007 from $300 to $350 per kilogram at the beginning of the year to about $500 per kilogram by midyear. Producers in China claimed that there was a shortage of supply, which was the principal reason for the increase in prices. Some were offering gallium at prices as high as $800 per kilogram, but little business was completed at this price level.

Prepared by **Deborah A. Kramer [(703) 648-7719, dkramer@usgs.gov, fax: (703) 648-7975]**

GALLIUM

The Canada-based firm that was attempting to develop a property in Humboldt County, NV, continued drilling at the property in 2007. Combining analytical results from new and previous drilling, the company believed that it developed a gallium mineralization model that was sufficient to identify additional higher grade exploration targets on the property. The company planned to begin geochemical surveys in September 2007.

After several years in which fabrication capacity has far exceeded market demand, global supply and demand of GaAs-base ICs returned to balance. Global consumption for GaAs ICs rose sharply to about 75% of total available capacity in 2006, from only 50% in 2005. Global capacity was estimated to be about 800,000 6-inch GaAs wafer equivalents. GaAs was expected to continue to be the dominant technology in cell phone handsets, the leading market for GaAs-base radio-frequency components, through 2012, according to market analysts. Overall, analysts estimated that the market for GaAs components exceeded $3 billion in 2006, and they predicted a compound average annual growth rate of 7% through 2010. In some applications, however, such as automotive radar and fiber optics applications, GaAs components were expected to face competition from silicon-germanium and silicon components.

Companies continued to try to improve the quality of GaN by improving growth and fabrication techniques. In addition to improvements in traditional substrate materials, such as sapphire and silicon carbide, companies are developing GaN grown on diamond and glass substrates. Firms also are trying to improve bulk GaN growth methods (similar to that used to produce GaAs crystals).

World Production, Reserves, and Reserve Base:[3] Data on world production of primary gallium are unavailable because data on the output of the few producers are considered to be proprietary. However, in 2007, world primary production was estimated to be about 80 metric tons, about the same as that in 2006. China, Germany, Japan, and Ukraine were the leading producers; countries with smaller output were Hungary, Kazakhstan, Russia, and Slovakia. Refined gallium production was estimated to be about 103 metric 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 2007 was estimated to be 184 metric 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 that is comparable to the definition of reserves of other minerals cannot be made. The world bauxite reserve base is so large that much of it will not be mined for many decades; hence, most of the gallium in the bauxite reserve base 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-base LEDs that may compete with GaAs in the future. Indium phosphide components can be substituted for GaAs-base 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 for GaAs in solar cell applications. GaAs-base ICs are used in many defense-related applications because of their unique properties, and there are no effective substitutes for GaAs in these applications. GaAs in heterojunction bipolar transistors is being challenged in some applications by silicon-germanium.

[e]Estimated. NA Not available. — Zero.
[1]Estimated based on the average values of U.S. imports for 99.9999%- and 99.99999%-pure gallium.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions.

GARNET (INDUSTRIAL)[1]

(Data in metric tons of garnet unless otherwise noted)

Domestic Production and Use: Garnet for industrial use was mined in 2007 by four firms, one in Idaho, one in Montana, and two in New York. The estimated value of crude garnet production was about $4.23 million, while refined material sold or used had an estimated value of $5.33 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:	2003	2004	2005	2006	2007[e]
Production (crude)	29,200	28,400	40,100	34,100	34,000
Sold by producers	33,100	30,400	23,100	16,800	16,800
Imports for consumption[e]	34,800	36,500	41,800	50,800	56,100
Exports[e]	11,000	10,900	13,400	13,300	12,500
Consumption, apparent[e, 2]	53,000	54,000	68,600	71,600	77,600
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]	180	160	160	160	160
Net import reliance[4] as a percentage of apparent consumption	45	47	41	52	56

Recycling: Small amounts of garnet reportedly are recycled.

Import Sources (2003-06):[e] Australia, 41%; India, 26%; China, 20%; Canada, 11%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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.

Prepared by **Donald W. Olson [(703) 648-7721, dolson@usgs.gov, fax: (703) 648-7975]**

GARNET (INDUSTRIAL)

Events, Trends, and Issues: During 2007, U.S. garnet consumption increased 9%, while domestic production of crude garnet concentrates remained about the same compared with the production of 2006. In 2007, imports were estimated to have increased 10% compared with those of 2006, and exports were estimated to have decreased 6% from those of 2006. The 2007 estimated domestic sales of garnet remained at about the same level as sales of 2006. In 2007, the United States was a net importer. Garnet imports have displaced 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 minerals that occur with garnet may be produced.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	2006	2007[e]		
United States	34,100	34,000	5,000,000	25,000,000
Australia	160,000	160,000	1,000,000	7,000,000
China	30,000	30,000	Moderate to Large	Moderate to Large
India	65,000	65,000	90,000	5,400,000
Other countries	35,500	36,000	6,500,000	20,000,000
World total (rounded)	325,000	325,000	Moderate	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 located 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 + net trade.
[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.

GEMSTONES[1]

(Data in million dollars unless otherwise noted)

Domestic Production and Use: The combined value of U.S. natural and synthetic gemstone output increased slightly in 2007 from that of 2006. The value of natural gemstone production increased by about 6% during 2007. 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, California, Arkansas, Alabama, Montana, Idaho, and Nevada produced 83% of U.S. natural gemstones. The value of laboratory-created (synthetic) gemstones production increased slightly during the year. Laboratory-created gemstones were manufactured by five firms in North Carolina, Florida, Massachusetts, Michigan, and Arizona, in decreasing order of production. Major gemstone uses were jewelry, carvings, and gem and mineral collections.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production:[2]					
Natural[3]	12.5	14.5	13.4	11.3	12.0
Laboratory-created (synthetic)	33.4	30.7	51.1	52.1	52.3
Imports for consumption	13,600	15,500	17,200	18,300	19,600
Exports, including reexports[4]	5,490	7,230	8,850	9,930	11,400
Consumption, apparent[5]	8,160	8,220	8,410	8,430	8,260
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[6] as a percentage of apparent consumption	99	99	99	99	99

Recycling: Insignificant.

Import Sources (2003-06 by value): Israel, 47%; India, 19%; Belgium, 17%; South Africa, 5%; and other, 12%. Diamond imports accounted for 95% of the total value of gem imports.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Imitation precious stones	7018.10.2000	Free.
Pearls, imitation, not strung	7018.10.1000	4.0% ad val.
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.

Prepared by **Donald W. Olson [(703) 648-7721, dolson@usgs.gov, fax: (703) 648-7975]**

GEMSTONES

Events, Trends, and Issues: In 2007, the U.S. market for unset gem-quality diamonds was estimated to have exceeded $17.7 billion, accounting for more than an estimated 35% of world demand. The domestic market for natural, unset nondiamond gemstones was estimated to be about $1.03 billion. The United States is expected to dominate global gemstone consumption throughout this decade.

Canada's Ekati Mine completed its eighth full year in 2006, with diamond production of 2.52 million carats. The Diavik Diamond Mine completed its fourth full year in 2006, with diamond production of 9.8 million carats. Canada's third diamond mine, the Jericho Diamond Mine, began production of rough diamonds during the first quarter of 2006 and declared commercial production on July 1, 2006. The Jericho mine's production for the year was 296,000 carats. Diamond exploration is continuing in Canada, and many new deposits have been found. Canada produced about 14% of the world's natural gemstone diamond production in 2006. The success of Canadian diamond mines has stimulated interest in exploration for commercially feasible diamond deposits in the United States. Currently, there are no operating commercial diamond mines in the United States.

Mine production of diamond in 2007 for Canada, Congo (Kinshasa), and Russia increased, while production for South Africa decreased, and production in Angola, Australia, Botswana, Brazil, the Central African Republic, China, Côte d'Ivoire, Ghana, Guinea, Guyana, Namibia, Sierra Leone, and Tanzania remained the same compared with that of 2006, based on submissions from country sources.

World Mine Production,[7] Reserves, and Reserve Base:

	Mine production	
	2006	2007[e]
Angola	7,000	7,000
Australia	7,310	7,300
Botswana	24,000	24,000
Brazil	300	300
Canada	12,400	12,600
Central African Republic	315	320
China	100	100
Congo (Kinshasa)	5,600	5,780
Côte d'Ivoire	200	200
Ghana	780	780
Guinea	355	360
Guyana	300	300
Namibia	2,200	2,200
Russia	23,400	35,800
Sierra Leone	360	360
South Africa	6,240	6,080
Tanzania	195	200
Other countries[9]	245	250
World total (rounded)	91,300	104,000

Reserves and reserve base[8]

World reserves and reserve base of diamond-bearing deposits are substantial. No reserves or reserve base 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.
[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]Reexports excluded from apparent consumption calculation.
[6]Defined as imports – exports and reexports + adjustments for Government and industry stock changes.
[7]Data in thousands of carats of gem diamond.
[8]See Appendix C for definitions.
[9]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: The value of domestic refinery production of germanium, based upon an estimated 2007 producer price, was $5.7 million. 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. Another mine in Tennessee planned to begin producing germanium-rich zinc concentrates in the fourth quarter of 2007.

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. Six companies account for most of the U.S. germanium consumption. The major end uses for germanium, worldwide, were estimated to be fiber-optic systems, 35%; infrared optics, 30%; polymerization catalysts, 15%; 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.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production, refinery[e]	4,700	4,400	4,500	4,600	4,600
Total imports[1]	18,600	23,800	23,500	50,000	52,000
Total exports[1]	6,200	13,800	10,100	12,400	14,500
Shipments from Government stockpile excesses	1,760	7,190	4,510	6,080	7,500
Consumption, estimated	20,000	25,000	27,000	55,000	60,000
Price, producer, yearend, dollars per kilogram:					
Zone refined	380	600	660	950	1,240
Dioxide, electronic grade	245	400	405	660	800
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant[2] number[e]	65	65	65	65	65
Net import reliance[3] as a percentage of estimated consumption	NA	NA	NA	NA	NA

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. In the European Union, recent technological advancements in the production of optical fibers has reduced, somewhat, the available supply of germanium scrap.

Import Sources (2003-06):[4] Belgium, 37%; Canada, 28%; Germany, 13%; China, 10%; and other, 12%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
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), Defense Logistics Agency, continued the Basic Ordering Agreement sales program for germanium using weekly postings on Thursdays on the DNSC Web site. In April 2007, the DNSC also announced the offer for sale of germanium metal through the Department of Defense Electronic Mall (DOD EMALL).

Stockpile Status—9-30-07[5]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2007**	**Disposals FY 2007**
Germanium	17,529	90	17,529	8,000	7,336

Prepared by **Gerald R. Smith [(703) 648-4983, grsmith@usgs.gov, fax: (703) 648-7757]**

GERMANIUM

Events, Trends, and Issues: Demand for germanium continued to grow in 2007 as fiber optic network construction was begun in many parts of the world. Accelerated construction was particularly evident in North America and Japan. Fiber optic demand worldwide was reported growing at about 15% per year, having recovered from the downturn in activity during the early part of this decade. Significant domestic growth also was seen in the infrared optics sector, owing to its continued military use in navigation systems, detection and search devices, and optical imaging and target evaluation systems. Commercial use of germanium in night vision lenses for automobiles continued to grow, as did its commercial use in gamma ray detection instrumentation, the latter a result of an increased focus on homeland security. Use in solar energy conversion systems was seen as an expanding market for germanium, in view of technological advancements utilizing germanium single crystals as a component of solar cells to improve the photovoltaic conversion efficiency.

Germanium prices continued to move upward in 2007 as demand grew and supplies remained tight. China removed toll trading tax benefits for germanium and most other minor metals in April, effectively decreasing the supply of germanium to the world market. As a result, renewed interest was shown in the reopening of mines previously producing significant quantities of germanium concentrate byproduct. In October, a Canadian company entered into a technology development agreement to evaluate and recommend processes to optimize the recovery of germanium from zinc concentrate smelter residues at its Tennessee mining complex, which last operated in 2002. Another Canadian company continued to move toward zinc and germanium production in late 2008 at its previously operated mine in northern Mexico. The current supply-demand status continued to generate further interest in the recovery of germanium from coal fly ash.

Silicon-germanium (SiGe) continued to gain interest as a viable semiconductor material. Research and development efforts have resulted in the capability to produce smaller integrated circuits that exhibit reduced electronic noise pollution, thereby prolonging the life of cells while ensuring steady operation in an ultra high-frequency environment. SiGe chips, with high-speed properties, can be made with low-cost, well-established production techniques of the silicon-chip industry.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production[e]		Reserves[6]	Reserve base[6]
	2006	**2007**		
United States	4,500	4,600	450,000	500,000
Other countries	85,500	95,000	NA	NA
World total	90,000	100,000	NA	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 and reserve base figures exclude germanium contained in coal ash.

Substitutes: A new sintered zinc sulfide lens has been developed for use in far-infrared-ray cameras, and is reported to be competitive with germanium lenses. Its uses range from automotive night-vision systems and home appliance control equipment to various security systems. 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.

[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 was revised to include 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 and industry stock changes.

[4]Imports are based on the gross weight of wrought and unwrought germanium and waste and scrap; includes estimated germanium dioxide, metal content; 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.

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 dozen or more large placer mines (nearly 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 mines yielded more than 99% of the gold produced in the United States. In 2007, the value of mine production was about $5.1 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, 84%; electrical and electronics, 6%; dental and other, 10%.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production:					
Mine	277	258	256	252	240
Refinery:					
Primary	194	222	195	181	190
Secondary (new and old scrap)	89	92	81	89	90
Imports[2]	249	283	341	263	180
Exports[2]	352	257	324	389	580
Consumption, reported	183	185	183	185	190
Stocks, yearend, Treasury[3]	8,140	8,140	8,140	8,140	8,140
Price, dollars per ounce[4]	365	411	446	606	675
Employment, mine and mill, number[5]	7,300	7,550	7,910	8,350	8,700
Net import reliance[6] as a percentage of apparent consumption	E	8	4	E	E

Recycling: 90 tons of new and old scrap, equal to about 47% of reported consumption, was recycled in 2007.

Import Sources (2003-06):[2] Canada, 33%; Peru, 33%; Colombia, 7%; Mexico, 7%; and other, 20%.

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 2007 was estimated to be 6% less than the level of 2006, which dropped the United States to the fourth leading gold-producing nation. Mine production from several mines in Nevada accounted for much of the decrease; this decrease was partially offset by increases in production from Alaskan mines. Despite the decrease in production from Nevada mines, the State was still the leading gold producer, with about 80% of the U.S. total. In 2007, the United States was a net exporter of gold.

Prepared by **Micheal W. George [(703) 648-4962, mgeorge@usgs.gov, fax: (703) 648-7757]**

GOLD

The continued rise in costs at South African gold mines, owing to the strengthening of the rand and continued labor problems, has caused several mines to curtail operations and expansion projects. With production decreases in the United States and South Africa, increased gold production in Australia made it the leading gold-producing nation, followed by South Africa. Steadily increasing gold mining in China raised it to the third leading producer of gold worldwide from fourth in 2006.

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.

During the first 9 months of 2007, the Engelhard Corporation's daily price of gold ranged from a low of about \$608 per troy ounce in January to a high of about \$743 per troy ounce at the end of September.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7]	Reserve base[7]
	2006	2007[e]		
United States	252	240	2,700	3,700
Australia	244	280	5,000	6,000
Canada	104	100	1,300	3,500
China	245	250	1,200	4,100
Indonesia	164	120	1,800	2,800
Peru	203	170	3,500	4,100
Russia	159	160	3,000	3,500
South Africa	272	270	6,000	36,000
Other countries	818	920	[8]17,000	[8]26,000
World total (rounded)	2,460	2,500	42,000	90,000

World Resources: An assessment of U.S. gold resources indicated 33,000 tons of gold in identified (15,000 tons) and undiscovered resources (18,000 tons).[9] Nearly one-quarter of the gold in undiscovered resources was estimated to be contained in porphyry copper deposits. The gold resources in the United States, however, are only a small portion of global gold resources.

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

[e]Estimated. E Net exporter.
[1]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: 29.9 (2003), 3.0 (2004), 0.0 (2005), 0.0 (2006), and 0.0 (2007 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.
[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.
[8]Reserves and reserve base for the "Other countries" category does not include some countries for which reliable data were not available.
[9]U.S. Geological Survey National Mineral Resource Assessment Team, 2000, 1998 assessment of undiscovered deposits of gold, silver, copper, lead, and zinc in the United States: U.S. Geological Survey Circular 1178, 21 p.

GRAPHITE (NATURAL)

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Although natural graphite was not produced in the United States in 2007, 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 2007 were refractory applications, 36%; brake linings, 15%; and batteries, foundry operations, and lubricants, 8%.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production, mine	—	—	—	—	—
Imports for consumption	52	64	65	53	55
Exports	22	46	22	22	23
Consumption, apparent[1]	30	18	43	30	32
Price, imports (average dollars per ton at foreign ports):					
Flake	619	485	512	528	598
Lump and chip (Sri Lankan)	2,270	2,420	2,550	2,320	2,460
Amorphous	152	177	170	188	194
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. Abundance of graphite in the world market and continuing low prices inhibit increased recycling efforts. Information on the quantity and value of recycled graphite is not available.

Import Sources (2003-06): China, 46%; Mexico, 23%; Canada, 18%; Brazil, 6%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Crystalline flake (not including flake dust)	2504.10.1000	Free.
Other	2504.90.0000	Free.

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

Government Stockpile: All stockpiled graphite inventories have been sold, and as of December 31, 2006, the National Defense Stockpile contained no graphite inventories.

Prepared by **Donald W. Olson [(703) 648-7721, dolson@usgs.gov, fax: (703) 648-7975]**

GRAPHITE (NATURAL)

Events, Trends, and Issues: Graphite was in near supply-demand balance worldwide in 2007. Leading sources for graphite imports were: flake graphite from China, Canada, Brazil, and Madagascar (in descending order of tonnage), graphite lump and chip from Sri Lanka; and amorphous graphite from Mexico and China (in descending order of tonnage). 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, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	2006	2007[e]		
United States	—	—	—	1,000
Brazil	76	76	360	1,000
Canada	28	28	([4])	([4])
China	720	720	74,000	140,000
Czech Republic	3	3	1,300	14,000
Germany	3	—	([4])	([4])
India	120	120	800	3,800
Korea, North	32	32	([4])	([4])
Madagascar	15	15	940	960
Mexico	13	11	3,100	3,100
Norway	2	2	([4])	([4])
Sri Lanka	3	3	([4])	([4])
Turkey	1	1	([4])	([4])
Ukraine	8	8	([4])	([4])
Other countries	6	6	5,100	44,000
World total (rounded)	1,030	1,030	86,000	210,000

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

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

[e]Estimated. NA Not available. — Zero.
[1]Defined as imports – exports.
[2]Defined as imports – exports + adjustments for Government and industry stock changes. Data on changes in stocks were not available and were assumed to be zero in the calculations.
[3]See Appendix C for definitions.
[4]Included with "Other countries."

GYPSUM

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2007, domestic production of crude gypsum was estimated to be 22.0 million tons with a value of about $165 million. The leading crude gypsum-producing States were, in descending order, Oklahoma, Iowa, Nevada, California, Arkansas, Texas, Indiana, and Michigan, which together accounted for 77% of total output. Overall, 25 companies produced gypsum in the United States at 59 mines in 17 States, and 9 companies calcined gypsum at 66 plants in 28 States. Almost 87% of domestic consumption, which totaled approximately 42.4 million tons, was accounted for by manufacturers of wallboard and plaster products. Approximately 3.5 million tons for cement production, 1.8 million tons for agricultural applications, and small amounts of high-purity gypsum for a wide range of industrial processes, such as smelting and glassmaking, accounted for the remaining tonnage. At the beginning of 2007, the capacity of operating wallboard plants in the United States was about 38.0 billion square feet[1] per year.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production:					
Crude	16,700	17,200	21,100	21,100	22,000
Synthetic[2]	8,300	8,400	8,690	9,290	9,300
Calcined[3]	20,400	23,200	21,100	26,100	25,000
Wallboard products sold (million square feet[1])	33,300	34,300	36,200	35,000	36,100
Imports, crude, including anhydrite	8,300	10,100	11,200	11,400	11,200
Exports, crude, not ground or calcined	166	149	148	150	150
Consumption, apparent[4]	33,100	35,500	40,800	41,600	42,400
Price:					
Average crude, f.o.b. mine, dollars per metric ton	6.90	7.21	7.48	9.08	7.50
Average calcined, f.o.b. plant, dollars per metric ton	20.01	21.10	20.25	17.63	17.37
Stocks, producer, crude, yearend	1,500	1,500	1,500	1,500	1,500
Employment, mine and calcining plant, number[e]	5,900	5,900	5,900	5,900	6,000
Net import reliance[5] as a percentage of apparent consumption	25	28	27	27	26

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 chiefly for agricultural purposes and for the manufacture of new wallboard. Other potential markets for recycled gypsum waste are in athletic field marking, cement production as a stucco additive, grease absorption, sludge drying, and water treatment.

Import Sources (2003-06): Canada, 67%; Mexico, 23%; Spain, 8%; Dominican Republic, 1%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Gypsum; anhydrite	2520.10.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: The United States was the world's leading producer of gypsum in 2007. The U.S. gypsum industry remained stable as the flat housing market kept demand constant. The construction of new wallboard plants and the expansion of existing plants that began in 2005 continued into 2007. These plants were expected to come online in 2008 and would result in an increase in annual domestic wallboard production capacity to about 42 billion square feet. Much of the production at new and expanded facilities will consume synthetic gypsum produced by scrubbing emissions from coal-fired electric powerplants. Increasing 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 wallboard products, building plasters, and the manufacture of portland cement. Road building and repair will continue to spur gypsum consumption in the cement industry. The construction of large wallboard plants designed to use synthetic gypsum as feedstock will result in less use of natural gypsum as the new plants become operational. In 2007, small, local shortages in wallboard supplies were met by increased imports.

Prepared by **Donald Olson [(703) 648-7721, dolson@usgs.gov, fax: (703) 648-7975]**

GYPSUM

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	2006	2007[e]		
United States	21,100	22,000	700,000	Large
Algeria	1,500	1,500		
Australia	4,000	4,000		
Austria	1,000	1,000		
Brazil	1,600	1,600	1,300,000	Large
Canada	9,500	9,500	450,000	Large
China	7,500	7,700		
Egypt	2,000	2,000		
France	4,800	4,800		
Germany	1,650	1,650		
India	2,450	2,500		
Iran	13,000	13,000		
Italy	1,200	1,220	Reserves and reserve base are large in major producing countries, but data are not available.	
Japan	5,950	5,950		
Mexico	7,000	7,400		
Poland	1,250	1,300		
Russia	2,200	2,400		
Spain	13,200	13,200		
Thailand	8,355	8,400		
United Kingdom	2,900	2,900		
Uruguay	1,130	1,130		
Other countries	11,800	11,800		
World total (rounded)	125,000	127,000	Large	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 coasts. Imports from Mexico augment 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; more than 90 countries produce gypsum. Spain is the leading European producer and second in the world, and supplies both crude gypsum and gypsum products to much of Western Europe. Iran ranks third in world production and supplies much of the gypsum needed for construction and reconstruction in the Middle East. Increased wallboard use and new gypsum product plants in Asia led to increased production in that region. As more cultures recognize the economics and efficiency of building with wallboard, worldwide production of gypsum should increase proportionally.

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 2007, synthetic gypsum accounted for 22% 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 + adjustments for industry stock changes.
[5]Defined as imports – exports + adjustments for industry stock changes.
[6]See Appendix C for definitions.

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 (99.995% or better) extracted domestically during 2007 by private industry was about $525 million. Nine industry plants (five 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 industry plants (four in Kansas, and one each in Colorado, Oklahoma, New Mexico,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. Six industry plants (four in Kansas, one in Oklahoma, and one in Texas) accepted a crude helium product from other producers and the Bureau of Land Management (BLM) pipeline and purified it to a Grade-A helium product. Estimated 2007 domestic consumption of 70.4 million cubic meters (2.5 billion cubic feet) was used for cryogenic applications, 28%; for pressurizing and purging, 26%; for welding cover gas, 20%; for controlled atmospheres, 13%; leak detection, 4%; breathing mixtures, 2%; and other, 7%.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Helium extracted from natural gas[2]	87	86	76	79	80
Withdrawn from storage[3]	35	44	57	58	58
Grade-A helium sales	122	130	133	137	138
Imports for consumption	—	—	—	—	—
Exports[4]	41.3	44.9	51.4	61.9	67.7
Consumption, apparent[4]	80.7	85.1	81.6	75.2	70.4
Employment, plant, number[e]	325	325	325	325	325
Net import reliance[5] as a percentage of apparent consumption	E	E	E	E	E

Price: The Government price for crude helium was $2.12 per cubic meter ($58.75 per thousand cubic feet) in fiscal year (FY) 2007. 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 $3.24 to $3.79 per cubic meter ($90 to $105 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 (2003-06): None.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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, located 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.

In FY 2007, privately owned companies purchased nearly 7.1 million cubic meters (256 million cubic feet) of in-kind crude helium. In addition to this, privately owned companies also purchased 57.2 million cubic meters (2,062 million cubic feet) of open market sales helium. During FY 2007, BLM's Amarillo Field Office, Helium Operations (AMFO), accepted about 15.5 million cubic meters (557 million cubic feet) of private helium for storage and redelivered nearly 76.1 million cubic meters (2,742 million cubic feet). As of September 30, 2007, about 37.2 million cubic meters (1,343 million cubic feet) of privately owned helium remained in storage at Cliffside Field.

Stockpile Status—9-30-07[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Helium	609.4	16.6	609.4	63.8	64.3

Prepared by **Norbert Pacheco[7] [(806) 356-1031, Norbert_Pacheco@blm.gov, fax: (806) 356-1041]**

HELIUM

Events, Trends, and Issues: During FY 2007, most helium suppliers announced price increases of 10% to 40%. These increases were implemented in response to high capacity utilization, rising raw material, energy and distribution costs, and to support reinvestment in cylinders, production, and distribution equipment. In addition to price increases, some of the companies increased high-pressure cylinder rental charges, while others will continue cost-recovery efforts through various charges and surcharges. It is anticipated that the factors that have caused the price of pure helium to increase will continue in the near term, along with increasing production and crude helium costs as U.S. helium reserves continue to be depleted. Even if helium prices continue to escalate, helium demand is expected to continue to grow at about 2.5% to 3.5% per year. Based on helium export totals through August 2007, calendar year (CY) 2007 exports are expected to increase by about 9% to 10% from 2006 exports. During FY 2007, the AMFO conducted four open market helium sales. Sales totaled 57.2 million cubic meters (2,062 million cubic feet). During 2007, the two helium projects at Skikda, Algeria, and Qatar that came onstream in late 2005 continued to have operational problems resulting in production outputs substantially below capacity. This resulted in helium supply shortages and interruptions for several months in late 2006 and throughout most of 2007.

World Production, Reserves, and Reserve Base: Reserves and reserve base data were revised based on estimated production for CY 2007.

	Production		Reserves[8]	Reserve base[8]
	2006	2007[e]		
United States (extracted from natural gas)	79	80	3,400	[9]8,200
United States (from Cliffside Field)	58	58	([10])	([10])
Algeria	15	20	1,800	8,300
Canada	NA	NA	NA	2,000
China	NA	NA	NA	1,100
Poland	3	3	26	280
Qatar	4.4	5.5	NA	10,000
Russia	6.3	6.4	1,700	6,700
Other countries	NA	NA	NA	2,800
World total (rounded)	166	173	NA	39,000

World Resources: The identified helium resources of the United States were estimated to be about 8.5 billion cubic meters (305 billion cubic feet) as of January 1, 2003. This includes 0.87 billion cubic meters (31.4 billion cubic feet) of helium stored in the Cliffside Field Government Reserve (these resources are included in the reserves and reserve base figures above), 3.7 billion cubic meters (133 billion cubic feet) of helium in helium-rich natural gas (0.30% helium or more) from which helium is currently being extracted, and 3.1 billion cubic meters (112 billion cubic feet) in helium-lean natural gas (less than 0.30% helium). The Hugoton (Kansas, Texas, and Oklahoma), Panhandle West, Panoma, Riley Ridge, and Cliffside Fields are currently depleting gasfields and contain an estimated 3.6 billion cubic meters (130 billion cubic feet) of helium. Future helium supplies will probably come from known helium-rich natural gas with little fuel value and from helium-lean gas resources.

Helium resources of the world exclusive of the United States were estimated to be about 31 billion cubic meters (1.1 trillion cubic feet). The locations and volumes of the major deposits, in billion cubic meters, are Qatar, 10; Algeria, 8; Russia, 7; Canada, 2; and China, 1. As of December 31, 2007, AMFO had analyzed over 21,800 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.
[7]Team Leader, Resources Evaluation, Bureau of Land Management, Amarillo Field Office, Helium Operations, Amarillo, TX.
[8]See Appendix C for definitions.
[9]All domestic measured and indicated helium resources in the United States.
[10]Included in United States (extracted from natural gas) reserves and reserve base.

INDIUM

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Indium was not recovered from ores in the United States in 2007. 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) thin-film coatings continued to be the leading end use of indium and accounted for approximately 84% of global indium consumption. ITO thin-film coatings are mostly 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, 8%; compounds, 5%; electrical components and semiconductors, 2%; and research and other, 1%. The estimated value of primary indium metal consumed in 2007, based upon the annual average price, was about $75 million.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production, refinery	—	—	—	—	—
Imports for consumption[1]	123	143	142	100	116
Exports	NA	NA	NA	NA	NA
Consumption, estimated	90	100	115	125	95
Price, average annual, dollars per kilogram[2]	170	643	827	918	795
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, number	NA	NA	NA	NA	NA
Net import reliance[3] 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. However, the amount of indium scrap recycled in 2007 was considered small owing to the lack of domestic infrastructure for collecting indium-containing products. Indium recycling could increase significantly in the United States if the current price of indium is sustained or continues to rise. Sputtering, the process in which ITO is deposited as a thin-film coating onto a substrate, is highly inefficient, as only approximately 15% of an ITO sputtering target is deposited onto the substrate. The remainder is scrap. The ITO recycling process takes about 12 weeks from collection of scrap to fabrication of secondary indium products. A recycler may have millions of dollars worth of indium in the recycling loop at any one time. A large increase in ITO scrap could be difficult for the recycling industry to handle because of large capital costs, environmental restrictions, and storage space.

Import Sources (2003-06):[1] China, 45%; Japan, 18%; Canada, 16%; Belgium, 6%; and other, 15%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Unwrought indium, including powders	8112.92.3000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Global secondary indium production increased significantly during the past several years and now accounts for a greater share of indium production than primary. This trend was expected to continue in the future. In 2007, several major secondary indium producers in Japan and the Republic of Korea announced plans to further increase their recycling capacity. The indium market, however, remained in deficit as demand for the metal, supported largely by ITO demand, continued to outpace supply. In 2007, year-on-year shipments of LCD television panels were forecast to increase 47%, and LCD monitor panels to increase 24%. Mainstream LCD devices were also trending toward larger panel sizes, which require more indium per unit.

Prepared by **Amy C. Tolcin [(703) 648-4940, atolcin@usgs.gov, fax: (703) 648-7757]**

INDIUM

Photovoltaic applications could become another large market opportunity for indium. Thin-film copper indium gallium diselenide (CIGS) solar cells require approximately 50 metric tons of indium to produce 1 gigawatt of solar power. Research was underway to develop a low-cost manufacturing process for flexible CIGS solar cells that would yield high production throughput. Flexible CIGS solar cells could be used in roofing materials and in various applications in the aerospace, military, and recreational industries.

The U.S. producer price for indium began 2007 at $835 per kilogram, where it remained for most of the year. In late September, the price fell to $685 per kilogram.

World Refinery Production, Reserves, and Reserve Base: Definitive data on the economic reserves and resources for indium are not available. Data are revised, based on an estimated average indium content of zinc ores.

	Refinery production		Reserves[4]	Reserve base[4]
	2006	2007[e]		
United States	—	—	280	450
Belgium	30	30	([5])	([5])
Canada	50	50	150	560
China	350	250	8,000	10,000
France	10	10	([5])	([5])
Japan	55	50	—	—
Korea, Republic of	50	85	—	—
Peru	6	6	360	580
Russia	16	17	80	250
Other countries	15	15	1,800	4,200
World total (rounded)	580	510	11,000	16,000

World Resources: Indium's abundance in the continental crust is estimated to be approximately 0.05 parts 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 has substitutes in many, perhaps most, of its uses; however, the substitutes usually lead to losses in production efficiency or product characteristics. Silicon has largely replaced germanium and indium in transistors. Although more expensive, gallium can be used in some applications as a substitute for indium in several alloys. In glass-coating applications, silver-zinc oxides or tin oxides can be used. Although technically inferior, zinc-tin oxides can be used in LCDs. Another possible substitute for indium glass coating is transparent carbon nanotubes, which are untested in mass production of LCDs. Indium phosphide can be substituted by gallium arsenide in solar cells and in many semiconductor applications. Hafnium can replace indium alloys in nuclear reactor control rods.

[e]Estimated. NA Not available. — Zero.
[1]Imports for consumption of unwrought indium and indium powders (Tariff no. 8112.92.3000).
[2]Indium Corporation's price for 99.97% purity metal; 1-kilogram bar in lots of 10,000 troy ounces. Source: Platts Metals Week.
[3]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.
[4]See Appendix C for definitions.
[5]Reserves and reserve base for this country are included with "Other countries."

IODINE

(Data in metric tons elemental iodine unless otherwise noted)

Domestic Production and Use: Iodine was produced in 2007 by three companies operating in Oklahoma. Production increased slightly in 2007. The operation at Woodward, OK, continued production of iodine from subterranean brines. A second company operated a miniplant in Kingfisher County, OK, using waste brine associated with oil. A third company continued production at Vici, OK. Prices for iodine have increased in recent years owing to high demand and high capacity utilization. The average c.i.f. value of iodine imports was estimated to be $20.63 per kilogram. Establishing an accurate end-use pattern for iodine was difficult because intermediate iodine compounds were marketed before reaching their final end uses. Of the consumers that participate in an annual USGS canvass, 22 plants reported consumption of iodine in 2006. Iodine compounds reported used were unspecified organic compounds, including ethyl and methyl iodide, 38%; crude iodine, 13%; povidine-iodine (iodophors), 10%; sodium iodide, 10%; potassium iodide, 9%; ethylenediamine dihydroiodide, 4%; and other, 16%. Estimated world consumption of iodine was 26,800 tons.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production	1,090	1,130	1,570	W	W
Imports for consumption, crude content	5,750	5,700	6,250	5,640	6,770
Exports	1,590	1,270	2,660	2,020	2,970
Shipments from Government stockpile excesses	361	245	444	467	93
Consumption:					
Apparent	5,610	5,810	5,600	W	W
Reported	3,930	4,070	4,680	4,570	4,600
Price, average c.i.f. value, dollars per kilogram, crude	11.81	13.38	16.75	19.34	20.63
Employment, number	30	30	30	30	30
Net import reliance[1] as a percentage of apparent consumption	81	81	72	W	W

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

Import Sources (2003-06): Chile, 73%; Japan, 26%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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: In October, the Defense National Stockpile Center announced that the fiscal year 2008 Annual Materials Plan would include sales of 454 tons (1,000,000 pounds) of crude iodine, which would deplete the existing stockpile.

Stockpile Status—9-30-07[2]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Stockpile-grade	3	—	3	454	208

Prepared by **Robert L. Virta [(703) 648-7726, rvirta@usgs.gov, fax: (703) 648-7975]**

IODINE

Events, Trends, and Issues: Chile was the leading producer of iodine in the world. Iodine was a coproduct from surface mineral deposits used to produce nitrate fertilizer. Two of the leading iodine companies in the world were located in Chile. Japan was the second leading producer; its production was associated with gas brines.

A leading producer of iodine in Chile continued construction of a mechanical agitated leach plant. The plant was expected to be operational in the first quarter of 2008. With completion of the plant, the company expected iodine production to increase to 1,500 tons per year from 900 tons per year. The company also was building a powerline to connect the plant to a local power grid, replacing its diesel-powered generator system.

Another Chilean producer announced plans to expand iodine production in its northern Chile deposits to 6,000 tons per year from 1,800 tons per year over the 25-year lifespan of the $15 million project.

The Turkmenistan Government merged its fertilizer and iodine producers into one state organization. The objective of the merger was to stimulate further development of the chemical industry.

In October, the U.S. Environmental Protection Agency (EPA) approved the use of methyl iodide (iodomethane), an agricultural fumigant, for a 1-year trial. Iodomethane would be injected into the soil to kill insects and weeds prior to planting crops such as peppers, strawberries, and tomatoes. The compound was developed to replace methyl bromide, which contributes to degradation of the ozone layer. EPA concluded that iodomethane is safe to use if strict registration and risk mitigation guidelines are followed.

Governments continued to be concerned about iodine deficiencies in children throughout the world. An estimated 35% of children in developing countries suffer from iodine deficiency. Iodine deficiencies can result in goiter and mental impairment. This has prompted several countries to pass laws requiring universal salt iodization, and in parts of China, to subsidize iodized salt use.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	2006	2007[e]		
United States	W	W	250,000	550,000
Azerbaijan	300	300	170,000	340,000
Chile	15,500	16,500	9,000,000	18,000,000
China	560	570	4,000	120,000
Indonesia	75	75	100,000	200,000
Japan	8,000	8,800	4,900,000	7,000,000
Russia	300	300	120,000	240,000
Turkmenistan	270	270	170,000	350,000
Uzbekistan	2	2	NA	NA
World total (rounded)	[4]25,000	[4]26,800	15,000,000	27,000,000

World Resources: In addition to the reserve base shown above, seawater contains 0.05 part 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.
[1]Defined as imports – exports + adjustments for Government and industry stock changes.
[2]See Appendix B for definitions.
[3]See Appendix C for definitions.
[4]Excludes U.S. production.

IRON ORE[1]

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

Domestic Production and Use: In 2007, mines in Michigan and Minnesota shipped 95% of the usable ore produced, with an estimated value of greater than $3.1 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 produced and consumed about 3% of the world's iron ore output.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production, usable	48.6	54.7	54.3	52.7	52.0
Shipments	46.1	54.9	53.2	52.7	49.0
Imports for consumption	12.6	11.8	13.0	11.5	9.0
Exports	6.8	8.4	11.8	8.3	9.0
Consumption:					
Reported (ore and total agglomerate)[3]	61.6	64.5	60.1	58.2	56.0
Apparent	55.2	[e]57.9	[e]56.6	[e]57.4	52.0
Price[4], U.S. dollars per metric ton	32.30	37.92	44.50	53.88	63.00
Stocks, mine, dock, and consuming plant, yearend, excluding byproduct ore[5]	17.5	[e]17.6	[e]16.5	[e]15.1	15.0
Employment, mine, concentrating and pelletizing plant, quarterly average, number	4,670	4,410	4,450	4,470	4,470
Net import reliance[6] as a percentage of apparent consumption (iron in ore)	12	6	4	8	—

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

Import Sources (2003-06): Canada, 55%; Brazil, 38%; Chile, 2%; Trinidad & Tobago, 1%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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 a year of almost 20% increase in worldwide price for lump and fines in 2006, increases of almost 10% in 2007 have resulted from a continuing supply deficit. Pellet prices in 2007 rebounded with an increase of greater than 5% following a slight decrease in 2006.

Major iron-ore-mining companies continue to reinvest profits in mine development, but increases in capacity have not been keeping up with the demand growth, which is dominated by China. In 2006, it is estimated that China increased production of mostly lower grade ores by about 40%. Estimates of Chinese imports of higher grade ores, mostly from Australia and Brazil, show an increase of about 15% compared with those of 2006, a slowdown from the 19% growth rate between 2005 and 2006.

International iron ore trade and production of iron ore and pig iron—key indicators of iron ore consumption—clearly show that iron ore consumption in China is the major factor upon which the expansion of the international iron ore industry depends. China has become more active in pursuing overseas joint ventures, increased iron ore imports, and expanded domestic production of low-grade ores—all of which indicate continued growth of iron ore consumption.

In 2007, India's Essar Global Limited reached an agreement to acquire Algoma Steel Inc. of Canada for $1.64 billion. Three days later, Essar announced plans to acquire Minnesota Steel Industries, LLC. Essar planned to take advantage of synergies between Algoma, a manufacturer of rolled steel products, based in Sault Ste. Marie, Ontario, and Minnesota Steel, a company currently planning a mine, ore-processing facility, direct reduction works, and steel slab-making facilities on Minnesota's Mesabi Range.[7]

Prepared by **John D. Jorgenson [(703) 648-4912, jjorgenson@usgs.gov, fax: (703) 648-7757]**

IRON ORE

Owing to increased prices and interest by Chinese importers, the opening or reopening of several lower grade iron ore deposits has been investigated during the past few years by small capitalization miners in Alaska, Arizona, Missouri, Nevada, New Mexico, and Utah.

Permitting and financing activities for a direct-reduced iron nugget plant—the Mesabi Nugget project—progressed during 2005 and into 2006. Expanded efforts to locate a plant to produce these 96%-to-98% iron-content nuggets in Michigan were begun in 2007.

Increased operating costs have been offsetting operational improvements in the U.S. iron ore industry. Fuel costs are substantially higher than originally projected in the fuel-intensive iron ore industry. Other production costs, such as transportation, have also increased, and the availability of capital equipment and skilled labor has been reduced by increased demand for these resources, as the worldwide mining boom continues.

World Mine Production, Reserves, and Reserve Base: 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 reserve estimates for Australia and Brazil and the reserve base estimate for Brazil have been revised based on new information from those countries.

	Mine production		Crude ore		Iron content	
	2006	2007[e]	Reserves[8]	Reserve base[8]	Reserves[8]	Reserve base[8]
United States	53	52	6,900	15,000	2,100	4,600
Australia	275	320	16,000	45,000	10,000	28,000
Brazil	318	360	16,000	27,000	8,900	14,000
Canada	34	33	1,700	3,900	1,100	2,500
China	588	600	21,000	46,000	7,000	15,000
India	140	160	6,600	9,800	4,200	6,200
Iran	20	20	1,800	2,500	1,000	1,500
Kazakhstan	19	23	8,300	19,000	3,300	7,400
Mauritania	11	11	700	1,500	400	1,000
Mexico	11	12	700	1,500	400	900
Russia	102	110	25,000	56,000	14,000	31,000
South Africa	41	40	1,000	2,300	650	1,500
Sweden	23	24	3,500	7,800	2,200	5,000
Ukraine	74	76	30,000	68,000	9,000	20,000
Venezuela	23	20	4,000	6,000	2,400	3,600
Other countries	67	70	11,000	30,000	6,200	17,000
World total (rounded)	1,800	1,900	150,000	340,000	73,000	160,000

World Resources: World resources are estimated to exceed 800 billion tons of crude ore containing more than 230 billion tons of iron. U.S. resources are estimated to be about 110 billion tons of ore containing about 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 for commercial use.

Substitutes: Iron ore, used directly, as lump ore, or converted to briquettes, concentrates, pellets, or sinter, is the only source of primary iron. In some operations, ferrous scrap may constitute as much as 7% of the blast furnace feedstock. Scrap is extensively used in steelmaking in electric arc furnaces and in iron and steel foundries, but availability of scrap can become an issue in any given year. In general, price increases for iron ore were 9.5% for lump and fine ores during the past year, and a 5.3% increase for pellets with some premium for shorter transport. The margin between iron ore and scrap import prices continued to decrease between 2004 and 2006, but has remained level for 2007; therefore, the relative attractiveness of scrap compared to iron ore has not changed since 2006.

[e]Estimated.
[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 was not available after 2003 (these stock changes were estimated).
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]Jorgenson, J.D., 2007, Iron ore in April 2007: U.S. Geological Survey Mineral Industry Surveys, July, 6 p.
[8]See Appendix C for definitions.

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 2007 that were valued at about $150 billion. The industry consisted of about 57 companies that produced raw steel at about 116 plants, with combined production capability of about 113 million tons. Indiana accounted for about 24% of total raw steel production, followed by Ohio, 15%, Pennsylvania, 6%, and Michigan, 5%. Pig iron was produced by 8 companies operating integrated steel mills in 18 locations. The distribution of steel shipments was estimated to be warehouses and steel service centers, 21%; construction, 17%; transportation (predominantly for automotive production), 13%; cans and containers, 2%; and other, 47%. About 1,100 ferrous foundries continued to import pig iron into the United States, mainly from Brazil, Russia, and Ukraine.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Pig iron production[2]	40.6	42.3	37.2	37.9	36.1
Steel production:	93.7	99.7	94.9	98.2	97.8
Basic oxygen furnaces, percent	49.0	47.9	45.0	57.1	41
Electric arc furnaces, percent	51.0	52.1	55.0	42.9	59
Continuously cast steel, percent	97.3	97.1	96.8	96.7	96.7
Shipments:					
Steel mill products	96.1	101	95.2	99.3	96.8
Steel castings[3]	0.7	0.7	0.7	[e]0.7	[e]0.7
Iron castings[3]	7.5	7.5	7.4	[e]7.4	[e]7.4
Imports of steel mill products	21.0	32.5	29.1	41.1	31.5
Exports of steel mill products	2.5	7.2	8.5	8.8	10.1
Apparent steel consumption[4]	107	117	113	120	110
Producer price index for steel mill products (1982=100)[5]	109.5	147.2	159.7	174.1	183.3
Steel mill product stocks at service centers, yearend[6]	12.3	14.4	11.7	15.0	17.0
Total employment, average, number[7]					
Blast furnaces and steel mills	127,000	123,000	122,000	122,000	121,000
Iron and steel foundries[e]	116,000	116,000	115,000	115,000	115,000
Net import reliance[8] as a percentage of apparent consumption	10	14	15	17	12

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

Import Sources (2003-06): Canada, 17%; European Union, 16%; Mexico, 11%; Brazil, 8%; and other, 48%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Pig iron	7201.10.0000	Free.
Carbon steel:		
Semifinished	7207.12.0050	Free.
Structural shapes	7216.33.0090	Free.
Bars, hot-rolled	7213.20.0000	Free.
Sheets, hot-rolled	7208.39.0030	Free.
Hot-rolled, pickled	7208.27.0060	Free.
Cold-rolled	7209.18.2550	Free.
Galvanized	7210.49.0090	Free.
Stainless steel:		
Semifinished	7218.91.0015	Free.
Do.	7218.99.0015	Free.
Bars, cold-finished	7222.20.0075	Free.
Pipe and tube	7304.41.3045	Free.
Cold-rolled sheets	7219.33.0035	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Prepared by **Michael D. Fenton [(703) 648-4972, mfenton@usgs.gov, fax: (703) 648-7757]**

IRON AND STEEL

Events, Trends and Issues: Gross domestic product (GDP) growth may be considered a predictor of the health of the steelmaking and steel manufacturing industries worldwide and domestically. The global economy is projected by the International Monetary Fund to grow by 4.8% in 2008, down from 5.2% in 2007. The U.S. GDP growth is projected by the World Bank to increase by 3.0% in 2008, down from 2.1% in 2007.

Global raw steelmaking capacity was expected to increase steadily to 1.48 billion metric tons in 2008 from 1.44 billion tons in 2007. Global crude steel production increased 12.8% to 1.32 billion tons in 2007 from 1.17 billion tons in 2006. Production growth is expected to fall to 5.2% in 2008. Global steel production may reach 1.55 billion metric tons in 2015, according to the Boston Consulting Group. Global consumption of finished steel products was projected to increase by 6.8% to 1.20 billion tons in 2007, and by 6.8% in 2008, driven by high demand in Brazil, China, India, and Russia, which together accounted for about 41% of global steel consumption in 2006. Consumption was expected to increase in 2007 and 2008 in the United States by 5.0% and 6.7%, respectively; in the European Union, by 4.0% and1.4%, respectively; in India by 13.7% and 11.8%, respectively; in Brazil by 15.7% and 5.1%, respectively; in the Commonwealth of Independent States, by 8.9% in 2007 and 2008; and in Canada, Mexico, and the United States combined by 4.0% in 2007 and 2008.

Economic activity in China, which is the world's leading steel producer, continued to be an important influence on the world economy and steel markets. China contributed about 36% to total global production and accounted for about 64% of production growth recorded during the year. Steel production growth in China may slow to 11% in 2008 from 15% in 2007. China's steel production was 419 million tons in 2006, up from 353 million tons in 2005, and may reach an estimated 482 million tons in 2007. Steel consumption growth should remain strong (11.4% in 2007 and 11.5% in 2008) but should start to decelerate, especially after the Olympics in 2008, which accounted for 4% to 5% of China's economy in 2006-07. Steel use in China accounted for 35% of the world total in 2007. Raw steelmaking capacity may increase to 1.48 billion tons in 2008, from 1.44 billion tons in 2007 and 1.40 billion tons in 2006. China has been encouraging consolidation in the steelmaking sector to limit overcapacity. China is expected to have a capacity of 538 million tons in 2008. By 2010, China may produce 63 million tons of steel in excess of domestic demand.

World Production:

	Pig iron		Raw steel	
	2006	2007[e]	2006	2007[e]
United States	38	36	98	98
Brazil	35	35	33	32
China	404	465	419	482
France	13	13	20	14
Germany	47	31	47	33
Italy	12	11	32	21
Japan	84	87	116	120
Korea, Republic of	28	30	48	51
Russia	52	50	71	70
Ukraine	33	36	41	43
United Kingdom	11	11	14	10
Other countries	108	132	231	350
World total (rounded)	865	940	1,170	1,320

World Resources: Not applicable. See Iron Ore.

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

[e]Estimated.

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

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

[3]U.S. Census Bureau.

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

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

[6]Metals Service Center Institute.

[7]U.S. Department of Labor, Bureau of Labor Statistics. Blast furnaces and steel mills: NAICS 33111; Iron and steel foundries: NAICS 33151.

[8]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 $20.7 billion in 2007, up by about 37% from that of 2006. U.S. apparent steel consumption, an indicator of economic growth, decreased to about 113 million metric tons in 2007. Manufacturers of pig iron, raw steel, and steel castings accounted for 83% 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 17% 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 ton.

During 2007, raw steel production was an estimated 100 million tons, about 4% more than that of 2006; annual steel mill capability utilization was about the same as that of 2006. Net shipments of steel mill products were estimated to have been about 97 million tons compared with 102 million tons for 2006. The domestic ferrous castings industry shipped an estimated 11.7 million tons of all types of iron castings in 2007 and an estimated 1.1 million tons of steel castings.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production:					
Home scrap	17	14	15	13	13
Purchased scrap[2]	56	59	58	58	58
Imports for consumption[3]	4	5	4	5	5
Exports[3]	11	12	13	15	15
Consumption, reported	65	67	66	66	66
Price, average, dollars per metric ton delivered, No. 1 Heavy Melting composite price, Iron Age Average, Pittsburgh, Philadelphia, Chicago	108.00	205.00	188.51	214	249
Stocks, consumer, yearend	4.4	5.4	5.1	4.7	4.7
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. The steel industry in North America has been recycling steel scrap for more than 200 years. The automotive recycling industry recycled through more than 200 car shredders more than 14 million tons of steel from end-of-life vehicles, the equivalent of nearly 13.5 million automobiles. More than 12,000 vehicle dismantlers throughout North America resell parts. In the United States alone, an estimated 66 million tons of steel was recycled in steel mills and foundries in 2007. 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 48% post-consumer (old, obsolete) scrap, 29% prompt scrap (produced in steel-product manufacturing plants), and 23% home scrap (recirculating scrap from current operations).

Import Sources (2003-06): Canada, 64%; United Kingdom, 16%; Sweden, 6%; Netherlands, 4%; and other, 10%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
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.

Prepared by **Michael D. Fenton (703) 648-4972, mfenton@usgs.gov, fax: (703) 648-7757]**

IRON AND STEEL SCRAP

Events, Trends, and Issues: Hot-rolled steel prices increased during early 2007 to a peak in April, after which they decreased to early 2007 levels. Prices during 2007 were lower than those in 2006. The producer price index for steel mill products continued to rise unevenly to 190.3 in April 2007 from 98.3 in February 2002. Steel mill capability utilization peaked at 97.3% in September 2004, before decreasing to 75.0 in December 2006, and then fluctuating around 85% during most of 2007.

Scrap prices fluctuated widely between about $194 and $243 per metric ton in 2006. 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 $252 per metric ton during the first 10 months of 2007. As reported by Iron Age Scrap Price Bulletin, the average price for nickel-bearing stainless steel scrap delivered to purchasers in Pittsburgh was about $2,913 per ton in 2007, which was higher than the 2006 average price of $2,009 per ton. The prices fluctuated widely between $1,287 and $4,188 per ton in 2007. Exports of ferrous scrap increased to an estimated 16.2 million tons from 14.9 million tons during 2006, mainly to Turkey, China, the Republic of Korea, Canada, and Taiwan, in descending order. Export scrap value increased from $4.2 billion in 2006 to an estimated $6.8 billion in 2007.

In the United States, the primary source of old steel scrap was the automobile. The recycling rate for automobiles in 2006, the latest year for which statistics were available, was about 104%. 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 recycling rates for appliances and steel cans in 2006 were 90% and 63%, respectively. Recycling rates for construction materials in 2006 were about 98% for plates and beams and 65% for rebar and other materials. The recycling rates for appliance, can, and construction steel are expected to increase in the United States, but also in emerging industrial countries at a greater rate. As environmental regulations increase, recycling becomes more profitable and convenient, and public interest in recycling continues to increase.

World Mine Production, Reserves, and Reserve Base: Not applicable.

World Resources: Not applicable.

Substitutes: About 1.7 million tons of direct-reduced iron was used in the United States in 2007 as a substitute for iron and steel scrap, up from 1.5 million tons in 2006.

[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: Ferrous slags are marketable coproducts of iron- and steelmaking. Actual production data are unavailable, but may be estimated as being in the range of 20 to 25 million tons. In 2007, at least 20.0 million tons of domestic iron and steel slag, valued at about $400 million[1] (f.o.b.), was sold. Iron or blast furnace slag accounted for about 60% of the tonnage sold and had a value of about $380 million; about 90% of this value was granulated slag. Steel slag produced from basic oxygen and electric arc furnaces accounted for the remainder.[2] Slag processing was by about 30 companies servicing active iron and/or steel facilities or reprocessing old slag piles: iron slag at about 40 sites in 14 States and steel slag at about 100 sites in 30 States. Included in these data are about a dozen 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 2007 from about $0.50 for steel slags in areas having abundant natural aggregates to nearly $95 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 over short distances only (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:[3]	**2003**	**2004**	**2005**	**2006**	**2007**[e]
Production, marketed[1, 4]	19.7	21.2	21.6	20.3	20.0
Imports for consumption[5]	1.1	1.0	1.6	1.6	1.5
Exports	0.1	0.1	([6])	0.1	0.1
Consumption, apparent[5, 7]	19.7	21.1	21.6	20.2	19.9
Price average value, dollars per ton, f.o.b. plant	15.00	15.50	17.60	20.00	20.00
Stocks, yearend	NA	NA	NA	NA	NA
Employment, number[e]	2,700	2,700	2,600	2,500	2,500
Net import reliance[8] as a percentage of apparent consumption	5	4	7	8	7

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 (2003-06): 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 (by nearly 2 million tons per year) imports of granulated blast furnace slag. Principal sources for 2003-06 were Canada, 47%; Italy, 20%, France, 16%; Japan, 10%; and other, 7%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-07**
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.

Prepared by **Hendrik G. van Oss [(703) 648-7712, hvanoss@usgs.gov, fax: (703) 648-7757]**

IRON AND STEEL SLAG

Events, Trends, and Issues: Domestic supplies of air-cooled blast furnace slag have been declining in recent years because of the depletion of old slag piles and the closure of many blast furnaces for economic and/or environmental reasons. No new blast furnaces are under construction or are planned. Steel slag from integrated iron and steel works also is in decline, but slag from electric arc furnaces (largely fed with steel scrap) remains abundant. Both of these slag types compete with natural aggregates. For performance and environmental reasons, demand is growing for GGBFS in concrete, although the demand is subject to fluctuations related to public sector construction funding levels. The high unit sales prices for GGBFS relative to other slag types has led to the addition of granulation cooling at two domestic blast furnaces in recent years, and other blast furnaces are currently being evaluated as candidates for this type of cooling. An incentive in this regard is the replacement of granulation capacity lost as a result of the likely permanent idling of one granulator-equipped blast furnace in 2005. Absent new granulators, growth in demand for granulated slag will have to be met through imports and this likely will result in additional domestic grinding facilities being built to process the material. 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.

World Mine Production, Reserves, and Reserve Base: Slag is not a mined material and thus the concept of reserves does not apply to this commodity. Slag production data for the world are unavailable, but it is estimated that annual world iron slag output is on the order of 220 to 280 million tons, and steel slag about 130 to 200 million tons, based on typical ratios of slag to crude iron and steel output.

World Resources: Not applicable.

Substitutes: Slag competes with crushed stone and sand and gravel as aggregates in the construction sector. Fly ash, 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 cement kilns.

[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 2003-07.
[3]Owing to inclusion of more complete information (especially for granulated slag), data in 2003-07 are not strictly comparable to those of recent years prior to 2002.
[4]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.
[5]Comparison of official (U.S. Census Bureau) with unofficial import data suggest that the official data understate the true imports of granulated slag by nearly 2 million tons per year. Of these apparently missing imports, the USGS canvass appears to captures only about 0.6 million tons within its sales data. Thus the apparent consumption statistics are likely too low by about 1.0 to 1.3 million tons per year.
[6]Less than ½ unit.
[7]Defined as total sales of slag (includes that from imported feed) – exports. Calculation is based on unrounded original data.
[8]Defined as total sales of imported slag – exports of slag. Data are not available to allow adjustments for changes in stocks.

KYANITE AND RELATED MINERALS

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: One firm in Virginia with integrated mining and processing operations produced kyanite from 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:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production:					
Mine[e]	90	90	90	90	90
Synthetic mullite[e]	40	40	40	40	40
Imports for consumption (andalusite)	4	4	6	4	1
Exports[e]	35	35	35	35	35
Shipments from Government stockpile excesses	—	0.1	—	—	—
Consumption, apparent[e]	99	99	101	99	96
Price, average, dollars per metric ton:					
U.S. kyanite, raw[1]	NA	NA	NA	NA	224
U.S. kyanite, calcined[1]	279	272	272	313	333
Andalusite, Transvaal, South Africa[1]	220	238	238	248	235
Stocks, producer	NA	NA	NA	NA	NA
Employment, kyanite mine, office, and plant, number[e]	125	120	130	135	130
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2003-06): South Africa, 100%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
Andalusite, kyanite, and sillimanite	2508.50.0000	Free.
Mullite	2508.60.0000	Free.

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

Government Stockpile: None

Prepared by **Michael J. Potter [(703) 648-7723, mpotter@usgs.gov, fax: (703) 648-7757]**

KYANITE AND RELATED MINERALS

Events, Trends, and Issues: The steel industry worldwide continued to be the leading consumer of refractories. According to International Iron and Steel Institute data, world crude steel production for the first 8 months of 2007 was about 7% higher than in the comparable period of 2006. The three leading steel-producing countries were China with about 39%; Japan, 10%; and the United States, 8%.

The refractories industry continues to consolidate and adjust according to domestic and global market conditions. Demand for refractories has been favorable; however, the rate of refractory consumption by industry has declined in recent years because of materials advances and product improvements. Other factors have been processing and operations changes by user industries.[3]

Natural raw materials such as andalusite and kyanite continue to be important in refractory manufacturing. In addition, as the need for higher grade, more durable refractories has continued to increase, refractories technology has advanced, with increased usage of synthetic raw materials. Examples include aluminosilicate fiber, mullite, zirconia–mullite, and other materials.[3]

Other trends are the increased development and use of monolithic (unshaped) refractories and a gradual increase in usage of recycled refractory materials.[3]

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[4]
	2006	2007[e]	
United States[e]	90	90	Large in the United States. South Africa reports a reserve base of about 51 million tons of aluminosilicates ore (andalusite and sillimanite).
France	65	65	
India	22	23	
South Africa	230	230	
Other countries	5	6	
World total (rounded)	410	410	

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]Prices from trade journal.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]Semler, C.E., 2007, The refractories world today—An overview: Industrial Minerals, no. 475, April, p. 55-61.
[4]See Appendix C for definitions.

LEAD

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

Domestic Production and Use: The value of recoverable mined lead in 2007, based on the average U.S. producer price, was $1.17 billion. Five lead mines in Missouri, plus lead-producing mines in Alaska, Idaho, Montana, and Washington, yielded most of the total. Primary lead was processed at one smelter-refinery in Missouri. Of the 21 plants that produced secondary lead, 12 had annual capacities of 15,000 tons or more and accounted for more than 99% of secondary production. Lead was consumed at about 110 manufacturing plants. The lead-acid battery industry continued to be the principal user of lead, accounting for 89% of the reported U.S. lead consumption for 2007. Lead-acid batteries were primarily used as starting-lighting-ignition (SLI) batteries for automobiles and trucks. Lead-acid batteries were also used as industrial-type batteries for uninterruptible power-supply equipment for computer and telecommunications networks and hospitals; for load-leveling equipment for commercial electrical power systems; and as traction batteries used in airline ground equipment, industrial forklifts, mining vehicles, golf carts, etc. About 8% of lead was used in ammunition; casting material; sheets (including radiation shielding), pipes, traps and extruded products; cable covering, caulking lead, and building construction; solder; and oxides for glass, ceramics, pigments, and chemicals. The balance was used in ballast and counter weights, brass and bronze, foil, terne metal, type metal, wire, and other undistributed consumption.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production:					
Mine, lead in concentrates	460	445	437	429	430
Primary refinery	245	148	143	153	150
Secondary refinery, old scrap	1,140	1,130	1,150	1,160	1,160
Imports for consumption, lead in concentrates	—	—	—	([1])	([1])
Exports, lead in concentrates	253	292	390	298	300
Imports for consumption, refined metal, wrought and unwrought	183	208	310	343	310
Exports, refined metal, wrought and unwrought	123	83	65	68	60
Shipments from Government stockpile excesses, metal	60	42	29	24	([1])
Consumption:					
Reported	1,390	1,480	1,490	1,560	1,570
Apparent[2]	1,490	1,470	1,480	1,580	1,630
Price, average, cents per pound:					
North American Producer	43.8	55.1	61.0	77.4	123
London Metal Exchange	23.3	40.2	44.2	58.0	109
Stocks, metal, producers, consumers, yearend	85	59	47	54	45
Employment:					
Mine and mill (peak), number[3]	830	1,020	1,100	1,070	1,100
Primary smelter, refineries	320	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: About 1.16 million tons of secondary lead was produced, an amount equivalent to 76% of reported domestic lead consumption. Nearly all of it was recovered from old (post-consumer) scrap.

Import Sources (2003-06): Metal, wrought and unwrought: Canada, 73%; Australia, 8%; China, 7%; Peru, 6%; and other, 6%.

Tariff: Item	Number	Normal Trade Relations[5] 12-31-07
Unwrought (refined)	7801.10.0000	2.5% ad val.

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

Government Stockpile:

Stockpile Status—9-30-07[6]
(Metric tons)

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Lead	—	—	—	34,000	536

Prepared by **Gerald R. Smith [(703) 648-4983, grsmith@usgs.gov, fax: (703) 648-7757]**

LEAD

Events, Trends, and Issues: During 2007, the average price of refined lead rose appreciably from that of 2006 on both the U.S. and world markets, approaching record highs. Consistent with this rise in price, the global supply situation for refined lead remained tight, as stocks continued to decline and demand remained strong. Use of lead worldwide was estimated to have increased by 4% in 2007. Continued strong economic growth in the automotive, telecommunications, and information technology sectors in China was the most significant factor influencing increased lead usage. Automobile sales alone in China increased by an estimated 25% during 2007. Also contributing to the increase in worldwide lead demand were notably stronger economies continuing to emerge in other areas of Southeast Asia, particularly India, as well as many of the countries in Eastern Europe.

Global mine production of lead concentrate increased by about 5% in 2007. However, Chinese net imports of lead concentrate rose significantly during the year, affecting the supply of concentrate on the world market. Increases in lead concentrate production are anticipated in China, Europe, and South America to meet the rising world demand. Influenced by the higher domestic demand for lead, China removed the value-added tax rebate and imposed a 10% tax on exports of refined lead, leading to significantly decreased such exports. As a result, an appreciable shortage of refined lead was evident on the world market during 2007. Increases in refined lead production were begun in China, India, and some European countries in order to more closely meet the rising demand for refined lead.

U.S. mine production of lead in concentrate remained steady during 2007, as did production of secondary lead that was sourced principally from recycled spent lead-acid batteries. According to Battery Council International statistics, demand for replacement SLI batteries in 2007 was equivalent to that of 2006, whereas original equipment SLI demand was down, the latter being consistent with lower new vehicle sales figures.

World Mine Production, Reserves, and Reserve Base: Reserves estimates for Australia, Canada, and the United States were revised based on information released by producers in the respective countries.

	Mine production		Reserves[7]	Reserve base[7]
	2006	2007[e]		
United States	429	430	7,700	19,000
Australia	686	640	24,000	59,000
Canada	82	75	400	5,000
China	1,200	1,320	11,000	36,000
India	67	75	NA	NA
Ireland	62	55	NA	NA
Kazakhstan	48	50	5,000	7,000
Mexico	120	110	1,500	2,000
Morocco	45	45	500	1,000
Peru	313	330	3,500	4,000
Poland	51	50	NA	5,400
South Africa	48	45	400	700
Sweden	77	75	500	1,000
Other countries	240	250	24,000	30,000
World total (rounded)	3,470	3,550	79,000	170,000

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 building construction, electrical cable covering, cans, and containers. Aluminum, iron, plastics, and tin compete with lead in other packaging and protective coatings, and tin has replaced lead in solder for new or replacement potable water systems in the United States. In the electronics industry, there has been a move towards lead-free solders with varying compositions of tin, bismuth, silver, and copper.

[e]Estimated. E Net exporter. NA Not available; included in “Other countries.” — Zero.
[1]Less than ½ unit.
[2]Apparent consumption series revised to reflect a total raw material balance. 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 B for definitions.
[7]See Appendix C for definitions.

LIME[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2007, 20.2 million tons (22.3 million short tons) of quicklime and hydrate was produced (excluding commercial hydrators) at a value of about $1.8 billion. Production came from 35 companies, which included 24 companies with commercial sales and 11 companies that produced lime strictly for internal use (for example, sugar companies). These companies operated 82 plants in 35 States and Puerto Rico. Principal producing States, each with production of more than 1 million tons, were Alabama, Kentucky, Missouri, Nevada, Ohio, Pennsylvania, and Texas. These seven States produced about 12.8 million tons (14.1 million short tons), or 63% of the total output. Major markets for lime were steelmaking, flue gas desulfurization (fgd), mining, construction, pulp and paper, precipitated calcium carbonate, and water treatment.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production[2]	19,200	20,000	20,000	21,000	20,200
Imports for consumption	202	232	310	298	390
Exports	98	100	133	116	200
Consumption, apparent	19,300	20,100	20,200	21,200	20,400
Quicklime average value, dollars per ton at plant	61.40	64.80	72.10	78.10	84.00
Hydrate average value, dollars per ton at plant	84.80	89.80	91.10	98.30	105.00
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and plant, number	5,350	5,350	5,300	5,300	5,300
Net import reliance[3] as a percentage of apparent consumption	([4])	1	1	1	1

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

Import Sources (2003-06): Canada, 74%; Mexico, 25%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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 2007, owing to a downturn in major markets, such as construction, mining, and steel, lime production decreased by about 4% compared with that of 2006. Prices continued to increase, with quicklime prices increasing an estimated $6 per metric ton and hydrate prices increasing $7 per ton. This continues the trend in recent years that has seen quicklime prices increase by 38% since 2003.

Carmeuse North America and Oglebay Norton Co. announced an agreement under which Carmeuse would acquire Oglebay Norton. Oglebay Norton has two groups—ON Minerals, which produces lime and limestone products, and Oglebay Norton Industrial Sands. One of ON Minerals' important limestone markets is fgd, which is expected to combine well with Carmeuse's expertise in lime-based fgd products. Carmeuse has lime plants in Alabama, Illinois, Indiana, Kentucky, Louisiana, Michigan, Ohio, and Pennsylvania. ON Minerals' lime and limestone facilities are in Georgia, Indiana, Michigan, Ohio, Pennsylvania, Tennessee, and Virginia. The transaction was expected to be finalized by the end of 2007.[5]

Pete Lien & Sons, Inc. was in the planning and permitting stage for the construction of a new limestone quarry, lime plant, and hydrating plant, on a tract of land about 9 miles north of Laramie in Albany County, WY. The cost of the project is estimated to be $50 to $80 million and plant startup is expected to be in 2008 or 2009.[6]

Western Lime Corp. commissioned a new lime plant in Port Inland, MI. The plant has a preheater rotary kiln with the capacity to produce more than 230,000 metric tons per year of high-calcium lime from limestone that is quarried on site. Quarry operations will cease in the winter, so the plant has the capacity to stockpile about 200,000 t of limestone, which allows the plant to operate year round. Western Lime has two other plants in Eden and Green Bay, WI.[7]

Prepared by **M. Michael Miller [(703) 648-7716, mmiller1@usgs.gov, fax: (703) 648-7757]**

LIME

World Lime Production and Limestone Reserves and Reserve Base:

	Production 2006	Production 2007[e]	Reserves and reserve base[8]
United States	21,000	20,200	Adequate for all countries listed.
Austria	2,000	2,000	
Belgium	2,400	2,400	
Brazil	6,900	6,900	
Bulgaria	2,500	2,500	
Canada	2,410	2,500	
China	160,000	170,000	
France	3,500	3,000	
Germany	7,000	7,000	
Iran	2,500	2,500	
Italy[9]	4,800	4,800	
Japan (quicklime only)	8,900	8,900	
Mexico	5,700	5,800	
Poland	2,000	1,800	
Romania	2,000	2,000	
Russia	8,200	8,500	
South Africa (sales)	1,600	1,600	
Turkey (sales)	3,600	3,400	
United Kingdom	2,000	2,000	
Other countries	22,000	19,000	
World total (rounded)	271,000	277,000	

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, lime kiln dust, and fly ash 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]Less than ½ unit.
[5]Carmeuse North America, 2007, Carmeuse to acquire Oglebay Norton for $36 per share in cash: Pittsburgh, PA, Carmeuse Lime press release, October 12, 3 p.
[6]LeClair, Aaron, 2007, Development of limestone plant moves forward: Laramie Boomerang, July 25. (Accessed October 29, 2007, at http://www.laramieboomerang.com/news/archivemore.asp?StoryID=106895.)
[7]Ferenco, 2007, Western Lime announces new facility commissioned: Vancouver, British Columbia, Canada, Ferenco news release, August 16, 2 p.
[8]See Appendix C for definitions.
[9]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, Russia, and the United States also were major producers. Australia, Canada, and Zimbabwe were major producers of lithium ore concentrates. The United States remained the leading consumer 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 data cannot be published. 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.

Although lithium markets vary by location, global end-use markets are estimated as follows: batteries, 20%; ceramics and glass, 20%; lubricating greases, 16%; pharmaceuticals and polymers, 9%; air conditioning, 8%; primary aluminum production, 6%; and other uses, 21%. 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:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production	W	W	W	W	W
Imports for consumption	2,200	2,910	3,580	3,260	4,000
Exports	1,520	1,690	1,720	1,500	1,400
Consumption:					
Apparent	W	W	W	W	W
Estimated	1,400	1,900	2,500	2,500	3,300
Employment, mine and mill, number[e]	100	100	100	100	100
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 (2003-06): Chile, 69%; Argentina, 29%; and other, 2%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
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.

Prepared by **Joyce A. Ober [(703) 648-7717, jober@usgs.gov, fax: (703) 648-7757]**

LITHIUM

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

The market for lithium compounds with the largest potential for growth is batteries, especially rechargeable batteries. Demand for rechargeable lithium batteries continued to grow for use in video cameras, portable computers and telephones, and cordless tools. At least two 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.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[2]	Reserve base[2]
	2006	2007[e]		
United States	W	W	38,000	410,000
Argentina[e]	2,900	3,000	NA	NA
Australia[e]	5,500	5,500	160,000	260,000
Bolivia	—	—	—	5,400,000
Brazil	242	240	190,000	910,000
Canada	707	710	180,000	360,000
Chile	8,200	9,400	3,000,000	3,000,000
China	2,820	3,000	540,000	1,100,000
Portugal	320	320	NA	NA
Russia	2,200	2,200	NA	NA
Zimbabwe	600	600	23,000	27,000
World total (rounded)	[3]23,500	[3]25,000	4,100,000	11,000,000

World Resources: The identified lithium resources total 760,000 tons in the United States and more than 13 million tons in other countries.

Substitutes: Substitutes for lithium compounds are possible in manufactured glass, ceramics, greases, and batteries. Examples are sodic and potassic fluxes in ceramics and glass manufacture; calcium and aluminum soaps as substitutes for stearates in greases; and calcium, magnesium, mercury, and zinc as anode material in primary batteries. Lithium carbonate is not considered to be an essential ingredient in aluminum potlines. Substitutes for aluminum-lithium alloys as 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. — Zero.
[1]Defined as imports – exports + adjustments for Government and industry stock changes.
[2]See Appendix C for definitions.
[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 60% of U.S. magnesium compounds production in 2007. Magnesium oxide and other compounds were recovered from seawater by three companies in California, Delaware, and Florida; from well brines by two companies in Michigan; and from lake brines by two companies in Utah. Magnesite was mined by one company in Nevada, brucite was mined by one company in Texas, and olivine was mined by one company in Washington. About 60% of the magnesium compounds consumed in the United States was used for refractories. The remaining 40% was used in agricultural, chemical, construction, environmental, and industrial applications.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production	329	292	301	262	266
Imports for consumption	332	356	391	371	380
Exports	53	35	31	28	27
Consumption, apparent	608	613	661	605	619
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant, number[e]	370	370	370	370	370
Net import reliance[2] as a percentage of apparent consumption	46	52	54	57	57

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

Import Sources (2003-06): China, 76%; Canada, 7%; Austria, 4%; Australia, 3%; and other, 10%.

Tariff:[3] Item	Number	Normal Trade Relations 12-31-07
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.

Prepared by **Deborah A. Kramer [(703) 648-7719, dkramer@usgs.gov, fax: (703) 648-7975]**

MAGNESIUM COMPOUNDS

Events, Trends, and Issues: One of the two magnesium chloride producers in Utah planned to spend $25 million to upgrade its processing plant and modify its solar evaporation ponds near the Great Salt Lake. The 3-year expansion, which would begin in 2008, was expected to increase the company's sulfate of potash production by 20%, and the company's magnesium chloride brine production likely would increase as well. The State of Utah also agreed to lease 23,000 additional acres to the firm to build new solar evaporation ponds. The company also must get construction permits from the U.S. Army Corps of Engineers before it can build additional solar evaporation ponds.

A company that began producing magnesium chloride from bischofite in Russia at the end of 2006 announced that it would construct a plant to produce high-purity magnesium oxide and magnesium hydroxide. The new production, which was scheduled to start in 2009, would come from thermal decomposition of bischofite. When completed, the new plant would be capable of producing 15,000 tons per year of magnesium oxide and 20,000 tons per year of magnesium hydroxide.

One of the olivine producers in Turkey announced that it had begun producing magnesite from the same region from which the olivine was produced. Production capacity at the magnesite mine was reported to be 5,000 metric tons per month.

A private equity group purchased the leading magnesite producer in Brazil. The company's magnesia plant has the capacity to produce 345,000 tons per year of dead-burned magnesia and 70,000 tons per year of caustic-calcined magnesia. From 2003 through 2006, the company had invested $100 million to increase production, improve quality, and introduce new refractory products for the steel industry. The equity firm planned to expand the business further, although no specific details were available.

World Mine Production, Reserves, and Reserve Base:

	Magnesite production		Magnesite reserves and reserve base[4]	
	2006	2007[e]	Reserves	Reserve base
United States	W	W	10,000	15,000
Australia	137	140	100,000	120,000
Austria	202	200	15,000	20,000
Brazil	111	110	45,000	65,000
China	1,370	1,870	380,000	860,000
Greece	144	150	30,000	30,000
India	107	105	14,000	55,000
Korea, North	345	350	450,000	750,000
Russia	346	350	650,000	730,000
Slovakia	115	115	45,000	320,000
Spain	144	150	10,000	30,000
Turkey	922	930	65,000	160,000
Other countries	117	120	390,000	440,000
World total (rounded)	[5]4,060	[5]4,600	2,200,000	3,600,000

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.
[5]Excludes the United States.

MAGNESIUM METAL[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2007, magnesium was produced by one company in Utah by an electrolytic process that recovered magnesium from brines from the Great Salt Lake. Magnesium used as a constituent of aluminum-based alloys that were used for packaging, transportation, and other applications was the leading use for primary magnesium, accounting for 43% of primary metal use. Structural uses of magnesium (castings and wrought products) accounted for 37% of apparent consumption. Desulfurization of iron and steel accounted for 10% of U.S. consumption of primary metal, and other uses were 10%.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production:					
Primary	W	W	W	W	W
Secondary (new and old scrap)	70	72	73	76	75
Imports for consumption	83	99	85	76	65
Exports	20	12	10	12	13
Consumption:					
Reported, primary	103	101	82	78	75
Apparent[2]	120	140	130	120	110
Price, yearend:					
Metals Week, U.S. spot Western, dollars per pound, average	1.14	1.58	1.23	1.40	2.00
Metal Bulletin, European free market, dollars per metric ton, average	1,900	1,875	1,595	2,100	3,000
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	53	61	60	53	47

Recycling: In 2007, about 20,000 tons of secondary production was recovered from old scrap.

Import Sources (2003-06): Canada, 44%; Russia, 21%; Israel, 13%; China, 10%; and other, 12%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
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: Tight magnesium supplies drove prices up in 2007. By October, the Metals Week U.S. spot Western price range for primary magnesium was $1.80 to $2.00 per pound, a $0.45- to $0.55-per-pound increase since the beginning of the year. This was the highest price reported for magnesium since 1996. Contract magnesium prices for 2008 were reported to be as high as $2.00 per pound. The tight supply primarily resulted from the March closure of the primary magnesium plant in Becancour, Quebec, Canada, removing 48,000 tons per year of capacity from the world market. This plant, in addition to a 63,000-ton-per-year plant in Asbestos, Quebec, that had been closed since 2003, were scheduled to be demolished by yearend. The only plant remaining in Canada—a 9,000-ton-per-year plant in Haley, Ontario—had moved most of its production to China, sold its production equipment, and was primarily reprocessing magnesium from China at the site.

Prepared by **Deborah A. Kramer [(703) 648-7719, dkramer@usgs.gov, fax: (703) 648-7975]**

MAGNESIUM METAL

The U.S. magnesium producer announced that it would increase its production capacity from 43,000 tons per year to more than 50,000 tons per year, with increased production starting in the fourth quarter of 2007. The plant would reach full capacity by mid-2008. The company had begun construction of new electrolytic cells in 2004, but had not completed the expansion because of market conditions. The U.S. magnesium producer had signed a 2-year agreement, beginning in January 2008, to supply one of the U.S. automobile manufacturers with magnesium ingot for its North American parts production. The auto manufacturer had been supplied with 20,000 tons per year from the Becancour, Quebec, plant until its closure; magnesium from the United States producer (estimated at 9,000 tons) would be used for parts production in the United States, and magnesium from China would be used for parts production in Canada and Mexico.

After a review of the antidumping duty on magnesium metal from Russia, the U.S. Department of Commerce, International Trade Administration reduced the antidumping duty to 0.41% ad valorem (a de minimus duty that is equivalent to a 0% ad-valorem duty) for one of the two magnesium producers in Russia. The duty for the other producer remained at 3.77% ad valorem.

The company that had planned to build a magnesium plant in Egypt closed its office and released its staff in the first quarter of 2007. Inability to find financing for the plant was cited as the reason for the closure.

Magnesium supplies in the United States were expected to remain tight. The only new plants that were either being constructed or planned were in China. With antidumping duties assessed on most forms of magnesium imported from China into the United States, imports of magnesium from China were expected to continue to supply only a minimal portion of consumption. This would leave Israel and Russia as the principal magnesium suppliers to the United States. In addition, new U.S. titanium sponge plants that were scheduled to be completed within the next several years would require a significant quantity of magnesium for the initial startup and, depending on the ability of the sponge producer to recycle magnesium, may require significant quantities annually. This would constrain supplies further and lead to more price increases.

World Primary Production, Reserves, and Reserve Base:

	Primary production	
	2006	2007[e]
United States	W	W
Brazil	6	6
Canada	50	8
China	534	550
Israel	25	28
Kazakhstan	21	20
Russia	50	50
Serbia	2	2
Ukraine	2	2
World total[5] (rounded)	690	670

Reserves and reserve base[4]

Magnesium metal is derived from seawater, natural brines, dolomite, and other minerals. The reserves and reserve base 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.
[5]Excludes the United States.

MANGANESE

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

Domestic Production and Use: Manganese ore containing 35% or more manganese was not produced domestically in 2007. 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, although one operated sporadically throughout the year. Construction, machinery, and transportation end uses accounted for about 24%, 10%, and 10%, 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 $730 million.

Salient Statistics—United States:[1]	2003	2004	2005	2006	2007[e]
Production, mine[2]	—	—	—	—	—
Imports for consumption:					
Manganese ore	347	451	656	572	610
Ferromanganese	238	429	255	358	322
Silicomanganese[3]	267	422	327	400	390
Exports:					
Manganese ore	18	123	13	2	2
Ferromanganese	11	9	14	22	33
Shipments from Government stockpile excesses:[4]					
Manganese ore	28	172	34	73	5
Ferromanganese	28	37	36	56	66
Consumption, reported:[5]					
Manganese ore[6]	398	441	368	365	300
Ferromanganese	248	315	267	296	280
Consumption, apparent, manganese[7]	643	1,030	773	1,050	910
Price, average value, 46% to 48% Mn metallurgical ore, dollars per metric ton unit contained Mn, c.i.f. U.S. ports	2.41	2.89	4.39	3.51	3.32
Stocks, producer and consumer, yearend:					
Manganese ore[6]	156	159	337	159	115
Ferromanganese	20	16	30	31	31
Net import reliance[8] 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 (2003-06): Manganese ore: Gabon, 65%; South Africa, 19%; Australia, 7%; Ghana, 2%; and other, 7%. Ferromanganese: South Africa, 51%; China, 14%; Mexico, 6%; Republic of Korea, 5%; and other, 24%. Manganese contained in all manganese imports: South Africa, 35%; Gabon, 22%; Australia, 8%; China, 7%; and other, 28%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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).

Government Stockpile: The uncommitted inventory of metallurgical ore was classed as nonstockpile-grade. Disposals reported in fiscal year 2007 may not be reflected in committed inventory levels owing to end of fiscal year transactions.

Prepared by **Lisa A. Corathers [(703) 648-4973, lcorathers@usgs.gov, fax: (703) 648-7757]**

MANGANESE

Stockpile Status—9-30-07[9]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Manganese ore:					
Battery grade	16	2	16	27	2
Chemical grade	0.456	—	0.456	36	—
Metallurgical grade	328	34	328	454	359
Ferromanganese, high-carbon	477	8	477	91	77
Electrolytic metal	—	—	—	—	—
Synthetic dioxide	3	—	—	3	1

Events, Trends, and Issues: Apparent consumption in 2007 was about 13% lower than that of 2006 owing to constant demand by the domestic steel industry, and reduction of producer and consumer stocks. During the first 8 months of 2007, domestic steel production was 1.4% less than that for the same period in 2006. Despite this, manganese alloy spot-market prices rose because of concerns that temporary production cuts by manganese alloy producers in Brazil, France, and the United States might lead to supply shortages, increased demand by the global steel industry, and higher manganese ore spot prices and ocean transportation costs. By the end of October 2007, U.S. weekly average spot prices for medium- and high-carbon ferromanganese and silicomanganese were all about double those at the start of the year. The annual average domestic manganese ore contract price followed the 10% decrease in the international price for metallurgical-grade ore set between Japanese consumers and major suppliers in January 2007, although the average weekly spot market price had tripled to $8.65 per metric ton unit during the first 10 months of 2007 owing to increased global demand for manganese ore, particularly in China and India.

World Mine Production, Reserves, and Reserve Base (metal content): Reserve estimates have been revised from those previously published for Australia (downward), Brazil (upward), India (downward), and South Africa (upward) based on information reported by the Governments of Australia, Brazil, and India and the major manganese producers of South Africa. Reserves are based on estimates of demonstrated resources.

	Mine production 2006	Mine production 2007[e]	Reserves[10]	Reserve base[10]
United States	—	—	—	—
Australia	2,190	2,200	62,000	160,000
Brazil	1,370	1,000	35,000	57,000
China	[e]1,600	1,600	40,000	100,000
Gabon	[e]1,350	1,550	20,000	160,000
India	[e]811	650	56,000	[11]150,000
Mexico	133	130	4,000	9,000
South Africa	2,300	2,300	100,000	[11]4,000,000
Ukraine	[e]820	820	140,000	520,000
Other countries	1,360	1,360	Small	Small
World total (rounded)	[e]11,900	11,600	460,000	5,200,000

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 20%.

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, defined as stockpile shipments – receipts; updated from previous estimates.
[5]Manganese consumption should not 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 estimates of average content for all significant components except imports, for which content is reported.
[8]Defined as imports – exports + adjustments for Government and industry stock changes.
[9]See Appendix B for definitions.
[10]See Appendix C for definitions.
[11]Includes inferred resources.

MERCURY

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

Domestic Production and Use: Mercury was produced as a byproduct from several gold-silver mines in Nevada; however, byproduct production data were not reported. Mercury has not been produced as a primary mineral commodity in the United States since 1992, when the McDermitt Mine in Nevada closed. Processing of calomel, a mercury-chlorine compound obtained from domestic and foreign mines, is another source of mercury. Retorting end-of-use mercury-containing products, such as batteries, dental amalgam, and fluorescent lamps, and mercury contaminated soils, provided another source of mercury. The domestic chlorine-caustic soda industry was the leading end user of mercury. Some of the mercury used at these facilities was recycled in-plant; however, approximately 100 tons of replacement mercury is purchased yearly. Some mercury-containing chlor-alkali waste, as “amalgam” (not chemically defined), was exported to Canada and landfilled. Mercury use has declined in the United States because of mercury toxicity. Mercury has been released to the environment from coal-fired power plants, car switches when the automobile is scrapped for recycling, and from incinerated mercury-containing medical devices. Mercury is no longer used in batteries and paints manufactured in the United States. Exported mercury is widely used for artisanal gold mining, chlorine-caustic soda production, and dental amalgam. Button-type batteries, cleansers, fireworks, folk medicines, grandfather clocks, pesticides, and some skin-lightening creams and soaps may also contain mercury.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production:					
Mine (byproduct)	NA	NA	NA	NA	NA
Secondary	NA	NA	NA	NA	NA
Imports for consumption (gross weight):					
Metal	46	50	212	94	100
Calomel[2]	8	165	260	47	140
Amalgam, not chemically defined	NA	NA	NA	NA	NA
Total	54	215	472	141	240
Exports (gross weight):					
Metal	287	300	319	390	300
Amalgam, not chemically defined	NA	NA	NA	NA	NA
Total	287	300	319	390	300
Price, average value, dollars per flask, free market[3]	170.00	400.00	775.00	650.00	550.00
Net import reliance[4] as a percentage of apparent consumption	E	E	E	E	E

Recycling: In 2007, five companies accounted for the majority of secondary mercury reclamation and production. Smaller companies collected dental amalgam, barometers, computers, gym flooring, manometers, thermometers, thermostats, and some mercury-containing toys and moved them on to larger companies for retorting. The reservoir of mercury-containing products for recycling is shrinking because of increased use of nonmercury substitute devices.

Import Sources (2003-06): Peru, 38%; Chile, 20%; Germany, 15%; Russia, 11%; and other, 16%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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 1,306 tons of mercury was held by the U.S. Department of Energy, Oak Ridge, TN.

Stockpile Status—9-30-07[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2006	Disposals FY 2006
Mercury	4,436	—	4,436	—	—

Prepared by **William E. Brooks [(703) 648-7791, wbrooks@usgs.gov, fax: (703) 648-7757]**

MERCURY

Events, Trends, and Issues: The United States is a leading exporter of mercury, and the principal export destinations of U.S. mercury in 2006 were the Netherlands (118 t), India (80 t), Vietnam (74 t), and Singapore (25 t). According to trade journals, the average cost of a flask of domestic mercury was $550 in 2007. The rising price of gold has driven the global demand for mercury that is used for artisanal gold mining. 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 U.S. Department of State, the U.S. Environmental Protection Agency, the U.S. Geological Survey, and other Government agencies participated in interagency meetings to address possible export bans of mercury. This ban is addressed by recent legislation that includes the Mercury Export Ban Act of 2007 (H.R. 1534) and the Mercury Market Minimization Act of 2007 (S. 3627). 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 gold-silver mining and processing, as is recycling of mercury from a diminishing supply of mercury-containing products such as auto convenience switches, dental amalgam, fluorescent lamps, and thermostats. Imported calomel is another significant source of mercury. Domestic mercury consumption will continue to decline as nonmercury-containing products, such as digital thermometers or galistan-containing thermometers, are substituted.

World Mine Production, Reserves, and Reserve Base: Reserves have been revised to zero for Spain because it no longer mines mercury; however, Spain is a leading exporter of virgin mercury produced from stockpiled ore.

	Mine production		Reserves[6]	Reserve base[6]
	2006	2007[e]		
United States	NA	NA	—	7,000
Algeria	—	—	—	3,000
China	1,100	1,100	—	—
Italy	—	—	—	69,000
Kyrgyzstan	250	250	7,500	13,000
Spain	—	—	—	90,000
Other countries	125	150	38,000	61,000
World total (rounded)	1,480	1,500	46,000	240,000

World Resources: China, Kyrgyzstan, Russia, Slovenia, Spain, and Ukraine have most of the world's estimated 600,000 tons of mercury resources. Spain, once a leading producer of mercury from its centuries-old Almaden Mine, stopped mining in 2003, and production is from stockpiled or recycled material. In the United States, there are mercury occurrences in Alaska, Arkansas, California, Nevada, and Texas; however, there has been no mining of mercury as a primary metal commodity since 1992. The declining consumption of mercury, except for artisanal gold mining, indicates that these resources are sufficient for another century or more of use. There are no data on the mercury produced from calomel or as a byproduct from gold, silver, or other mines.

Substitutes: Many dentists use ceramic composites as substitutes for mercury-containing dental amalgam for esthetic and human health concerns. "Galistan," an alloy of gallium, indium, and tin, or alternatively, digital thermometers, now replaces the mercury used in thermometers. At chlorine-caustic soda plants, mercury-cell technology is being replaced by newer diaphragm and membrane cell technology. Light-emitting diodes (LEDs) that contain indium, such as those used at the Thomas Jefferson Memorial in Washington, DC, 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 0.034 ton.
[2]Estimated to be 40% mercury content.
[3]Platts Metals Week average mercury price quotation for the year. Actual prices may vary significantly from quoted prices.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix B for definitions.
[6]See Appendix C for definitions.

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 71,800 tons in 2007. North Carolina accounted for about 40% of U.S. 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 2007 scrap mica production was estimated to be $8 million. Ground mica sales in 2006 were valued at about $49 million and were expected to decline in value in 2007. There were eight domestic producers of scrap and flake mica.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production:[2, 3]					
Mine	79	99	78	110	72
Ground	94	98	120	123	110
Imports, mica powder and mica waste	35	42	36	45	41
Exports, mica powder and mica waste	10	10	9	7	8
Consumption, apparent[4]	103	132	105	148	106
Price, average, dollars per metric ton, reported:					
Scrap and flake	213	155	248	204	112
Ground:					
Wet	938	NA	776	784	780
Dry	205	269	226	237	230
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine, number[5]	NA	NA	NA	NA	NA
Net import reliance[6] as a percentage of apparent consumption	24	25	26	26	32

Recycling: None.

Import Sources (2003-06): Canada, 38%; China, 28%; India, 23%; Finland, 6%; and other, 5%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
Mica powder	2525.20.0000	Free.
Mica waste	2525.30.0000	Free.

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

Government Stockpile: None.

Prepared by **James B. Hedrick [(703) 648-7725, jhedrick@usgs.gov, fax: (703) 648-7757]**

MICA (NATURAL), SCRAP AND FLAKE

Events, Trends, and Issues: Domestic production of ground mica decreased in 2007. The decrease primarily resulted from lower production in Alabama and North Carolina, but also included South Carolina, while production in Georgia and South Dakota increased. 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. India and China were the major sources of imported crude and rifted mica valued at under $1.00 per kilogram. The United States, Russia, and Finland were major world producers of scrap and flake mica in 2007. Imported mica scrap and flake is primarily used for making mica paper and as a filler and reinforcer in plastics.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7]	Reserve base[7]
	2006	2007[e]		
United States[2]	110	72	Large	Large
Brazil	4	4	Large	Large
Canada	18	18	Large	Large
Finland	71	70	Large	Large
France	10	10	Large	Large
India	4	4	Large	Large
Korea, Republic of	37	40	Large	Large
Norway	26	25	Large	Large
Russia	100	100	Large	Large
Other countries	33	15	Large	Large
World total (rounded)	410	360	Large	Large

World Resources: Resources of scrap and flake mica are available in granite, pegmatite, schist, and clay deposits 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 the 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 ground mica.
[5]Total employment at mines and mills where mica was produced and processed, excluding feldspar companies with byproduct production. Employees were not assigned to specific commodities in calculating employment.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]See Appendix C for definitions.

MICA (NATURAL), SHEET[1]

(Data in metric tons unless otherwise noted)

Domestic Production and Use: In 2007, a minor amount of sheet mica was produced, incidental to scrap and flake mica production and the mining of a gemstone-bearing pegmatite in Virginia. The domestic consuming industry was dependent upon imports and shipments of U.S. Government stockpile excesses to meet demand for sheet mica. During 2007, an estimated 141 tons of imported unworked mica split block and mica splittings valued at $171,000 was consumed by five companies in four States, mainly in the East and the Midwest. Most was fabricated into parts for electronic and electrical equipment. An additional estimated 1,760 tons of imported worked mica valued at $14 million also was consumed.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production, mine[e]	([2])	([2])	([2])	([2])	([2])
Imports, plates, sheets, strips; worked mica; split block; splittings; other > $1.00/kg	1,130	1,400	1,390	1,770	1,900
Exports, plates, sheets, strips; worked mica; crude and rifted into sheet or splittings > $1.00/kg	917	1,090	1,430	1,400	1,430
Shipments from Government stockpile excesses	1,280	1,170	38	6	4
Consumption, apparent	1,390	1,760	[3]3	[3]380	[3]478
Price, average value, dollars per kilogram, muscovite and phlogopite mica, reported:					
Block	67	67	125	130	135
Splittings	1.74	1.73	1.56	1.53	1.60
Stocks, fabricator and trader, yearend	NA	NA	NA	NA	NA
Net import reliance[4] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2003-06): India, 24%; Belgium, 21%; China, 15%; Brazil, 13%; and other, 27%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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:

Stockpile Status—9-30-07[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Block:					
Muscovite (stained and better)	0.68	0.077	([6])	([6])	3.9
Film, muscovite	—	—	—	—	—
Splittings:					
Muscovite	6.81	—	([6])	([6])	—
Phlogopite	—	—	—	—	—

Prepared by **James B. Hedrick [(703) 648-7725, jhedrick@usgs.gov, fax: (703) 648-7757]**

MICA (NATURAL), SHEET

Events, Trends, and Issues: Demand for sheet mica in 2007 increased for the second year in a row, following a 27% increase in imports in 2006. Imports of worked sheet increased for "plates, sheets, and strips of agglomerated or reconstituted mica," and declined for "mica, worked, and articles of mica not classified elsewhere." U.S. imports of split block declined to zero in 2007 (based on data through September), and imports of mica splittings declined as unworked sheet declined an estimated 60%. Shipments from the National Defense Stockpile (NDS) declined in 2007 as remaining stocks decreased. Stocks of muscovite film in the NDS were depleted by fiscal year 2004. Stocks of phlogopite splittings were sold out in fiscal year 2005, and remaining uncommitted stocks of muscovite block and muscovite splittings are 684 kilograms and 6,815 kilograms, respectively. Imports were the principal source of the domestic supply of sheet mica in 2007. Significant stocks of mica previously sold from the NDS to various mica traders and brokers 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 and 2007. Overall, stocks of mica remaining in the NDS declined in 2007, however, muscovite block stocks increased, as material that was previously committed was returned to the stockpile. Future supplies were expected to come increasingly from imports, primarily from China, India, and Russia. Prices for imported sheet mica also were expected to increase, and good quality sheet mica remained in short supply. There were no environmental concerns associated with the manufacture and use of mica products.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e]		Reserves[7]	Reserve base[7]
	2006	**2007**		
United States	([2])	([2])	Very small	Small
India	3,500	3,500	Very large	Very large
Russia	1,500	1,500	Moderate	Large
Other countries	200	200	Moderate	Large
World total	5,200	5,200	Very large	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®, nylon, nylatron, Nomex®, Noryl®, 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]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix B for definitions.
[6]The total disposal plan for all categories of mica in the National Defense Stockpile is all remaining stocks.
[7]See Appendix C for definitions.

MOLYBDENUM

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

Domestic Production and Use: In 2007, molybdenum, valued at about $3.8 billion (based on average oxide price), was produced by nine mines. Molybdenum ore was produced as a primary product at four mines, one each in Colorado, Idaho, Nevada, and New Mexico, whereas five copper mines (two 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 81% of the molybdenum consumed.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production, mine	33,500	41,500	58,000	59,800	59,400
Imports for consumption	11,900	17,300	20,700	16,700	19,500
Exports	21,900	34,500	42,100	34,500	35,200
Consumption:					
Reported	16,400	17,400	18,900	19,200	20,100
Apparent	26,200	24,100	34,600	43,900	44,000
Price, average value, dollars per kilogram[1]	11.75	36.73	70.11	54.62	64.68
Stocks, mine and plant concentrates, product, and consumer materials	7,200	7,500	9,400	7,400	7,100
Employment, mine and plant, number	510	630	880	910	940
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 (2003-06): Ferromolybdenum: China, 82%; Chile 7%; Canada, 4%; United Kingdom, 4%; and other, 3%. Molybdenum ores and concentrates: Canada, 33%; Chile, 31%; Mexico, 26%; Peru, 7%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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.

Prepared by **Michael J. Magyar [(703) 648-4964, mmagyar@usgs.gov, fax: (703) 648-7757]**

MOLYBDENUM

Events, Trends, and Issues: U.S. mine output of molybdenum in concentrate in 2007 decreased slightly from that of 2006. U.S. imports for consumption increased an estimated 17% from those of 2006, while the U.S. exports increased only about 2% from those of 2006. Domestic roasters operated at full production levels in 2006 and 2007. U.S. reported consumption increased 5% from that of 2006 while apparent consumption was about level, owing to reduced destocking offsetting increased imports. Mine capacity utilization in 2007 was about 80%.

China's high level of steel production and consumption continued to generate strong internal consumption of molybdenum. This consumption, coupled with limited production in the Huludao area of Liaoning Province, led to reduced Chinese exports in 2006 and 2007, and continued to support historically high molybdenum prices. Most byproduct and primary molybdenum mines in the United States maintained high production levels in 2007. Production capacity at the Henderson Mine, Empire, CO, was expanded to about 18,100 tons per year of contained molybdenum in 2006 and mine production approached that level in 2007. The Ashdown Mine, near Denio, NV, started molybdenum operations in 2007.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	2006	2007[e]	(thousand metric tons)	
United States	59,800	59,400	2,700	5,400
Armenia	3,000	3,000	200	400
Canada	7,270	8,000	450	910
Chile	43,278	41,100	1,100	2,500
China	43,900	46,000	3,300	8,300
Iran	2,000	2,500	50	140
Kazakhstan	250	400	130	200
Kyrgyzstan	250	250	100	180
Mexico	2,500	4,000	135	230
Mongolia	1,200	1,500	30	50
Peru	17,209	17,500	140	230
Russia[e]	3,100	3,100	240	360
Uzbekistan[e]	600	500	60	150
World total (rounded)	184,000	187,000	8,600	19,000

World Resources: Identified resources amount to about 5.4 million tons of molybdenum in the United States and about 13 million tons in the rest of the world. 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.

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 2007. 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 North Carolina. Approximately 52% of the primary nickel consumed went into stainless and alloy steel production, 34% into nonferrous alloys and superalloys, 10% into electroplating, and 4% into other uses. End uses were as follows: transportation, 30%; chemical industry, 15%; electrical equipment, 10%; construction, 9%; fabricated metal products, 8%; household appliances, 8%; petroleum industry, 7%; machinery, 6%; and other, 7%. Estimated value of apparent primary consumption was $4.19 billion.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production, refinery byproduct	W	W	W	W	W
Shipments of purchased scrap[1]	137,000	133,000	141,000	147,000	207,000
Imports: Primary	125,000	136,000	143,000	153,000	125,000
Imports: Secondary	11,500	18,800	15,500	20,300	15,100
Exports: Primary	6,330	8,000	7,630	8,050	13,000
Exports: Secondary	47,300	48,300	55,600	59,300	103,000
Consumption: Reported, primary[2]	90,400	102,000	100,000	124,000	113,000
Consumption: Reported, secondary[2]	101,000	103,000	101,000	108,000	119,000
Consumption: Apparent, primary	117,000	128,000	135,000	144,000	112,000
Consumption: Total[3]	218,000	232,000	236,000	252,000	231,000
Price, average annual, London Metal Exchange:					
Cash, dollars per metric ton	9,629	13,823	14,738	24,244	37,744
Cash, dollars per pound	4.368	6.270	6.685	10.997	17.121
Stocks: Consumer, yearend	11,700	11,900	13,500	14,100	14,100
Stocks: Producer, yearend[4]	8,040	6,580	5,940	6,450	6,500
Net import reliance[5] as a percentage of apparent consumption	45	49	48	49	17

Recycling: About 119,000 tons of nickel was recovered from purchased scrap in 2007. This represented about 52% of reported secondary plus apparent primary consumption for the year.

Import Sources (2003-06): Canada, 41%; Russia, 16%; Norway, 11%; Australia, 8%; and other, 24%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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 5,100 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: World nickel mine production was at an alltime high in 2007, just meeting demand. Stainless steel accounted for two-thirds of global primary nickel use. U.S. production of austenitic (nickel-bearing) stainless steel reached a record high of 1.71 million tons in 2006, 21% more than the 1.41 million tons in 2005. Since 1993, global stainless steel production has been growing at an average rate of 5.6% per year. Consumption of stainless steel in China has been particularly robust since 2003 and exceeded the combined output of Japan and the United States in 2007. Chinese and Australian companies have joined to explore for nickel across China. China imported nickel feedstocks from six countries to help supply its growing stainless steel-producing industry. Brazil was expected to become a significant global supplier of nickel by 2012. Nickel prices climbed to unprecedented levels in the first half of 2007, but weakened during the summer. In October 2007, the London Metal Exchange cash mean for 99.8%-pure nickel averaged $31,045 per metric ton ($14.08 per pound).

Prepared by **Peter H. Kuck [(703) 648-4965, pkuck@usgs.gov, fax: (703) 648-7757]**

NICKEL

Acquisitions and mergers have completely changed the structure of the global nickel industry since 2004. In 2006, the two leading nickel producers in Canada were taken over by even larger foreign mining companies. In 2007, the leading nickel producer in the world—a Russian company—created an entire overseas production operation by acquiring and then integrating existing facilities in Australia, Botswana, and Finland. The larger of the two Canadian takeover targets was preparing to commission a laterite mining complex at Goro, New Caledonia. The New Caledonian nickel was to be recovered onsite using advanced pressure acid leach technology. Australia's leading nickel producer was developing a laterite deposit near Ravensthorpe, Western Australia. Nickel and cobalt were to be leached from the ore and converted onsite to an intermediate hydroxide, which would be refined at Yabulu, Queensland. Several other companies were considering employing some form of acid leach technology to recover nickel at greenfield sites in Brazil, Cuba, Guatemala, Indonesia, Kazakhstan, Madagascar, and the Philippines. A new type of heap-leaching process was being used to recover nickel in Turkey. Work was underway on a more traditional, ferronickel plant in Goias, Brazil. Some nickel consumers were concerned that global consumption of the metal would outstrip supply before new mining projects could be completed. Continued high prices for gasoline and other petroleum products have spurred development and production of novel hydrogen storage and battery materials, such as lanthanum-nickel-cobalt alloys. Nickel-metal hydride (NiMH) batteries continue to be widely used in hybrid motor vehicles, despite inroads made by lithium-ion batteries. Sales in the United States of hybrid electric passenger vehicles have risen steadily to 247,000 in 2006 from 9,370 in 2000. Major air carriers began ordering planes again, after a 5-year lull in the wake of the 2001 terrorist attacks, thus increasing demand for superalloys.

World Mine Production, Reserves, and Reserve Base: Estimates of reserves for Canada and New Caledonia and the reserve base for the United States were revised based on new mining industry information.

	Mine production		Reserves[6]	Reserve base[6]
	2006	2007[e]		
United States	—	—	—	150,000
Australia	185,000	180,000	24,000,000	27,000,000
Botswana	38,000	35,000	490,000	920,000
Brazil	82,500	75,300	4,500,000	8,300,000
Canada	233,000	258,000	4,900,000	15,000,000
China	82,100	80,000	1,100,000	7,600,000
Colombia	94,100	99,500	830,000	1,100,000
Cuba	75,000	77,000	5,600,000	23,000,000
Dominican Republic	46,500	47,000	720,000	1,000,000
Greece	21,700	20,100	490,000	900,000
Indonesia	140,000	145,000	3,200,000	13,000,000
New Caledonia[7]	103,000	119,000	7,100,000	15,000,000
Philippines	58,900	88,400	940,000	5,200,000
Russia	320,000	322,000	6,600,000	9,200,000
South Africa	41,600	42,000	3,700,000	12,000,000
Venezuela	20,000	20,000	560,000	630,000
Zimbabwe	8,820	9,000	15,000	260,000
Other countries	34,300	41,000	2,100,000	5,900,000
World total (rounded)	1,580,000	1,660,000	67,000,000	150,000,000

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% 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 begun 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-base 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]Changes in this section are due to revisions of 2003-05 ferrous scrap data, resulting from new information and improved software.

[3]Apparent primary consumption + reported secondary consumption.

[4]Stocks of producers, agents, and dealers held only in the United States.

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

[6]See Appendix C for definitions.

[7]Overseas territory of France.

NIOBIUM (COLUMBIUM)

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

Domestic Production and Use: No significant U.S. niobium mine production has been reported since 1959. Domestic niobium resources are of low grade, some are mineralogically complex, and most are not commercially recoverable. Five companies 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, 69%; superalloys, 31%. In 2007, the estimated value of niobium consumption was $161 million.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production:					
Mine	—	—	—	—	—
Secondary	NA	NA	NA	NA	NA
Imports for consumption[e, 1]	5,590	6,910	7,610	10,500	10,500
Exports[e, 1]	170	276	337	561	600
Government stockpile releases[e, 2]	223	90	152	156	10
Consumption:[e]					
Apparent	5,640	6,730	7,430	10,100	10,000
Reported[3]	3,670	4,220	4,600	5,050	5,000
Price, ferroniobium, dollars per pound[4]	6.60	6.57	6.58	NA	NA
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

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

Import Sources (2003-06): Niobium contained in niobium and tantalum ore and concentrate; ferroniobium; and niobium metal and oxide: Brazil, 83%; Canada, 8%; Estonia, 2%; Germany, 2%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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	8112.92.0600[6]	Free.
Alloys, metal, powders	8112.92.4000	4.9% ad val.
Niobium, other	8112.99.9000[6]	4.0% ad val.

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

Government Stockpile: For fiscal year 2007, the Defense National Stockpile Center (DNSC), Defense Logistics Agency, disposed of 31 tons of niobium contained in niobium mineral concentrates. The DNSC's niobium mineral concentrate inventory was exhausted in 2007, its niobium carbide inventory was exhausted in 2002, and its ferroniobium inventory was exhausted in 2001. The DNSC announced maximum disposal limits for fiscal year 2008 of about 9 tons[7] of niobium metal ingots.

Stockpile Status—9-30-07[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Niobium:					
Concentrates	—	—	—	254	31
Metal	10	—	10	9	—

Prepared by **John F. Papp [(703) 648-4963, jpapp@usgs.gov, fax: (703) 648-7757]**

NIOBIUM (COLUMBIUM)

Events, Trends, and Issues: Niobium was imported principally in the form of ferroniobium (71%) and niobium unwrought metal, alloy, and powder (14%). Brazil was the leading supplier of niobium. By weight, Brazil supplied 91% of ferroniobium and 82% of niobium unwrought metal, alloy, and powder. Niobium apparent consumption is believed to have increased slightly in 2007 compared with that of 2006.

World Mine Production, Reserves, and Reserve Base: The Australian and Brazilian reserves and reserve base were revised based on information reported by their respective Governments. Canadian reserves and reserve base were revised based on information published by a mining company.

	Mine production		Reserves[9]	Reserve base[9]
	2006	2007[e]		
United States	—	—	—	NA
Australia	200	200	21,000	320,000
Brazil	40,000	40,000	2,600,000	2,600,000
Canada	4,167	4,200	62,000	92,000
Ethiopia	11	10	NA	NA
Mozambique	29	30	NA	NA
Nigeria	35	40	NA	NA
Rwanda	80	80	NA	NA
Other countries	18	20	NA	NA
World total (rounded)	44,500	45,000	2,700,000	3,000,000

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 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 2007 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. Imports have been aggregated for consistency.
[2]Government stockpile releases are the uncommitted inventory change as reported by the Defense National Stockpile Center (DNSC). In Mineral Commodity Summaries 2007, Government stockpile releases were the sales reported by DNSC.
[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]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]This category includes other than niobium-containing material.
[7]Actual quantity limited to remaining sales authority; additional legislative authority is required.
[8]See Appendix B for definitions.
[9]See Appendix C for definitions.

NITROGEN (FIXED)—AMMONIA

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

Domestic Production and Use: Ammonia was produced by 14 companies at 24 plants in 16 States in the United States during 2007; 3 additional plants were idle for the entire year. Fifty-seven 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 2007, U.S. producers operated at about 86% 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 90% 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]	2003	2004	2005	2006	2007[e]
Production[2]	8,450	8,990	8,340	8,180	8,300
Imports for consumption	5,720	5,900	6,520	5,920	6,500
Exports	400	381	525	194	100
Consumption, apparent	13,900	14,400	14,400	14,000	14,700
Stocks, producer, yearend	195	298	254	201	200
Price, dollars per ton, average, f.o.b. Gulf Coast[3]	245	274	314	302	300
Employment, plant, number[e]	1,550	1,300	1,150	1,150	1,050
Net import reliance[4] as a percentage of apparent consumption	39	38	42	41	44

Recycling: None.

Import Sources (2003-06): Trinidad and Tobago, 55%; Canada, 16%; Russia, 12%; Ukraine, 9%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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: Natural gas prices stabilized somewhat during 2007. Except for a brief spike in February, the Henry Hub spot natural gas price fluctuated between $5 and $8 per million British thermal units for most of the year. The average Gulf Coast ammonia price also fell from $345 per short ton at the beginning of 2007 to its low for the year of $265 per short ton at the beginning of August before beginning to increase. The U.S. Department of Energy, Energy Information Administration, projected that Henry Hub natural gas spot prices would average $7.62 per million British thermal units in 2008.

Despite sustained high natural gas prices in the United States, a new 1.2-million-ton-per-year ammonia plant was scheduled to be constructed in Faustina, LA, by 2010. The new plant was expected to be fed by a proposed synthetic gas facility to be constructed concurrently. Two current ammonia producers signed agreements to market the ammonia produced at the plant. The 231,000-ton-per-year Beaumont, TX, ammonia plant that has been closed since 2004 was purchased by a chemical company that planned to integrate the facility into a $1.6 billion industrial gasification project that it was developing at Beaumont. The project was scheduled to be operational by 2011.

Prepared by **Deborah A. Kramer [(703) 648-7719, dkramer@usgs.gov, fax: (703) 648-7975]**

NITROGEN (FIXED)—AMMONIA

In September, the Kenai, AK, ammonia plant was closed because of a shortage of supply of natural gas from Alaska's Cook Inlet. The plant had been operating at reduced capacity for several years because of the natural gas shortage. Much of the plant's output was exported to the Republic of Korea. The company that owned the plant, however, continued to investigate the feasibility of a coal gasification project. The gas produced would replace natural gas as the plant's feedstock, but the earliest the coal gasification facility could be operational is 2012.

Two ammonia plants outside the United States were opened in 2007—a 677,000-ton-per-year plant in Iran and a 1.1-million-ton-per-year plant in Saudi Arabia. Several companies announced plans to build new ammonia plants in Algeria, Egypt, Pakistan, Qatar, and Saudi Arabia, which, if completed on time, would add 6 million tons of annual capacity by the end of 2010. Two plants in Spain, with a total capacity of 600,000 tons per year, and a plant in the United Kingdom, with a capacity of 265,000 tons per year, were closed in 2007.

According to the U.S. Department of Agriculture, U.S. corn growers planted 37.8 million hectares of corn in the 2007 crop year (July 1, 2006, to June 30, 2007), which was the largest area planted in corn in more than 60 years. The increase in plantings was principally in response to the expected increase in consumption of corn for ethanol production. Corn plantings for the 2008 crop year, however, were expected to decrease to 35.2 million hectares. Although this would be less than that planted in the 2007 crop year, it still would be 8% to 12% above the 1997-2006 average. The decrease was attributed to an increase in prices for competing crops, such as soybeans and wheat, and a 50% increase in corn stocks at the end of the 2007 crop year compared with those at the end of 2006.

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

World Ammonia Production, Reserves, and Reserve Base:

	Plant production		Reserves and reserve base[5]
	2006	2007[e]	
United States	8,180	8,300	Available atmospheric nitrogen and sources of natural gas for production of ammonia are considered adequate for all listed countries.
Canada	4,000	3,700	
China	39,000	39,500	
Egypt	1,800	2,500	
Germany	2,300	2,200	
India	10,900	9,200	
Indonesia	4,300	4,400	
Netherlands	1,800	1,750	
Pakistan	2,200	2,200	
Poland	2,100	2,100	
Qatar	1,750	1,850	
Russia	10,500	11,000	
Saudi Arabia	2,000	2,600	
Trinidad and Tobago	5,190	5,200	
Ukraine	4,200	4,200	
Other countries	23,400	24,000	
World total (rounded)	124,000	125,000	

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.

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 $19.1 million in 2007. Peat was harvested and processed by about 40 companies in 15 of the conterminous States. The Alaska Department of Commerce, Office of Minerals Development, which conducted its own canvass of producers, reported 42,000 cubic meters of peat was produced in 2006; output was reported only by volume.[2] A production estimate was unavailable for Alaska for 2007. Florida, Michigan, and Minnesota were the leading producing States, in order of quantity harvested. Reed-sedge peat accounted for approximately 85% of the total volume produced, followed by sphagnum moss, 7%, humus, 6%, and hypnum moss, 2%. More than 87% 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 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:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production	634	696	685	551	615
Commercial sales	632	741	751	734	747
Imports for consumption	767	786	891	924	980
Exports	29	29	36	41	55
Consumption, apparent[3]	1,400	1,380	1,600	1,500	1,540
Price, average value, f.o.b. mine, dollars per ton	29.74	28.64	27.76	27.34	25.57
Stocks, producer, yearend	180	251	195	128	125
Employment, mine and plant, number[e]	700	700	700	650	625
Net import reliance[4] as a percentage of apparent consumption	55	50	57	63	60

Recycling: None.

Import Sources (2003-06): Canada, 98%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Peat	2703.00.0000	Free.

Depletion Allowance: 5% (Domestic).

Government Stockpile: None.

Prepared by **Stephen M. Jasinski [(703) 648-7711, sjasinsk@usgs.gov, fax: (703) 648-7757]**

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.

World Mine Production, Reserves, and Reserve Base: 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]	Reserve base[5]
	2006	2007[e]		
United States	551	615	150,000	10,000,000
Belarus	2,500	2,500	400,000	4,000,000
Canada	1,245	1,250	720,000	30,000,000
Estonia	1,100	1,100	60,000	2,000,000
Finland	9,100	9,000	6,000,000	6,400,000
Ireland	4,300	4,500	([6])	([6])
Latvia	650	650	76,000	1,300,000
Lithuania	550	550	190,000	300,000
Moldova	475	475	([6])	([6])
Russia	1,500	1,500	1,000,000	60,000,000
Sweden	1,370	1,300	([6])	([6])
Ukraine	1,000	1,000	([6])	([6])
Other countries	1,460	1,450	1,400,000	6,000,000
World total (rounded)	25,800	25,900	10,000,000	120,000,000

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 county. Reserve and reserve base 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 located 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]Szumigala, D.J., and Hughes, R.A., 2007, Alaska's mineral industry 2006—A summary: Alaska Department of Natural Resources Information Circular 54, p. 20.
[3]Defined as production + imports – exports + adjustments for industry stocks.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.
[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 perlite produced in 2007 was $20.7 million. Crude ore production came from eight mines operated by seven companies in six Western States. New Mexico continued to be the major producing State. Processed ore was expanded at 61 plants in 31 States. The principal end uses were building construction products, 60%; horticultural aggregate, 14%; fillers, 11%; filter aid, 7.5%; and other, 7.5%.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production[1]	493	508	508	454	444
Imports for consumption[e]	245	238	196	245	220
Exports[e]	37	37	32	30	30
Consumption, apparent	701	709	672	669	634
Price, average value, dollars per ton, f.o.b. mine	38.20	41.81	40.68	42.90	51.61
Employment, mine and mill	194	133	128	114	101
Net import reliance[2] as a percentage of apparent consumption	30	28	24	32	30

Recycling: Not available.

Import Sources (2003-06): Greece, 100%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
Vermiculite, perlite and chlorites, unexpanded	2530.10.0000	Free.

Depletion Allowance: 10% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Wallace P. Bolen [(703) 648-7727, wbolen@usgs.gov, fax: (703) 648-7975]**

PERLITE

Events, Trends, and Issues: The amount of processed perlite sold or used from U.S. mines dropped to its lowest level since 1983 when about 430,000 tons of processed perlite were sold or used. Domestic miners continued to lose market share to imports. Imports also decreased to about 220,000 tons, as consumption dropped to its lowest levels since 1993.

The cost of rail transportation from the mines in the Western United States to some areas of the Eastern United States continued to burden domestic perlite producers with strong cost disadvantages compared with Greek perlite exporters. However, U.S. perlite exports to Canada partially offset losses from competition with imports in Eastern U.S. markets.

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, Reserves, and Reserve Base: 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]	Reserve base[3]
	2006	2007[e]		
United States	454	444	50,000	200,000
Greece	525	500	50,000	300,000
Hungary	140	140	3,000	([4])
Japan	240	240	([4])	([4])
Mexico	100	100	([4])	([4])
Turkey	145	140	([4])	5,700,000
Other countries	205	200	600,000	1,500,000
World total (rounded)	1,810	1,760	700,000	7,700,000

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 and reserve base data are for crude ore.
[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 29.7 million tons of marketable product valued at $1.17 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 37% of the wet-process phosphoric acid produced was exported in the form of upgraded granular diammonium and monoammonium phosphate (DAP and MAP, respectively) fertilizer, merchant-grade phosphoric acid, and triple superphosphate fertilizer. 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:	2003	2004	2005	2006	2007[e]
Production, marketable	35,000	35,800	36,100	30,100	29,700
Sold or used by producers	36,400	36,500	35,200	30,200	31,000
Imports for consumption	2,400	2,500	2,630	2,420	2,800
Exports	64	—	—	—	—
Consumption[1]	38,800	39,000	37,800	32,600	33,800
Price, average value, dollars per ton, f.o.b. mine[2]	27.01	27.79	29.61	30.49	39.30
Stocks, producer, yearend	7,540	7,220	6,970	7,070	5,000
Employment, mine and beneficiation plant, number[e]	2,900	2,700	2,700	2,500	2,350
Net import reliance[3] as a percentage of apparent consumption	9	7	7	7	14

Recycling: None.

Import Sources (2003-06): Morocco, 99%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Natural calcium phosphates:		
Unground	2510.10.0000	Free.
Ground	2510.20.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Stephen M. Jasinski [(703) 648-7711, sjasinsk@usgs.gov, fax: (703) 648-7757]**

PHOSPHATE ROCK

Events, Trends, and Issues: In 2007, U.S. phosphate rock production fell below 30 million tons for the first time in more than 40 years, owing to lower production in Florida. Additionally, phosphate companies in Florida used a substantial amount of phosphate rock from stocks. One mine in Florida reopened after being closed for 18 months, but its output was offset by mine closures that occurred in 2006. China has surpassed the United States as the leading producer of phosphate rock in the world.

Domestic consumption of phosphate rock increased slightly because of higher phosphoric acid output. Domestic consumption of phosphate fertilizers was predicted to increase from 4 million tons P_2O_5 to about 4.3 million metric tons in 2008 because of higher corn planting, primarily for ethanol production.

The United States remained the world's leading consumer, producer, and supplier of phosphate fertilizers; however, its share of the world market has been shrinking. Phosphate fertilizer production increasingly is being located in the large consuming regions of Asia and South America, reducing the need for imported fertilizers to these regions. U.S. exports of phosphate fertilizer to China and India, the two largest consumers of phosphate fertilizers, have dropped significantly since 2000. Exports of DAP to India rebounded slightly in 2005-06 owing to temporary plant closures in India and increased consumption, but dropped by about 30% from 2006 to 2007 because of increased foreign competition. Export tonnage of P_2O_5 contained in phosphate fertilizers decreased by about 20% in 2007 compared with that of 2006.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2006	2007[e]		
United States	30,100	29,700	1,200,000	3,400,000
Australia	2,300	2,200	77,000	1,200,000
Brazil	5,800	6,000	260,000	370,000
Canada	550	500	25,000	200,000
China	30,700	35,000	6,600,000	13,000,000
Egypt	2,200	2,300	100,000	760,000
Israel	2,950	3,000	180,000	800,000
Jordan	5,870	5,700	900,000	1,700,000
Morocco and Western Sahara	27,000	28,000	5,700,000	21,000,000
Russia	11,000	11,000	200,000	1,000,000
Senegal	600	800	50,000	160,000
South Africa	2,600	2,700	1,500,000	2,500,000
Syria	3,850	3,800	100,000	800,000
Togo	1,000	1,000	30,000	60,000
Tunisia	8,000	7,700	100,000	600,000
Other countries	7,740	8,000	890,000	2,200,000
World total (rounded)	142,000	147,000	18,000,000	50,000,000

World Resources: Foreign reserve data were derived from information received from Government sources, individual companies, and independent sources. Reserve data for China were based on official government data and included deposits of low-grade ore. Production data for China do not include small "artisanal" mines. Domestic reserve 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, but cannot be recovered economically with current technology.

Substitutes: There are no substitutes for phosphorus in agriculture.

[e]Estimated. — Zero.
[1]Defined as phosphate rock sold or used + imports – exports.
[2]Marketable phosphate rock, weighted value, all grades, domestic and export.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions.

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 are 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. Catalysts for air-pollution abatement continued to be the leading demand sector for PGMs. Catalysts were also used in other air-pollution-abatement processes to remove organic vapors, odors, and carbon monoxide. Chemical uses include catalysts for organic synthesis, production of nitric acid, and fabrication of laboratory equipment. 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.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Mine production:[1]					
Platinum	4,170	4,040	3,920	4,290	3,400
Palladium	14,000	13,700	13,300	14,400	13,500
Imports for consumption:					
Platinum	88,500	86,400	106,000	114,000	140,000
Palladium	105,000	127,000	139,000	119,000	105,000
Rhodium	12,000	13,200	13,600	15,900	18,000
Ruthenium	15,900	18,800	23,200	36,000	37,000
Iridium	2,200	3,230	3,010	2,800	3,000
Osmium	53	75	39	56	40
Exports:					
Platinum	22,200	20,000	20,700	45,500	27,000
Palladium	22,300	31,500	27,000	53,100	45,000
Rhodium	479	311	615	1,600	2,000
Other PGMs	145	1,086	1,080	3,390	7,000
Price,[2] dollars per troy ounce:					
Platinum	694.44	848.76	899.51	1,144.42	1,260.00
Palladium	203.00	232.93	203.54	322.93	360.00
Rhodium	530.28	983.24	2,059.73	4,561.06	6,060.00
Ruthenium	35.43	64.22	74.41	193.09	610.00
Iridium	93.02	185.33	169.51	349.45	440.00
Employment, mine, number[1]	1,540	1,580	1,620	1,720	1,700
Net import reliance as a percentage of apparent consumption[e]					
Platinum	91	92	93	90	94
Palladium	82	83	84	75	73

Recycling: An estimated 12,700 kilograms of PGMs was recovered from new and old scrap in 2007.

Import Sources (2003-06): Platinum: South Africa, 44%; United Kingdom, 15%; Germany, 11%; Canada, 6%; and other, 24%. Palladium: Russia, 39%; South Africa, 24%; United Kingdom, 16%; Norway, 4%; and other, 17%.

Tariff: All unwrought and semimanufactured forms of PGMs can be imported duty free.

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

Government Stockpile:

Stockpile Status—9-30-07[3]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2007**	**Disposals FY 2007**
Platinum	261	—	[4]3,110	388	—
Palladium	—	—	[4]778	756	—
Iridium	18	—	[4]186	254	105

Prepared by **Micheal W. George [(703) 648-4962, mgeorge@usgs.gov, fax: (703) 648-7757]**

PLATINUM-GROUP METALS

Events, Trends, and Issues: The desire for an alternative fuel for automobiles has led to a large global public and private effort to develop fuel cell technology. Platinum is the catalyst used by fuel cells to convert hydrogen and oxygen to electricity. An increase in diesel car sales in Europe can be expected to cause a strong increase in use of platinum in the region in 2007 and beyond. The tightening of emissions standards in China, Europe, Japan, and other parts of the world is also 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 price differential of about $900 per troy ounce between platinum and palladium has led to the assumption that automobile manufacturers will change PGMs ratios in gasoline-engine vehicles in favor of palladium. The sales of platinum jewelry are expected to drop worldwide, as the price continues to be high and white gold and palladium are substituted for platinum.

World Mine Production, Reserves, and Reserve Base:

	Mine production				PGMs	
	Platinum		Palladium		Reserves[5]	Reserve base[5]
	2006	2007[e]	2006	2007[e]		
United States	4,290	3,400	14,400	13,500	900,000	2,000,000
Canada	9,000	8,500	14,000	18,000	310,000	390,000
Colombia	1,100	1,100	NA	NA	([6])	([6])
Russia	29,000	27,000	98,400	95,000	6,200,000	6,600,000
South Africa	170,000	183,000	85,000	93,000	63,000,000	70,000,000
Zimbabwe	5,100	5,400	4,000	4,400	([6])	([6])
Other countries	2,190	1,500	8,210	8,100	800,000	850,000
World total (rounded)	221,000	230,000	224,000	232,000	71,000,000	80,000,000

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 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 will be limited to remaining monetary sales authority or inventory.
[5]See Appendix C for definitions.
[6]Included with "Other countries."

POTASH

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

Domestic Production and Use: In 2007, the production value of marketable potash, f.o.b. mine, was about $517 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, a 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:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production, marketable[1]	1,100	1,200	1,200	1,100	1,200
Imports for consumption	4,720	4,920	4,920	4,470	5,300
Exports	329	233	200	332	300
Consumption, apparent[2]	5,600	6,000	6,000	5,200	6,200
Price, dollars per metric ton of K_2O, average, muriate, f.o.b. mine[3]	170	200	280	290	390
Employment, number:					
Mine	520	520	500	500	500
Mill	620	620	630	630	630
Net import reliance[4] as a percentage of apparent consumption	80	80	80	79	81

Recycling: None.

Import Sources (2003-06): Canada, 88%; Belarus, 6%; Russia, 3%; Germany, 1%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Potassium nitrate	2834.21.0000	Free.
Potassium chloride	3104.20.0000	Free.
Potassium sulfate	3104.30.0000	Free.
Potassic fertilizers, other	3104.90.0100	Free.
Potassium-sodium nitrate mixtures	3105.90.0010	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: About 93% of the world potash production was consumed by the fertilizer industry. The United States ranked sixth 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. Potash demand and prices increased throughout the year domestically and worldwide as a result of more crop acres that required potash fertilizer being planted, owing in part to high grain prices. Initiatives promoting the production of biofuels (transportation fuels made from agricultural products) have spurred increased plantings and increased fertilizer consumption.

U.S. production has been relatively stable for several years, but the increased demand prompted some producers to consider capacity expansions in New Mexico and Utah. One company, however, planned to close a solution mining operation in Michigan. Initially, the closure was announced to take place in 2007, but market conditions delayed the closure of the mine until 2008. Canada continued to lead the world in potash production, and output reached record levels. In addition to restarting idled operations, plans were announced to expand current facilities in Saskatchewan, open a new mine in New Brunswick, and explore for potash in Manitoba.

Prepared by **Joyce A. Ober [(703) 648-7717, jober@usgs.gov, fax: (703) 648-7757]**

POTASH

Production increased in Russia and Belarus, two other major potash producers, which ranked second and third, respectively, in global potash production. Projects to increase capacity were underway in both countries. After a mine flood in Russia in 2006, expectations were for reduced production in that country, but the strong market spurred additional production at other operations. The flood, however, had unanticipated consequences that became evident in late July 2007 when a sinkhole began to form near Berezniki and continued to expand in size until October, threatening the integrity of a nearby rail line. The precarious situation resulted in the emergency rerouting of the rail line, and shipments from other potash operations were delayed.

The Russian Federal Antimonopoly Service conducted an investigation into allegations of unfairly high prices that resulted in the imposition of export tariffs, price caps for potash sold in Russia, and fines levied against the producers. The potash companies responded with lawsuits that overturned the rulings by the Russian agency. In Russia, 85% of all fertilizer is exported, making export tariffs detrimental to producers and causing increased prices worldwide.

A company in Jordan announced plans to increase capacity at its facilities on the Dead Sea by early 2009. The project included expanded evaporation ponds, construction of a new refinery, and additional compaction facilities. The Jordanian firm also contemplated building a new potassium sulfate operation in Egypt. Based on the strong market, a company in the United Kingdom made investments to prolong potash production for at least 20 more years.

World Mine Production, Reserves, and Reserve Base: The reserve base data for Canada were revised based on information provided by a Canadian Government agency.

	Mine production 2006	Mine production 2007[e]	Reserves[5]	Reserve base[5]
United States	[1]1,100	[1]1,200	90,000	300,000
Belarus	4,605	5,400	750,000	1,000,000
Brazil	405	410	300,000	600,000
Canada	8,360	11,000	4,400,000	11,000,000
Chile	450	450	10,000	50,000
China	600	700	8,000	450,000
Germany	3,620	3,700	710,000	850,000
Israel	2,200	2,000	[6]40,000	[6]580,000
Jordan	1,036	1,100	[6]40,000	[6]580,000
Russia	5,720	6,300	1,800,000	2,200,000
Spain	437	450	20,000	35,000
Ukraine	65	65	25,000	30,000
United Kingdom	480	450	22,000	30,000
Other countries	—	—	50,000	140,000
World total (rounded)	29,100	33,000	8,300,000	18,000,000

World Resources: Estimated domestic potash resources total about 6 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 approximately 2 billion tons, mostly at depths of more than 1,200 meters. A large potash resource lies about 2,100 meters under central Michigan. The U.S. reserve figure above includes approximately 62 million tons in central Michigan. Estimated world resources total about 250 billion tons. The potash deposits in Russia and Thailand contain large amounts of carnallite; it is not clear if this can be mined profitably in a free market economy.

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]Rounded to within 0.1 million tons to avoid disclosing company proprietary data.
[2]Rounded to within 0.2 million tons to avoid disclosing company proprietary data.
[3]Average prices based on actual sales; excludes soluble and chemical muriates.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.
[6]Total reserves and reserve base 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 2007 was about $43 million. Domestic output came from 17 producers at 19 mines in 7 States. Pumice and pumicite were mined in California, Arizona, New Mexico, Oregon, Idaho, Nevada, and Kansas, in descending order of production. About 49% of production came from Arizona and California. About 85% of the pumice was consumed for building blocks. Horticulture consumed 5%; concrete admixture and aggregate, 5%; abrasives, 3%; and the remaining 2% was used in landscaping, stone-washing laundries, and other applications.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production, mine[1]	870	1,490	1,270	1,540	1,410
Imports for consumption	367	402	240	365	369
Exports[e]	26	27	21	22	22
Consumption, apparent	1,210	1,870	1,490	1,880	1,760
Price, average value, dollars per ton, f.o.b. mine or mill	25.20	16.80	31.00	28.85	30.33
Employment, mine and mill, number	100	100	110	110	115
Net import reliance[2] as a percentage of apparent consumption	28	20	15	18	20

Recycling: Not available.

Import Sources (2003-06): Greece, 75%; Italy, 21%; Turkey, 3%; and other, 1%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
Crude or in irregular pieces, including crushed pumice	2513.10.0010	Free.
Other	2513.10.0080	Free.

Depletion Allowance: 5% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Wallace P. Bolen [(703) 648-7727, wbolen@usgs.gov, fax: (703) 648-7975]**

PUMICE AND PUMICITE

Events, Trends, and Issues: The amount of domestically produced pumice and pumicite sold or used in 2007 decreased by 8% to 1.41 million tons compared with 1.54 million tons in 2006. Imports remained about the same as those of 2006. More than 96% of pumice imports were from Greece and Italy to supply markets in the Eastern United States and Gulf Coast. Apparent consumption in 2007 fell by about 6.5% compared with that of 2006.

In 2008, domestic mine production of pumice and pumicite and U.S. apparent consumption are expected to decrease owing to continued softness in the housing construction industry. Although pumice and pumicite are plentiful in the Western United States, changes in laws and public land designations could limit access to many deposits. Pumice and pumicite production is sensitive to mining and transportation costs, and if domestic production costs increase, imports and competing materials might replace pumice in many domestic markets.

All domestic mining of pumice in 2007 was by open pit methods and was 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 a dust problem at some operations, the environmental impact was restricted to a small geographic area.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	2006	2007[e]		
United States[1]	1,540	1,410	Large	Large
Algeria	500	430		
Cameroon	600	600		
Chile	1,620	1,600		
Ecuador	640	830	Quantitative estimates of reserves and reserve base for most countries are not available.	
France	450	450		
Greece	2,250	2,300		
Iran	1,600	1,500		
Italy	4,600	4,600		
Spain	900	600		
Syria	650	650		
Turkey	900	700		
Other countries	2,600	2,600		
World total (rounded)	18,800	18,300	NA	NA

World Resources: The identified U.S. resources of pumice and pumicite in the West are 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. Italy, Greece, and Chile are the leading producers of pumice and pumicite, followed by Iran, the United States, and Turkey. Recent analysis shows that the production estimates of past years for pumice and pumicite from some countries, notably Greece, Ecuador, and Cameroon, may have been erroneous. More reliable sources were used for the current production figures. There are large resources of pumice and pumicite on all continents.

Substitutes: The costs of transportation determine the maximum distance that pumice and pumicite can be shipped and still remain competitive with alternate materials. Competitive materials that can be substituted for pumice and pumicite for several end uses include crushed aggregates, diatomite, expanded shale and clay, and vermiculite.

[e]Estimated. NA Not available.
[1]Quantity sold and used by producers.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions.

QUARTZ CRYSTAL (INDUSTRIAL)

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Lascas[1] mining and processing in Arkansas ended in 1997 and, in 2007, no U.S. firms reported the production of cultured quartz crystals. Cultured quartz crystal production capacity still exists in the United States using imported and stockpiled lascas as feed material. 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.

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: Production statistics for cultured quartz crystals were withheld to avoid disclosing company proprietary data. The U.S. Department of Commerce (DOC), which is the primary Government source of U.S. trade data, does not provide specific import or export statistics on lascas. The DOC 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. The average value of as-grown cultured quartz and lumbered quartz, which is as-grown quartz that has been processed by sawing and grinding, was estimated to be about $215 per kilogram in 2007. Other salient statistics were not available.

Recycling: None.

Import Sources (2003-06): The United States is 100% import reliant. Brazil, Germany, and Madagascar reportedly are the major sources for lascas, with Canada becoming an important supplier. Other possible sources of lascas include China, South Africa, and Venezuela.

Tariff:

Item	Number	Normal Trade Relations 12-31-07
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:

Stockpile Status—9-30-07[2]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Quartz crystal	7	—	—	—	—

Prepared by **Thomas P. Dolley [(703) 648-7710, tdolley@usgs.gov, fax: (703) 648-7975]**

QUARTZ CRYSTAL (INDUSTRIAL)

Events, Trends, and Issues: Trends indicate that demand for quartz crystal devices should continue to grow, and consequently, quartz crystal production should 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, Reserves, and Reserve Base:[3] This information is unavailable, but the global reserve base for lascas is 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) and lithium tantalate, which have larger piezoelectric coupling constants, have been studied.

— 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.

RARE EARTHS[1]

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

Domestic Production and Use: Rare earths were not mined domestically in 2007. In October, processing of previously mined rare-earth concentrates resumed at Mountain Pass, CA. Initial production was to be lanthanum concentrate and didymium (75% neodymium, 25% praseodymium). Rare-earth concentrates, intermediate compounds, and individual oxides were available from stocks. The United States continued to be a major importer, exporter, and consumer of rare-earth products in 2007. The estimated value of refined rare earths consumed in the United States was more than $1 billion. Based on final 2006 reported data, the estimated 2006 distribution of rare earths by end use was as follows: automotive catalytic converters, 25%; petroleum refining catalysts, 22%; metallurgical additives and alloys, 20%; glass polishing and ceramics, 11%; rare-earth phosphors for lighting, televisions, computer monitors, radar, and X-ray intensifying film, 10%; permanent magnets, 3%; medical and lasers, 3%; and other, 6%.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production, bastnäsite concentrates[e]	—	—	—	—	—
Imports:[2]					
Thorium ore (monazite)	—	—	—	6	—
Rare-earth metals, alloy	1,130	804	880	867	831
Cerium compounds	2,630	1,880	2,170	2,590	3,090
Mixed REOs	2,150	1,660	640	1,570	2,250
Rare-earth chlorides	1,890	1,310	2,670	2,750	1,240
Rare-earth oxides, compounds	10,900	11,400	8,550	10,600	10,300
Ferrocerium, alloys	111	105	130	127	126
Exports:[2]					
Rare-earth metals, alloys	1,190	1,010	636	733	1,470
Cerium compounds	1,940	2,280	2,210	2,010	1,690
Other rare-earth compounds	1,450	4,800	2,070	2,700	1,470
Ferrocerium, alloys	2,800	3,720	4,320	3,710	3,230
Consumption, apparent	9,340	5,480	6,030	9,530	10,000
Price, dollars per kilogram, yearend:					
Bastnäsite concentrate, REO basis[e]	4.08	4.08	4.08	4.08	4.08
Monazite concentrate, REO basis[3]	0.50	0.59	0.54	0.54	0.54
Mischmetal, metal basis, metric ton quantity[4]	5-6	5-6	5-6	5-6	5-6
Stocks, producer and processor, yearend	W	W	W	W	W
Employment, mine and mill, number	90	NA	NA	NA	NA
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Small quantities, mostly permanent magnet scrap.

Import Sources (2003-06): Rare-earth metals, compounds, etc.: China, 84%; France, 6%; Japan, 4%; Russia, 2%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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.

Prepared by **James B. Hedrick [(703) 648-7725, jhedrick@usgs.gov, fax: (703) 648-7757]**

RARE EARTHS

Events, Trends, and Issues: Domestic demand for rare earths in 2007 increased based on apparent consumption, although rare-earth imports and exports were estimated to be lower than in 2006. Prices were higher in 2007 than in 2006 for most rare-earth products amid increased demand and a stable supply. Demand increased for cerium compounds used in automotive catalytic converters, glass polishing, and glass additives; rare-earth compounds used in automotive catalytic converters and many other applications; and yttrium compounds used in fiber optics, lasers, oxygen sensors, phosphors for fluorescent lighting, color televisions, electronic thermometers, X-ray intensifying screens, pigments, superconductors, and other applications. Demand was also higher for mixed rare-earth compounds and for rare-earth metals and their alloys used in permanent magnets, base-metal alloys, superalloys, pyrophoric alloys, lighter flints, and armaments. U.S. demand, however, was substantially lower for rare-earth chlorides used in the production of fluid cracking catalysts used in oil refining. The rare-earth separation plant at Mountain Pass, CA, resumed operations in October. Bastnäsite concentrates and other rare-earth intermediates and refined products continued to be sold from the mine stocks at Mountain Pass. 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. Rechargeable batteries were used in both electric and hybrid vehicles. Exploration for rare earths increased in 2007, and economic assessments continued at Hoidas Lake and Thor Lake in Canada, and Kangankunde in Malawi, Africa. Removal of overburden at the Mt. Weld rare-earth deposit in Australia was expected to be completed by yearend 2007.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e] 2006	Mine production[e] 2007	Reserves[6]	Reserve base[6]
United States	—	—	13,000,000	14,000,000
Australia	—	—	5,200,000	5,800,000
Brazil	730	730	48,000	84,000
China	119,000	120,000	27,000,000	89,000,000
Commonwealth of Independent States	NA	NA	19,000,000	21,000,000
India	2,700	2,700	1,100,000	1,300,000
Malaysia	200	200	30,000	35,000
Thailand	—	—	NA	NA
Other countries	NA	NA	22,000,000	23,000,000
World total (rounded)	123,000	124,000	88,000,000	150,000,000

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, secondary monazite, loparite, phosphorites, rare-earth-bearing (ion adsorption) clays, 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]Monazite price based on monazite exports from Malaysia for 2003 and 2004, and estimated for 2005 through 2007.
[4]Price range from Elements—Rare Earths, Specialty Metals and Applied Technology, Trade Tech, Denver, CO, and Web-based High Tech Materials, Longmont, CO.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]See Appendix C for definitions.

RHENIUM

(Data in kilograms of rhenium content unless otherwise noted)

Domestic Production and Use: During 2007, ores containing rhenium were mined by five operations (two in Arizona, one each in Montana, New Mexico, and Utah). Rhenium compounds are included in molybdenum concentrates derived from porphyry copper deposits, and rhenium is recovered as a byproduct from roasting such molybdenum concentrates. Rhenium-containing products included ammonium perrhenate, perrhenic acid, and metal powder. 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 60%, 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 2007 was about $84 million.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production[1]	3,400	5,900	7,100	8,100	7,300
Imports for consumption	14,500	20,200	28,900	38,700	44,500
Exports	NA	NA	NA	NA	NA
Consumption, apparent	18,400	26,100	36,000	46,800	51,800
Price,[2] average value, dollars per kilogram, gross weight:					
Metal powder, 99.99% pure	1,090	1,090	1,070	1,260	1,330
Ammonium perrhenate	790	710	680	840	780
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	81	77	80	83	86

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 (2003-06): Rhenium metal: Chile, 91%; Germany, 6%; and other, 3%. Ammonium perrhenate: Kazakhstan, 59%; Germany, 12%; Netherlands, 11%; Estonia, 4%; and other, 14%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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.

Prepared by **Michael J. Magyar [(703) 648-4964, mmagyar@usgs.gov, fax: (703) 648-7757]**

RHENIUM

Events, Trends, and Issues: During 2007, average rhenium metal price, based on U.S. Census Bureau customs value, was about $1,330 per kilogram, about 6% more than that of 2006. Rhenium imports increased by about 15% owing to continued strong demand for superalloys in the gas turbine engine market and improved demand in the catalyst market. Rhenium production in the United States decreased by about 10% owing to reduced imports of byproduct molybdenum concentrates for roasting in the United States. Byproduct molybdenum production from five of the six working copper-molybdenum mines maintained production levels near capacity in 2007; one mine did not operate its molybdenum circuit in 2007. 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. Exports of rhenium from Kazakhstan resumed in late 2006 after a dispute over payments for past utilities usage and rhenium-bearing residues was settled. Stockpiled quantities of low-grade APR were imported into the United States from Kazakhstan in early 2007, but they did not reach the market immediately, as the material had to be reprocessed and upgraded before use. Owing to strong demand, APR spot prices continued to rise, reaching $5,000 per kilogram in January, $7,000 per kilogram in April, and $9,000 per kilogram in September.

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, Reserves, and Reserve Base:

	Mine production[4]		Reserves[5]	Reserve base[5]
	2006	2007		
United States	8,100	7,300	390,000	4,500,000
Armenia	1,200	1,200	95,000	120,000
Canada	1,700	1,700	32,000	1,500,000
Chile[6]	19,800	22,900	1,300,000	2,500,000
Kazakhstan	8,000	8,000	190,000	250,000
Peru	5,000	5,000	45,000	550,000
Russia	1,400	1,400	310,000	400,000
Other countries	2,000	2,000	91,000	360,000
World total (rounded)	47,200	49,500	2,500,000	10,000,000

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 estimated rhenium contained in MoS_2 concentrates assuming 90% recovery of rhenium content.
[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.
[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 DNA separation, fiber optics, inorganic chemicals, lamps, night vision devices, and as standards for atomic absorption analysis. Other applications include the use of high-purity rubidium (>98%) in vapor cells as a wavelength reference, and rubidium may be substituted for cesium as a frequency standard in atomic clocks. 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 2007, one company offered 1-gram ampoules of 99.75%-grade rubidium (metals basis) at $58.20 each, and the price for 100 grams of the same material was $1,118.00. Prices were unchanged from those of 2006.

Recycling: None.

Import Sources (2003-06): The United States is 100% import reliant on byproduct rubidium concentrate imported from Canada.

Tariff:

Item	Number	Normal Trade Relations 12-31-07
Alkali metals, other	2805.19.9000	5.5% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **William E. Brooks [(703) 648-7791, wbrooks@usgs.gov, fax: (703) 648-7757]**

RUBIDIUM

Events, Trends, and Issues: Consumption of rubidium and its compounds is not commercially significant, and no change in use patterns is anticipated. Rubidium halide cathodes are being researched as substitutes for use in low-pressure, mercury-free lighting owing to environmental concern for mercury releases from lamps. Small amounts of rubidium may be released to 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, Reserves, and Reserve Base:[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. Supplies of rubidium-bearing lepidolite from Canada, the world's leading producer of rubidium, are adequate for current use patterns.

World Resources: Rubidium-bearing, zoned pegmatites are known in several locations in Canada, and there are also pegmatite occurrences in Afghanistan, Namibia, Peru, Zambia, and other countries. 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 close together on the Periodic Table, have similar atomic radii, and, therefore, have similar physical properties. These metals may be used interchangeably in most applications.

[1]See Appendix C for definitions.

SALT

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Domestic production of salt decreased slightly in 2007. The total value was estimated to be more than $1.3 billion. Twenty-nine companies operated 64 plants in 15 States. The estimated percentage of salt sold or used, by type, was salt in brine, 48%; rock salt, 34%; vacuum pan, 10%; and solar salt, 8%.

The chemical industry consumed nearly 39% 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. Salt for highway deicing accounted for 37% of U.S. demand. The remaining markets for salt, in declining order, were distributors, 8%; industrial, 7%; agricultural, 3%; food, 3%; water treatment, 2%; and other combined with exports, 1%.

Salient Statistics—United States:[1]	**2003**	**2004**	**2005**	**2006**	**2007**[e]
Production	43,700	46,500	45,100	44,300	43,800
Sold or used by producers	41,100	45,000	45,000	42,400	40,900
Imports for consumption	12,900	11,900	12,100	9,490	10,000
Exports	718	1,100	879	973	1,000
Consumption:					
Reported	50,200	50,700	53,100	53,100	49,900
Apparent	53,200	55,800	56,200	50,900	49,900
Price, average value of bulk, pellets and packaged salt, dollars per ton, f.o.b. mine and plant:					
Vacuum and open pan salt	124.24	128.39	130.75	146.97	150.00
Solar salt	53.42	49.25	58.14	46.75	57.00
Rock salt	23.11	25.83	25.84	25.18	25.00
Salt in brine	7.21	7.01	7.03	9.39	10.00
Stocks, producer, yearend[e, 2]	NA	NA	NA	NA	NA
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	17	23	20	17	18

Recycling: None.

Import Sources (2003-06): Canada, 36%; Chile, 29%; The Bahamas, 10%; Mexico, 9%; and other, 16%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-07**
Salt (sodium chloride)	2501.00.0000	Free.

Depletion Allowance: 10% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Dennis S. Kostick [(703) 648-7715, dkostick@usgs.gov, fax: (703) 648-7757]**

SALT

Events, Trends, and Issues: A major U.S. salt producer announced it would increase annual production capacity by 1 million tons at its rock salt mine in Goderich, Ontario, Canada. Despite fluctuations in the severity of winter weather, the decision to increase capacity was based on the continuing rising demand for deicing salt in the Great Lakes region. The facility, which is the world's largest underground rock salt mine, had raised annual production capacity by 750,000 tons in 2006. The total production capacity of the mine will be 8.25 million tons per year when the expansion is completed.

China surpassed the United States in 2006 as the leading producer of salt in the world. The strong growth of the chemical industry in China caused salt consumption to increase; however, salt supplies from domestic sources and imports have been insufficient to meet regional demand. To alleviate most of the salt shortages, China and Australia have expanded some of their salt operations.

The relatively mild winter of 2006-07 resulted in a decrease in deicing salt consumption, a buildup of rock salt inventories by municipalities, and the furloughing of many salt workers at some of the mines. Changes in global weather may reduce rock salt consumption for road deicing again for the winter of 2007-08.

World Production, Reserves, and Reserve Base:

	Production		Reserves and reserve base[4]
	2006	2007[e]	
United States[1]	44,300	43,800	Large. Economic and subeconomic deposits of salt are substantial in principal salt-producing countries. The oceans contain a virtually inexhaustible supply of salt.
Australia	12,000	12,400	
Brazil	7,340	7,300	
Canada	15,000	15,000	
Chile	6,000	6,100	
China	54,030	56,000	
Egypt	2,400	2,400	
France	7,000	7,000	
Germany	17,480	18,000	
India	15,500	15,500	
Iran	2,000	2,000	
Italy	3,000	3,000	
Mexico	8,171	8,200	
Netherlands	5,000	5,000	
Poland	5,000	5,000	
Romania	2,445	2,500	
Russia	2,800	2,800	
Spain	3,850	3,900	
Turkey	2,200	2,200	
Ukraine	3,500	3,500	
United Kingdom	8,000	8,000	
Other countries	24,000	20,000	
World total (rounded)	251,000	250,000	

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 southern 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. NA Not available.
[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.

SAND AND GRAVEL (CONSTRUCTION)[1]

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

Domestic Production and Use: Construction sand and gravel valued at $8.0 billion was produced by an estimated 4,000 companies from about 6,300 operations in 50 States. Leading producing States, in order of decreasing tonnage, were California, Texas, Arizona, Colorado, Washington, Utah, Ohio, Wisconsin, Michigan, and Minnesota, which together accounted for about 50% of the total output. It is estimated that about 46% of construction sand and gravel was used as concrete aggregates; 22% for road base and coverings and road stabilization; 14% as construction fill; 12% as asphaltic concrete aggregates and other bituminous mixtures; 2% 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 9 months of 2007, was about 852 million tons, a decrease of 15% compared with the revised total for the same period in 2006. 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:	2003	2004	2005	2006	2007[e]
Production	1,160	1,240	1,270	1,320	1,170
Imports for consumption	4	5	7	5	4
Exports	2	1	1	1	1
Consumption, apparent	1,160	1,240	1,280	1,320	1,180
Price, average value, dollars per ton	5.16	5.32	5.86	6.46	6.83
Employment, mines, mills, and shops, number	36,500	37,000	37,700	38,500	37,300
Net import reliance[3] as a percentage of apparent consumption	([4])	([4])	1	([4])	([4])

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

Import Sources (2003-06): Canada, 75%; Mexico, 18%; The Bahamas, 3%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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.

Prepared by **Wallace P. Bolen [(703) 648-7727, wbolen@usgs.gov, fax: (703) 648-7975]**

SAND AND GRAVEL (CONSTRUCTION)

Events, Trends, and Issues: In response to changes in demand from the struggling residential construction industry, construction sand and gravel output decreased for the first time since 1991. It is estimated that 2008 domestic production will decrease to about 1.12 billion tons as the housing market continues to be lackluster and revenues to governments are impacted by lower home values and associated revenues. 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, and safety 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, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	2006	2007[e]	
United States	1,320	1,170	The reserves and reserve base are controlled largely by land use and/or environmental concerns.
Other countries[6]	NA	NA	
World total	NA	NA	

World Resources: Sand and gravel resources of the world are 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 2007.

[e]Estimated. NA Not available.
[1]See also Sand and Gravel (Industrial).
[2]See Appendix A for conversion to short tons.
[3]Defined as imports – exports + adjustments for Government and industry stock changes; changes in stocks are not available and assumed to be zero.
[4]Less than ½ unit.
[5]See Appendix C for definitions.
[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 $883 million was produced by 68 companies from 138 operations in 34 States. Leading States, in order of tonnage produced, were Illinois, Florida, Georgia, Wisconsin, Texas, California, Oklahoma, and Minnesota. Combined production from these States represented 61% of the domestic total. About 33% of the U.S. tonnage was used as glassmaking sand, 16% as foundry sand, 15% as hydraulic fracturing sand and well-packing and cementing sand, 11% as ground silica and whole-grain silica, 10% as building products, and 15% for other uses.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production	27,500	29,700	30,600	31,700	35,000
Imports for consumption	440	490	711	855	580
Exports	2,620	1,790	2,910	3,830	3,800
Consumption, apparent	25,300	28,400	28,400	28,700	31,800
Price, average value, dollars per ton	22.14	23.06	24.57	25.46	25.28
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 (2003-06): Mexico, 53%; Canada, 41%; and other, 6%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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 2007 increased by about 10% compared with those of 2006, owing to increasing demand for many uses, which included ceramics, chemicals, fillers (ground and whole-grain), filtration, container, flat and specialty glass, hydraulic fracturing, and recreational uses. U.S. apparent consumption was 31.8 million tons in 2007, an 11% increase from that of the previous year. Imports of industrial sand and gravel in 2007 decreased by about 32% compared with those of 2006. 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 2007 remained essentially unchanged compared with those of 2006.

Prepared by **Thomas P. Dolley [(703) 648-7710, tdolley@usgs.gov, fax: (703) 648-7975]**

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 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 2007. 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, Reserves, and Reserve Base:

	Mine production[e]		Reserves and reserve base[3]
	2006	2007	
United States	31,700	35,000	
Australia	3,700	3,700	Large. Industrial sand and gravel deposits are widespread. Calculation of the reserves and reserve base is determined mainly by the location of population centers.
Austria	6,800	6,800	
Belgium	1,800	1,800	
Brazil	1,600	1,600	
Canada	1,600	1,600	
France	6,500	6,500	
Gambia	1,390	1,400	
Germany	7,700	7,700	
India	1,600	1,600	
Iran	1,900	1,900	
Italy	3,000	3,000	
Japan	4,600	4,600	
Mexico	2,630	2,600	
Norway	1,500	1,500	
Poland	1,500	1,500	
Romania	1,500	1,500	
Slovakia	2,000	2,000	
Slovenia	10,000	10,000	
South Africa	3,216	3,200	
Spain	5,100	5,100	
Turkey	1,200	1,200	
United Kingdom	5,000	5,000	
Other countries	10,600	11,000	
World total (rounded)	118,000	120,000	

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.

SCANDIUM[1]

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

Domestic Production and Use: Demand for scandium decreased slightly in 2007. Although scandium was not mined domestically in 2007, 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 located in Mead, CO, and Urbana, IL. Capacity to produce ingot and distilled scandium metal was located in Phoenix, AZ; Urbana, IL; and Ames, IA. Scandium used in the United States was essentially derived from foreign sources. Principal uses for scandium in 2007 were aluminum alloys for sporting equipment (baseball and softball bats, bicycle frames, crosse 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:	2003	2004	2005	2006	2007[e]
Price, yearend, dollars:					
Per kilogram, oxide, 99.0% purity	500	500	500	700	700
Per kilogram, oxide, 99.9% purity	1,300	1,300	1,300	1,400	1,400
Per kilogram, oxide, 99.99% purity[2]	2,500	2,500	2,500	1,450	1,620
Per kilogram, oxide, 99.999% purity[2]	3,200	3,200	3,000	1,500	2,540
Per kilogram, oxide, 99.9995% purity[2]	NA	NA	NA	2,100	3,260
Per gram, dendritic, metal[3]	185.00	193.60	162.50	208.00	208.00
Per gram, metal, ingot[4]	119.00	124.00	131.00	131.00	131.00
Per gram, scandium acetate, 99.99% purity[5]	68.70	68.70	70.30	74.00	74.00
Per gram, scandium chloride, 99.9% purity[5]	42.40	44.30	48.70	48.70	48.70
Per gram, scandium fluoride, 99.9% purity[5]	180.00	188.20	193.80	193.80	193.80
Per gram, scandium iodide, 99.999% purity[5]	162.00	169.00	174.00	174.00	174.00
Per metric ton, scandium-aluminum alloy[2]	NA	NA	NA	NA	74.00
Net import reliance[6] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2003-06): Not available.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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 compounds remained stable for the lower grades and increased for the higher purities from those of the previous year. The supply of domestic and foreign scandium remained strong to meet increased demand. Although demand increased in 2007, the total market remained very small. Domestic increases in demand were primarily from recently developed applications in welding wire, scandium-aluminum baseball and softball bats, scandium-aluminum bicycle frames, and high-strength, lightweight handgun frames and cylinders. New demand is expected to come from future fuel-cell markets and aerospace applications.

Prepared by **James B. Hedrick [(703) 648-7725, jhedrick@usgs.gov, fax: (703) 648-7757]**

SCANDIUM

Scandium's use continued to increase in metal halide lighting. 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. Demand decreased slightly for scandium-aluminum alloys in baseball and softball bats as new composite materials of carbon fiber and carbon nanotube were introduced to the market. Sports equipment remained the leading use of scandium. 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, Reserves, and Reserve Base:[7] Scandium was produced as a byproduct material in China, Kazakhstan, Russia, and Ukraine. Foreign mine production data were not available. No scandium was mined in the United States in 2007. Scandium occurs in many ores in trace amounts, but has not been found in sufficient quantities to be considered as a reserve or reserve base. 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 to combine with 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. Recent domestic production has primarily been 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 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 and Kazakhstan are in the Kola Peninsula apatites and in uranium-bearing deposits, respectively. 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. In metallurgical applications, titanium and aluminum high-strength alloys and carbon fiber and carbon nanotube material may substitute in sporting goods, especially baseball and softball bats and bicycle frames.

[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 in metric quantities from Stanford Materials Corporation.
[3]Scandium pieces, 99.9% purity, distilled dendritic, 2003-07 prices converted from 0.5-gram price, from Alfa Aesar, a Johnson Matthey company.
[4]Metal ingot pieces, 99.9% purity, 2003-07, 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.

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 two other refiners 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, art glass, and other glasses, such as that used in traffic lights 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.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production, refinery	W	W	W	W	W
Imports for consumption, metal and dioxide	367	412	589	409	485
Exports, metal, waste and scrap	249	160	254	191	300
Consumption, apparent	W	W	W	W	W
Price, dealers, average, dollars per pound, 100-pound lots, refined	5.68	24.86	51.44	24.57	33.00
Stocks, producer, refined, yearend	W	W	W	W	W
Net import reliance[1] as a percentage of apparent consumption	W	W	W	W	W

Recycling: The amount of domestic production of secondary selenium was unknown. Scrap xerographic materials were exported for recovery of the contained selenium. As electronic recycling continues to increase, a small amount of selenium may become available from other electronics.

Import Sources (2003-06): Belgium, 39%; Canada, 21%; Philippines, 15%; Germany, 8%; and other, 17%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Selenium metal	2804.90.0000	Free.
Selenium dioxide	2811.29.2000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Micheal W. George [(703) 648-4962, mgeorge@usgs.gov, fax: (703) 648-7757]**

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 and cobalt. Estimated domestic selenium production increased in 2007 compared with that of 2006.

China, which remains the leading consumer of selenium, continued to use selenium as a fertilizer supplement and as an ingredient in glassmaking, and selenium dioxide as a substitute for sulfur dioxide in the manganese refining process. It is believed that consumption of selenium in China increased in 2006 and in the first half of 2007 owing to increases in consumption from the manganese refining industry. The price of selenium increased in 2007 because of growth in worldwide consumption.

Domestic use of selenium in glass remained unchanged, while its use in copiers continued to decline. The use of selenium as a substitute for lead in free-machining brasses continued to increase as more stringent regulations on the use of lead were implemented. 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.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[2]	Reserve base[2]
	2006	2007[e]		
United States	W	W	10,000	19,000
Belgium	200	200	—	—
Canada	300	300	6,000	10,000
Chile	84	84	16,000	37,000
Finland	62	62	—	—
Germany	12	12	—	—
India	13	13	—	—
Japan	735	740	—	—
Peru	50	50	5,000	8,000
Philippines	65	65	2,000	3,000
Sweden	20	20	—	—
Other countries[3]	NA	NA	43,000	92,000
World total (rounded)	[4]1,540	[4]1,550	82,000	170,000

World Resources: The reserve base for selenium is 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. An assessment of U.S. copper resources indicated that total copper resources in identified and undiscovered resources totals about 550 million metric tons, almost 8 times the estimated U.S. copper reserve base.

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. Amorphous silicon and organic photoreceptors are substitutes in plain paper photocopiers. 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.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Defined as imports – exports + adjustments for Government and industry stock changes.
[2]See Appendix C for definitions.
[3]In addition to the countries listed, Australia, China, Kazakhstan, Russia, 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.
[4]Excludes U.S. production.

SILICON

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

Domestic Production and Use: Estimated value of silicon metal and alloys (excluding semiconductor-grade silicon) produced in the United States in 2007 was about $500 million. Four companies produced silicon materials in six plants. Of those companies, three produced ferrosilicon in four plants. Silicon metal was produced by two companies in four plants. Two of the four companies in the industry produced both products at two plants. All of the active 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 half of the United States. The main consumers of silicon metal were producers of aluminum and aluminum alloys and the chemical industry. The semiconductor industry, which manufactures chips for computers from high-purity silicon, accounted for only a small percentage of silicon demand.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production:					
Ferrosilicon, all grades[1]	117	128	125	146	156
Silicon metal	136	147	145	W	W
Imports for consumption:					
Ferrosilicon, all grades[1]	189	173	197	223	203
Silicon metal	126	165	152	146	152
Exports:					
Ferrosilicon, all grades[1]	6	6	8	5	6
Silicon metal	20	18	23	27	27
Consumption, apparent:					
Ferrosilicon, all grades[1]	304	297	317	360	354
Silicon metal	240	291	275	W	W
Price,[2] average, cents per pound Si:					
Ferrosilicon, 50% Si	47.7	58.2	55.0	62.9	73.0
Ferrosilicon, 75% Si	45.3	55.4	48.0	54.9	65.0
Silicon metal	61.3	81.9	76.2	79.3	105
Stocks, producer, yearend:					
Ferrosilicon, all grades[1]	17	15	13	16	14
Silicon metal	5	7	6	W	W
Net import reliance[3] as a percentage of apparent consumption:					
Ferrosilicon, all grades[1]	62	57	61	59	56
Silicon metal	43	50	47	<50	<50

Recycling: Insignificant.

Import Sources (2003-06): Ferrosilicon: China, 35%; Venezuela, 18%; Russia, 16%; Norway, 7%; and other, 24%. Silicon metal: Brazil, 39%; South Africa, 25%; Canada, 16%; Norway, 6%; and other, 14%. Total: Brazil, 18%; China, 13%; South Africa, 11%; Canada, 11%; and other, 47%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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.
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.

Depletion Allowance: Quartzite, 14% (Domestic and foreign); gravel, 5% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Lisa A. Corathers [(703) 648-4973, lcorathers@usgs.gov, fax: (703) 648-7757]**

SILICON

Events, Trends, and Issues: Domestic ferrosilicon production in 2007, expressed in terms of contained silicon, was expected to increase by 7% from that of 2006. Because the number of silicon metal producers in the United States declined to two in 2006, U.S. silicon metal statistics have been withheld to avoid disclosing company proprietary data. Through the first 10 months of 2007, spot market prices trended upward in the U.S. market for silicon materials owing to increased demand for ferrosilicon as a substitute for high-priced silicomanganese in steelmaking, increased Chinese ferrosilicon export prices, and increased demand for silicon metal production.

Demand for silicon metal comes primarily from the aluminum and chemical industries. In the first 9 months of 2007, domestic chemical production was nearly unchanged compared with that in 2006. Domestic primary aluminum production was projected to increase by 11% in 2007. Domestic apparent consumption of ferrosilicon in 2007 was projected to decrease by 3% compared with that of 2006. The annual growth rate for ferrosilicon demand usually falls in the range of 1% to 2%, in line with long-term trends in steel production, but through the first 8 months of 2007, domestic steel production was 3% lower than that for the same period in 2006.

Two developments affected the global supply of silicon materials. Production of silicon materials in Norway decreased to an estimated 160,000 tons in 2007 from 210,000 tons (revised) in 2006, owing to the indefinite closure of a ferrosilicon plant in 2005 and the permanent closure of two silicon metal plants in 2006. This was offset by the significant (22%) increase in Chinese ferrosilicon and silicon metal production compared with that of 2006.

World Production, Reserves, and Reserve Base:

	Production[e, 4]		Reserves and reserve base[5]
	2006	2007	
United States	[6]146	156	The reserves and reserve base in most major producing countries are ample in relation to demand. Quantitative estimates are not available.
Brazil	226	230	
Canada	66	66	
China	2,900	2,900	
France	124	170	
Iceland	74	75	
India	38	38	
Kazakhstan	68	68	
Norway	150	160	
Russia	541	540	
South Africa	144	140	
Spain	55	55	
Ukraine	84	120	
Venezuela	60	60	
Other countries	297	300	
World total (rounded)	4,970	5,100	

Ferrosilicon accounts for about four-fifths of world silicon production (gross-weight basis). The leading countries for ferrosilicon production, in descending order of production, were China, Russia, Ukraine, the United States, and Brazil, and for silicon metal, China, Brazil, and Norway. China was by far the leading producer of both ferrosilicon and silicon metal. An estimated 570,000 tons of silicon metal is included in China's production of silicon materials for 2007.

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]Based on U.S. dealer import price.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]Production quantities are combined totals of estimated silicon content for ferrosilicon and silicon metal, as applicable, except as noted.
[5]See Appendix C for definitions.
[6]Ferrosilicon only.

SILVER

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

Domestic Production and Use: Approximately 1,200 tons of silver with an estimated value of over $500 million were produced in the United States in 2007. Alaska continued as the country's leading silver-producing State, followed by Nevada; however, company production data are proprietary and were withheld. Domestic silver was produced as a byproduct from 36 base- and precious-metal mines. There were 21 refiners of commercial-grade silver, with an estimated total output of 3,000 tons from domestic and foreign ores and concentrates, and from old and new scrap. Silver's 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 cell phone covers to reduce the spread of bacteria, in clothing to minimize odor, in catalytic converters in automobiles, electronics and circuit boards, electroplating, hardening bearings, mirrors, solar cells, wood treatment to resist mold, and water purification. Silver was used for miniature antennas in Radio Frequency Identification Devices (RFIDs) that were used in 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:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production:					
Mine	1,240	1,250	1,230	1,140	1,220
Refinery:					
Primary	2,580	1,140	2,530	3,150	2,500
Secondary (old scrap)	1,010	1,920	980	1,500	1,200
Imports for consumption[2]	4,510	4,100	4,540	4,820	4,570
Exports[2]	181	422	319	1,670	1,000
Consumption, apparent[e]	6,440	6,700	7,560	7,550	7,980
Price, dollars per troy ounce[3]	4.91	6.69	7.34	11.61	13.40
Stocks, yearend:					
Treasury Department[4]	220	220	220	220	220
COMEX, CBT[5]	3,430	3,580	3,750	4,000	3,290
Employment, mine and mill,[6] number	840	900	900	800	900
Net import reliance[7] as a percentage of apparent consumption[e]	65	54	54	38	55

Recycling: In 2007, approximately 1,600 tons of silver was recovered from old and new scrap. This includes 60 to 90 tons of silver that are reclaimed and recycled annually from photographic wastewater.

Import Sources (2003-06):[2] Mexico, 49%; Canada, 31%; Peru, 13%; Chile, 2%; and other, 5%.

Tariff: No duties are imposed on imports of unrefined silver or refined bullion.

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

Government Stockpile: All of the remaining silver in the National Defense Stockpile was transferred to the U.S. Mint by the Defense Logistics Agency for use in the manufacture of numismatic and bullion coins by yearend 2004. This transfer marked the end of silver requirements for the National Defense Stockpile.

Prepared by **William E. Brooks [(703) 648-7791, wbrooks@usgs.gov, fax: (703) 648-7757]**

SILVER

Events, Trends, and Issues: In 2007, silver prices averaged $13.40 per troy ounce, surpassing 2006's average of $11.61, and rising to the highest average annual price since 1980. Prices rose to $15.47 in November 2007, which was more than 10% higher than the previous year's high of $14.89 per troy ounce established in May 2006. The rise in silver prices corresponded to investment interest in the newly established silver exchange traded fund (ETF). The ETF was established in April 2006 and was modeled after the gold ETF that was started in 2003. Exports of silver rose dramatically in 2006 owing to movement of physical silver to the ETF inventory agency in London, United Kingdom. ETF inventories at the end of 2006 totaled 3,330 tons of silver and by the end of October 2007 had risen to 4,200 tons. The demand for silver also continued to rise for fabrication and industrial applications. The use of high-purity silver for color paper in home and other color printers offset the losses to digital photography owing to weak film sales. Overall, the photographic use of silver was relatively stable. Silver is still used in X-ray films, and 99% of the silver in photographic wastewater may be recovered. Use of silver to help regulate body heat and control odor in shoes and sports and everyday clothing is increasing. The use of trace amounts of silver in bandages for wound care and minor skin infections is also increasing. The deficit in world silver mine production as compared with world silver consumption was about 800 tons in 2007. Increased production at new and existing mines in North America and South America, such as at the San Cristobal Mine in Bolivia, coupled with lower flow of silver into the ETF inventory, is likely to bring production and consumption for silver in 2008 into closer balance.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[8]	Reserve base[8]
	2006	2007[e]		
United States	1,140	1,220	25,000	80,000
Australia	1,727	2,000	31,000	37,000
Canada	980	1,200	16,000	35,000
Chile	1,600	1,400	NA	NA
China	2,600	2,700	26,000	120,000
Mexico	2,700	3,000	37,000	40,000
Peru	3,470	3,400	36,000	37,000
Poland	1,300	1,300	51,000	140,000
South Africa	87	90	NA	NA
Other countries	4,600	4,200	50,000	80,000
World total (rounded)	20,200	20,500	270,000	570,000

World Resources: Silver was obtained as a byproduct from processing and smelting copper, gold, and lead-zinc ores. 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 account for a significant share of future reserves and resources.

Substitutes: Silver was traditionally used in black-and-white as well as color printing applications; however, digital imaging, film with reduced silver content, silverless black-and-white film, and xerography may also be used. 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.

[e]Estimated. NA Not available.
[1]One metric ton (1,000 kilograms) = 32,150.7 troy ounces.
[2]Refined bullion, doré, and other unwrought silver; excludes coinage, 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]Source: U.S. Department of Labor, Mine Safety and Health Administration.
[7]Defined as imports – exports + adjustments for Government and industry stock changes.
[8]Includes silver recoverable from base-metal ores. See Appendix C for definitions.

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 2007 was estimated to be about $1.3 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 2006 reported data, the estimated 2007 distribution of soda ash by end use was glass, 50%; chemicals, 29%; soap and detergents, 9%; distributors, 4%; miscellaneous uses, 3%; flue gas desulfurization and pulp and paper, 2% each; and water treatment, 1%.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production[2]	10,600	11,000	11,000	11,000	11,100
Imports for consumption	5	6	8	7	8
Exports	4,450	4,670	4,680	4,820	5,100
Consumption:					
Reported	6,270	6,260	6,200	6,110	6,000
Apparent	6,090	6,290	6,380	6,100	6,000
Price:					
Quoted, yearend, soda ash, dense, bulk:					
F.o.b. Green River, WY, dollars per short ton	105.00	105.00	155.00	155.00	170.00
F.o.b. Searles Valley, CA, same basis	130.00	130.00	180.00	180.00	195.00
Average sales value (natural source), f.o.b. mine or plant, dollars per short ton	65.21	63.75	80.19	96.64	105.00
Stocks, producer, yearend	330	338	243	290	300
Employment, mine and plant, number	2,600	2,600	2,600	2,600	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 (2003-06): United Kingdom, 33%; Mexico, 30%; Canada, 10%; China, 7%; and other, 20%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Disodium carbonate	2836.20.0000	1.2% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: To meet the growing demand for soda ash in eastern Europe, a major European soda ash producer announced it was expanding capacity at its plant in Devnya, Bulgaria. The annual capacity of the plant would increase to 1.5 million tons from 1.2 million tons. The same European soda ash producer announced that it would increase production of ultra-pure soda ash at its facility in Dombasle, France, because of the growing demand for high-purity chemicals used in the pharmaceutical industry. The third leading synthetic soda ash manufacturer in India also announced it planned to raise production capacity at its plant in Sutrapada in Gujarat State.

An environmental and social impact assessment study was completed on a proposed $450 million natural soda ash venture at Lake Natron in the Arusha Region of Tanzania. If approved, the facility would produce 500,000 tons of soda ash annually that could expand to 1 million tons in the future. A major soda ash producer in India and the Tanzanian government were project partners. A major concern about the proposed plant was the potential adverse effect on the local flamingo population that inhabited the lake. The issue was unresolved by yearend.

Prepared by **Dennis S. Kostick [(703) 648-7715, dkostick@usgs.gov, fax: (703) 648-7757]**

SODA ASH

In May 2007, a major domestic soda ash producer announced a $15 per short ton increase in the list and off-list price of soda ash effective July 1 or as contracts permit. Other producers soon followed this price move. The same company made a second price increase announcement in September that would raise the off-list price another $15 per short ton. The company also announced an energy surcharge price increase of $7 per million British thermal units because of higher natural gas prices. One other company followed this move, but other companies remained uncommitted by yearend.

The economic slowdowns in domestic automobile production and housing starts that affected soda ash consumption in 2006 continued through 2007. 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 improves, U.S. demand may be slightly higher in 2008.

World Production, Reserves, and Reserve Base:

	Production		Reserves[4, 5]	Reserve base[5]
Natural:	2006	2007[e]		
United States	11,000	11,100	[6]23,000,000	[6]39,000,000
Botswana	250	250	400,000	NA
Kenya	370	380	7,000	NA
Mexico	—	—	200,000	450,000
Turkey	—	—	200,000	240,000
Uganda	NA	NA	20,000	NA
Other countries	—	—	260,000	220,000
World total, natural (rounded)	11,600	11,700	24,000,000	40,000,000
World total, synthetic (rounded)	30,400	31,300	XX	XX
World total (rounded)	42,000	43,000	XX	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. About 34 billion tons of reserve base soda ash could be obtained from the 36 billion tons of halite-free trona and the 25 billion tons of interbedded or intermixed trona and halite that are in beds more than 1.8 meters thick. Underground room-and-pillar mining, using conventional and continuous mining, is the primary method of mining Wyoming trona ore. The 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, 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.
[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. Fourteen companies operating 17 plants in 14 States recovered byproduct sodium sulfate from various manufacturing processes or products, including ascorbic acid, battery reclamation, cellulose, rayon, and silica pigments. About one-half of the total output was a byproduct of these plants in 2007. 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, 46%; pulp and paper, 13%; textiles, 12%; glass, 11%; carpet fresheners, 7%; and miscellaneous, 11%.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production, total (natural and synthetic)[1]	466	467	309	290	300
Imports for consumption	45	49	75	61	30
Exports	154	138	149	158	80
Consumption, apparent (natural and synthetic)	357	378	235	193	250
Price, quoted, sodium sulfate (100% Na_2SO_4), bulk, f.o.b. works, East, dollars per short ton	114	114	134	134	134
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 (2003-06): Canada, 83%; China, 5%; Mexico, 3%; India, 1%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Disodium sulfate:		
Saltcake (crude)	2833.11.1000	Free.
Other:	2833.11.5000	0.4% ad val.
Anhydrous	2833.11.5010	0.4% ad val.
Other	2833.11.5050	0.4% ad val.

Depletion Allowance: Natural, 14% (Domestic and foreign); synthetic, none.

Government Stockpile: None.

Prepared by **Dennis S. Kostick [(703) 648-7715, dkostick@usgs.gov, fax: (703) 648-7757]**

SODIUM SULFATE

Events, Trends, and Issues: The California natural sodium sulfate producer implemented a $4 per ton energy surcharge on all shipments of sodium sulfate in the third quarter of 2007 because escalating energy costs affected operating economics. Domestic producers used the New York Mercantile Exchange Henry Hub (interconnects nine interstate and four intrastate gas pipelines) to base surcharge increases or decreases. Each quarter, the surcharge is fixed using an average of three monthly spot prices taken on the 15th day of the month that precedes the beginning of each quarter.

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.

A Canadian industrial mineral producer purchased the natural sodium sulfate mine near Whiteshore Lake in Palo, Saskatchewan Province, Canada. The plant has an annual production capacity of 100,000 tons. Canada has only one other natural sodium sulfate producer, which has operations in Chaplin and Ingebrigt, Saskatchewan.

The outlook for sodium sulfate in 2008 is expected to be comparable with that of 2007, with detergents remaining the leading sodium-sulfate-consuming sector. If the winter of 2007-08 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, Reserves, and Reserve Base: 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]	Reserve base[3]
United States	860,000	1,400,000
Canada	84,000	270,000
Mexico	170,000	230,000
Spain	180,000	270,000
Turkey	100,000	NA
Other countries	1,900,000	2,400,000
World total (rounded)	3,300,000	4,600,000

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. NA Not available.
[1]Source: U.S. Census Bureau. Synthetic production data are revised in accordance with recent updated Census Bureau statistics.
[2]Defined as imports – exports + adjustments for Government and industry stock changes (if available).
[3]See Appendix C for definitions.

STONE (CRUSHED)[1]

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

Domestic Production and Use: Crushed stone valued at $14 billion was produced by 1,370 companies operating 3,360 quarries, 83 underground mines, and 193 sales/distribution yards in 50 States. Leading States, in descending order of production, were Texas, Pennsylvania, Florida, Missouri, Georgia, Illinois, Kentucky, Ohio, Tennessee, Indiana, and Virginia, together accounting for 56% of the total crushed stone output. Of the total crushed stone produced in 2007, about 68% was limestone and dolomite; 16%, granite; 9%, traprock; and the remaining 7% was shared, in descending order of tonnage, by sandstone and quartzite, miscellaneous stone, marble, shell, volcanic cinder and scoria, slate, and calcareous marl. It is estimated that of the 1.59 billion tons of crushed stone consumed in the United States in 2007, 47% was reported by use, 30% was reported for unspecified uses, and 23% of the total consumed was estimated for nonrespondents to the U.S. Geological Survey (USGS) canvasses. Of the 747 million tons reported by use, 84% was used as construction aggregates, mostly for highway and road construction and maintenance; 13% for chemical and metallurgical uses, including cement and lime manufacture; 2% for agricultural uses; and 1% for special and miscellaneous uses and products. To provide a more accurate estimate of the consumption patterns for crushed stone, the “unspecified uses—reported and estimated,” as defined in the USGS Minerals Yearbook, are not included in the above percentages.

The estimated output of crushed stone in the 48 conterminous States shipped for consumption in the first 9 months of 2007 was 1.1 billion tons, a 15% decrease compared with that of the same period of 2006. Third quarter shipments for consumption decreased 11% compared with those of the same period of 2006. Additional production information, by quarter for each State, geographic division, and the United States, is reported in the USGS quarterly Mineral Industry Surveys for Crushed Stone and Sand and Gravel.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production	1,530	1,630	1,700	1,720	1,590
Imports for consumption	15	19	21	20	20
Exports	1	1	1	1	1
Consumption, apparent[3]	1,550	1,650	1,730	1,740	1,610
Price, average value, dollars per metric ton	5.93	6.08	7.26	8.05	8.75
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e, 4]	79,400	79,600	81,000	82,600	82,600
Net import reliance[5] as a percentage of apparent consumption	1	1	1	1	1

Recycling: Road surfaces made of asphalt and crushed stone and, to a lesser extent, cement concrete surface layers and structures, were recycled on a limited but increasing basis in most States. Asphalt road surfaces were recycled by 50 companies in 30 States, and concrete was recycled by 45 companies in 23 States. The amount of material recycled decreased 24% compared with that in 2006.

Import Sources (2003-06): Mexico, 39%; Canada, 37%; The Bahamas, 23%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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.

Prepared by **Jason Christopher Willett [(703) 648-6473, jwillett@usgs.gov, fax: (703) 648-7757]**

STONE (CRUSHED)

Events, Trends, and Issues: Crushed stone production was 1.59 billion tons in 2007, a decrease of 8.0% compared with that of 2006. It is estimated that in 2007, apparent consumption will be about 1.61 billion tons, a 7% decrease. Demand for construction aggregates is anticipated to remain constant for 2008 based on the slowdown in activity that some of the principal construction markets have experienced over the last 2 years. Long-term projected increases 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 2008, 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, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[6]
	2006	2007[e]	
United States	1,720	1,590	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. High-purity limestone and dolomite suitable for specialty uses are 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 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.
[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 1.5 million tons of dimension stone, valued at $283 million, was sold or used by U.S. producers in 2007. Dimension stone was produced by 110 companies, operating 135 quarries, in 35 States. Leading producer States, in descending order by tonnage, were Wisconsin, Indiana, Georgia, Vermont, and Massachusetts. These five States accounted for about 60% of the production. Leading producer States, in descending order by value, were Indiana, Wisconsin, Vermont, Georgia, and South Dakota. These States contributed about 54% of the value of domestic production. Approximately 42%, by tonnage, of dimension stone sold or used was limestone, followed by granite (32%), sandstone (15%), miscellaneous stone (6%), marble (4%), and slate (1%). By value, the leading sales or uses were for granite (40%), followed by limestone (36%), sandstone (8%), marble (7%), miscellaneous stone (5%), and slate (4%). Dressed stone represented 56% 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 (28%), flagging (27%), and ashlars and partially squared pieces (20%). Rough stone mainly was sold for building and construction (50%), and flagging, exports, and unlisted and unspecified uses (20%), by tonnage.

Salient Statistics—United States:[2]	2003	2004	2005	2006	2007[e]
Sold or used by producers:					
Tonnage	1,340	1,460	1,360	1,330	1,500
Value, million dollars	268	281	269	265	283
Imports for consumption, value, million dollars	1,390	1,790	2,180	2,500	2,700
Exports, value, million dollars	64	64	66	76	133
Consumption, apparent, value, million dollars	1,590	2,010	2,380	2,690	2,850
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)	83	86	89	90	90
Granite only:					
Production	463	429	416	428	467
Exports (rough and finished)	144	143	135	108	125
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 (2003-06 by value): Dimension stone: Italy, 20%; Turkey, 17%; China, 12%; Mexico, 7%; and other, 44%. Granite only: Brazil, 31%; Italy, 19%; India, 16%; Canada, 8%; and other, 26%.

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 2007. 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.

Prepared by **Thomas P. Dolley [(703) 648-7710, tdolley@usgs.gov, fax: (703) 648-7975]**

STONE (DIMENSION)

Events, Trends, and Issues: The United States is the world's largest market for dimension stone. Imports of dimension stone continued to increase. Imports increased by 8% in value to about $2.7 billion compared with those of 2006. Dimension stone exports nearly doubled to about $133 million. Apparent consumption, by value, was $2.85 billion in 2007—a $160 million increase from that of 2006. Dimension stone for new construction and refurbishment is being used more commonly in both commercial and residential markets. Increased domestic production and imports, along with improved quarrying, finishing, handling technology, greater varieties of stone, and the rising costs of alternative construction materials, are among the factors that suggest the demand for dimension stone will continue to increase during the next 5 years.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	2006	2007[e]	
United States	1,330	1,500	Adequate except for certain special types and local shortages.
Other countries	NA	NA	
World total	NA	NA	

World Resources: Dimension stone resources of the world are sufficient. Resources can be limited on a local level or occasionally on a regional level by the lack of a particular kind of stone that is suitable for dimension purposes.

Substitutes: In certain applications, 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 + 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.
[5]See Appendix C for definitions.

STRONTIUM

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

Domestic Production and Use: No strontium minerals have been produced in the United States since 1959. The most common strontium mineral, celestite, which consists primarily of strontium sulfate, was imported exclusively from Mexico. A company in Georgia was the only major U.S. producer of strontium compounds, and analysis of celestite import data indicates 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, 43%; ferrite ceramic magnets, 26%; master alloys, 10%; pigments and fillers, 7%; electrolytic production of zinc, 6%; and other applications, 8%.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production	—	—	—	—	—
Imports for consumption:					
Strontium minerals	1,020	2,760	799	671	340
Strontium compounds	23,300	14,500	11,700	8,860	7,500
Exports, compounds	693	552	255	716	604
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent, celestite and compounds	23,600	16,700	12,200	8,820	7,240
Price, average value of mineral imports at port of exportation, dollars per ton	57	53	56	64	68
Net import reliance[2] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2003-06): Strontium minerals: Mexico, 100%. Strontium compounds: Mexico, 87%; Germany, 7%; and other, 6%. Total imports: Mexico, 88%; Germany, 6%; and other, 6%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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).

Prepared by **Joyce A. Ober [(703) 648-7717, jober@usgs.gov, fax: (703) 648-7757]**

STRONTIUM

Events, Trends, and Issues: China is the world's leading producer of strontium carbonate, with plant capacity of 200,000 tons per year, followed by Germany and Mexico, with 70,000 and 127,000 tons per year, respectively. China uses mostly domestic and some imported celestite to supply its strontium carbonate plants; the German producer uses imported celestite; and Mexican producers use domestic ore to supply their plants. Major markets for Chinese strontium carbonate are in Asia and Europe. Chinese celestite reserves are smaller and of lower quality than the ores in other major producing countries, including Mexico, Spain, and Turkey, raising the question of whether Chinese celestite producers will be able to maintain high enough production levels to meet the demand at strontium carbonate plants for an extended period of time, or if additional imports will be required.

The demand for strontium carbonate for faceplate glass for cathode ray tubes (CRTs) continues globally, but disappeared in the United States with the increased popularity of flat-panel television monitors. As a result, production facilities to manufacture CRTs for color televisions have shifted to other countries, causing the closure of all television glass plants in the United States, eliminating what was once the dominant U.S. market. Although CRTs are still available, growth continues in flat-panel technology, which requires much smaller quantities of strontium carbonate, resulting in steadily decreasing demand for strontium carbonate for television displays, especially in North America and Europe. Other end uses now represent larger shares of strontium use, but only because of the decline in the use of CRT glass, not because of significant growth in other uses.

World Mine Production, Reserves, and Reserve Base:[3]

	Mine production		Reserves[4]	Reserve base[4]
	2006	2007[e]		
United States	—	—	—	1,400,000
Argentina	7,500	7,500	All other:	All other:
China[e]	180,000	190,000	6,800,000	11,000,000
Iran	7,500	7,500		
Mexico	125,000	125,000		
Morocco	2,700	2,700		
Pakistan	1,900	3,500		
Spain	200,000	200,000		
Tajikistan	NA	NA		
Turkey	60,000	60,000		
World total (rounded)	585,000	600,000	6,800,000	12,000,000

World Resources: Resources in the United States are several times the reserve base. World resources are thought to exceed 1 billion tons.

Substitutes: Although it is possible to substitute other materials for strontium in some of its applications, such a change would adversely affect product performance and/or cost. For example, barium could replace strontium in CRT picture tube glass only after extensive circuit redesign to reduce operating voltages that produce harmful secondary X-rays. 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. NA Not available. — 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.

SULFUR

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

Domestic Production and Use: In 2007, elemental sulfur and byproduct sulfuric acid were produced at 113 operations in 29 States and the U.S. Virgin Islands. Total shipments were valued at about $400 million. Elemental sulfur production was 8.2 million tons; Louisiana and Texas accounted for about 45% of domestic production. Elemental sulfur was recovered at petroleum refineries, natural-gas-processing plants, and coking plants by 43 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 six nonferrous smelters in five States by six companies. Domestic elemental sulfur provided 63% of domestic consumption, and byproduct acid accounted for 5%. The remaining 32% of sulfur consumed was provided by imported sulfur and sulfuric acid. About 90% of sulfur was consumed in the form of sulfuric acid. Agricultural chemicals (primarily fertilizers) composed about 60% of reported sulfur demand; petroleum refining, 25%; and metal mining, 3%. Other uses, accounting for 12% 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:	**2003**	**2004**	**2005**	**2006**	**2007**[e]
Production:					
Recovered elemental	8,970	9,420	8,790	8,380	8,150
Other forms	683	739	711	674	670
Total (may be rounded)	9,650	10,200	9,500	9,060	8,820
Shipments, all forms	9,690	10,100	9,480	8,960	8,860
Imports for consumption:					
Recovered, elemental[e]	2,870	2,850	2,820	2,950	2,800
Sulfuric acid, sulfur content	297	784	877	793	860
Exports:					
Recovered, elemental	840	949	684	635	810
Sulfuric acid, sulfur content	67	67	110	79	100
Consumption, apparent, all forms	11,900	12,800	12,400	12,000	11,600
Price, reported average value, dollars per ton of elemental sulfur, f.o.b., mine and/or plant	28.70	32.62	30.88	32.85	40.00
Stocks, producer, yearend	206	185	160	221	180
Employment, mine and/or plant, number	2,700	2,700	2,700	2,700	2,700
Net import reliance[1] as a percentage of apparent consumption	19	21	24	25	24

Recycling: Between 3 million and 5 million tons of spent sulfuric acid was reclaimed from petroleum refining and chemical processes.

Import Sources (2003-06): Elemental: Canada, 71%; Mexico, 17%; Venezuela, 9%; and other, 3%. Sulfuric acid: Canada, 76%; Mexico, 12%; Germany, 3%; and other, 9%. Total sulfur imports: Canada, 72%; Mexico, 16%; Venezuela, 7%; and other, 5%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-07**
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.

Prepared by **Joyce A. Ober [(703) 648-7717, jober@usgs.gov, fax: (703) 648-7757]**

SULFUR

Events, Trends, and Issues: Total U.S. sulfur production declined for the third consecutive year. Decreases in 2005 and 2006 were a result of slow recovery from the two hurricanes that hit the Gulf Coast region in 2005 and complete implementation of an acid-gas reinjection project at a major natural-gas-processing plant in Wyoming, but decreases in 2007 were harder to pinpoint. Several oil refineries experienced temporary, unplanned shutdowns, but capacity utilization was relatively high. The average sulfur content of crude petroleum processed during the year was lower than expected, resulting in less sulfur to recover. Decreased production of elemental sulfur from petroleum refineries is not expected to establish a new trend, but rather a temporary downturn. Sulfur recovery from refineries is expected to return to normal and to resume its upward trend, supported by new facilities being installed that will increase refining capacity and the capability of current operations to handle higher sulfur crude oil. Recovered sulfur from domestic natural gas processing is expected to continue to decline. Byproduct sulfuric acid production is expected to remain relatively stable unless one or more of the remaining nonferrous smelters closes. World sulfur production was relatively stable, with Canada surpassing the United States as the leading global producer.

Domestic phosphate rock consumption was 4% higher in 2007 than in 2006, which resulted in increased demand for sulfur to process the phosphate rock into phosphate fertilizers. Worldwide sulfur prices increased throughout the year because of high demand in China and India. Some Canadian sulfur stocks were remelted to meet increased demand for overseas trade, while material in areas less accessible to markets was stockpiled.

World Production, Reserves, and Reserve Base:

	Production—All forms	
	2006	2007[e]
United States	9,060	8,820
Australia	941	950
Canada	9,047	9,000
Chile	1,000	1,000
China	8,020	8,500
Finland	615	600
France	945	950
Germany	2,290	2,300
India	1,170	1,200
Iran	1,465	1,500
Italy	650	750
Japan	3,330	3,300
Kazakhstan	2,000	2,000
Korea, Republic of	1,690	1,700
Kuwait	650	650
Mexico	1,774	1,800
Netherlands	530	530
Poland	1,240	1,200
Russia	7,000	7,000
Saudi Arabia	2,800	3,000
South Africa	643	650
Spain	651	600
United Arab Emirates	1,950	2,000
Uzbekistan	520	520
Venezuela	800	800
Other countries	4,920	5,000
World total (rounded)	65,700	66,000

Reserves and reserve base[2]

Previously published reserves and reserve base 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, actual sulfur production may not be in the country for which the reserves were attributed. For instance, sulfur from Saudi Arabian oil actually 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.

TALC AND PYROPHYLLITE

(Data in thousand metric tons unless noted)

Domestic Production and Use: The total estimated crude ore value of 2007 domestic talc production was $26 million. There were 12 talc-producing mines in 7 States in 2007. Companies in Montana, New York, Texas, and Vermont accounted for most of the domestic production. Domestically produced ground talc was used in ceramics, 33%; paint, 20%; paper, 16%; roofing, 8%; plastics, 5%; rubber, 3%; cosmetics, 1%; and other, 14%. Two companies in North Carolina mined pyrophyllite. Production of pyrophyllite decreased from that of 2006. Consumption was, in decreasing order by tonnage, in refractory products, ceramics, and paint.

Salient Statistics—United States:[1]	**2003**	**2004**	**2005**	**2006**	**2007**[e]
Production, mine	840	833	856	895	839
Sold by producers	845	854	826	900	823
Imports for consumption	237	226	237	314	210
Exports	192	202	198	179	220
Shipments from Government stockpile excesses	—	([2])	—	—	—
Consumption, apparent	885	857	895	1,030	829
Price, average, processed, dollars per ton	89	88	86	90	108
Employment, mine and mill	460	404	440	435	430
Net import reliance[3] as a percentage of apparent consumption	5	3	4	13	E

Recycling: Insignificant.

Import Sources (2003-06): China, 48%; Canada, 35%; Japan, 4%; France, 3%; and other, 10%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-07**
Not crushed, not powdered	2526.10.0000	Free.
Crushed or powdered	2526.20.0000	Free.
Cut or sawed	6815.99.2000	Free.

Depletion Allowance: Block steatite talc: 22% (Domestic), 14% (Foreign). Other: 14% (Domestic and foreign).

Government Stockpile:

Stockpile Status—9-30-07[4]
(Metric tons)

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2007**	**Disposals FY 2007**
Talc, block and lump	867	—	867	[5]907	—
Talc, ground	1,050	—	1,050	—	—

Prepared by **Robert L. Virta [(703) 648-7726, rvirta@usgs.gov, fax: (703) 648-7975]**

TALC AND PYROPHYLLITE

Events, Trends, and Issues: Production and sales of talc declined 6% and 9%, respectively, from those of 2006. A slow housing market resulted in sales losses by a Vermont talc producer. Smaller losses were seen because of consolidation of the talc industry in Texas. U.S. exports of talc increased 23% and U.S. imports decreased by 33% compared with those of 2006. The lower value of the U.S. dollar relative to other currencies was a major cause of these large trade changes. Additionally, imports were unusually high in 2006. A significant portion of the additional talc imported probably was stockpiled and entered commerce in 2007, thereby reducing imports in 2007. Canada remained the major destination for U.S. talc exports, accounting for 44% of the tonnage. Mexico was another significant importer of U.S. talc, accounting for 11% of the tonnage. In 2007, Canada and China supplied approximately 85% of the imported talc. Apparent consumption decreased by 20% in 2007. The large quantity of imports may have skewed the apparent consumption calculation in 2006. With 2006 imports adjusted to account for likely stockpiling, the actual change in apparent consumption in 2007 probably was 8% to 10%. The average value of processed talc increased to $110 per ton from $90 per ton in 2006. This is an artifact of more accurate reporting by a major producer in 2007 rather than a drastic change in talc pricing. In addition, some talc values reported by companies for 2003 to 2006 on the USGS annual canvass may not have included energy surcharges that were instituted during the past 5 years by the producers. Talc values probably increased 4% to 6% per year since 2003.

The talc industry in Texas has been consolidating for the past 2 years. In 2007, the leading Texas talc producer became the sole operator in Texas after it purchased the assets of its last remaining competitor in October. The company had purchased the assets of another producer in 2006.

A major U.S. talc producer in Montana announced that it had achieved a 26% reduction in greenhouse gas emissions at one of its mills through an increase in operating efficiency and equipment upgrades. Decreases of 26% and 15% also were achieved in natural gas and water use, respectively.

A European investment firm purchased a major talc producer with mines in Finland and plants in Finland and the Netherlands. The talc producer was reported to be the second leading producer of talc in the world and the leading supplier of talc to the European paper industry. It also markets talc to the adhesive, plastics, rubber, sealants, and various other industries.

World Mine Production, Reserves, and Reserve Base: World production of talc has been between 8 and 9 million tons since 2002, averaging about 8.6 million tons. Production was estimated to be 8.1 million tons in 2007 compared with 8.9 million tons in 2006. Updated information indicates that production in China and the Republic of Korea in 2006 may be significantly less than that shown in the table below. Production in other major producing countries appears to be relatively unchanged.

	Mine production		Reserves[6]	Reserve base[6]
	2006	2007[e]		
United States[1]	895	839	140,000	540,000
Brazil	608	610	180,000	250,000
China	3,000	2,500	Large	Large
Finland	550	560	Large	Large
India	646	650	4,000	9,000
Japan	375	375	100,000	160,000
Korea, Republic of	1,010	750	14,000	18,000
Other countries	1,840	1,800	Large	Large
World total (rounded)	8,920	8,100	Large	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 lump and block talc and ground talc.
[6]See Appendix C for definitions.

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. Three companies 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 2007 was estimated at about $47 million.

Salient Statistics—United States:[1]	2003	2004	2005	2006	2007[e]
Production:					
Mine	—	—	—	—	—
Recycling	NA	NA	NA	NA	NA
Imports for consumption	957	1,536	1,625	1,158	1,200
Exports	619	984	984	949	750
Government stockpile releases [e, 2]	336	127	210	289	2
Consumption, apparent	674	679	915	435	452
Price, tantalite, dollars per pound of Ta_2O_5 content[3]	30	30	35	32	36
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. In 2007, tantalum contained in imported tantalum scrap amounted to about 30% of tantalum apparent consumption.

Import Sources (2003-06): Tantalum contained in niobium (columbium) and tantalum ore and concentrate; tantalum metal; and tantalum waste and scrap: Australia, 19%; Brazil, 19%; China, 12%; Germany, 9%; and other, 41%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Synthetic tantalum-niobium concentrates	2615.90.3000	Free.
Tantalum ores and concentrates	2615.90.6060	Free.
Tantalum oxide	2825.90.9000	3.7% ad val.
Potassium fluotantalate	2826.90.9000	3.1% ad val.
Tantalum, unwrought:		
Powders	8103.20.0030	2.5% ad val.
Alloys and metal	8103.20.0090	2.5% ad val.
Tantalum, waste and scrap	8103.30.0000	Free.
Tantalum, other	8103.90.0000	4.4% ad val.

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

Government Stockpile: In fiscal year 2007, the Defense National Stockpile Center (DNSC), Defense Logistics Agency, sold about 1.87 tons of tantalum carbide powder and 63 tons of tantalum contained in tantalum-niobium minerals. DNSC announced maximum disposal limits for fiscal year 2008 of about 3.63 tons[5] of tantalum contained in tantalum carbide powder. DNSC exhausted stocks of tantalum minerals in fiscal year 2007; metal powder in fiscal year 2006; metal oxide in fiscal year 2006; and metal ingots in fiscal year 2005.

Prepared by **John F. Papp [(703) 648-4963, jpapp@usgs.gov, fax: (703) 648-7757]**

TANTALUM

Stockpile Status—9-30-07[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Tantalum:					
Carbide powder	1.73	—	1.73	[7]1.81	1.87
Metal:					
Powder	—	—	—	[7]4.54	—
Ingots	—	—	—	—	—
Minerals	—	—	—	227	63.1
Oxide	—	—	—	9.07	—

Events, Trends, and Issues: U.S. tantalum apparent consumption in 2007 was estimated to increase about 4% from that of 2006. 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, Australia supplied about 79% of tantalum mineral concentrate imports for consumption; Brazil, about 32% of metal; and China, 30% of waste and scrap.

World Mine Production, Reserves, and Reserve Base: The Australian reserve base was revised based on information reported by the government of Australia. Brazilian reserves and reserve base were revised based on information reported by the government of Brazil. Reserves of Canada were revised based on preproduction reserves and cumulative production.

	Mine production[8]		Reserves[9]	Reserve base[9]
	2006	2007[e]		
United States	—	—	—	Negligible
Australia	850	850	40,000	84,000
Brazil	250	250	88,000	90,000
Canada	68	70	3,000	>3,000
Ethiopia	70	70	NA	NA
Mozambique	70	70	NA	NA
Rwanda	62	60	NA	NA
Other countries	32	30	NA	NA
World total (rounded)	1,400	1,400	130,000	180,000

World Resources: Identified resources of tantalum, most of which are in Australia, Brazil, and Canada, 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 2007 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]Revisions principally based on reevaluation of import and export data.
[2]Disposals reported by DNSC, net quantity (uncommitted inventory).
[3]Price is an average based on trade journal reported prices. Changes from previous year’s series are due to a change in basis of calculation.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]Actual quantity limited to remaining sales authority or inventory; additional legislative authority is required.
[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.

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, 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. Other uses include those in photoreceptor and thermoelectric electronic devices, 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:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production, refinery	W	W	W	W	W
Imports for consumption, unwrought, waste and scrap	49	63	42	31	38
Exports	10	6	51	4	13
Consumption, apparent	W	W	W	W	W
Price, dollars per kilogram, 99.95% minimum[1]	10	13	96	89	80
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 small amount is recovered from scrapped selenium-tellurium photoreceptors employed in older plain paper copiers in Europe and Japan.

Import Sources (2003-06): Belgium, 40%; Canada, 23%; Germany, 18%; United Kingdom, 6%; and other, 13%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
Tellurium	2804.50.0020	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Micheal W. George [(703) 648-4962, mgeorge@usgs.gov, fax: (703) 648-7757]**

TELLURIUM

Events, Trends, and Issues: Estimated domestic tellurium production increased in 2007 as compared with that of 2006 owing to a full year of uninterrupted production from the one domestic producer. Though detailed information on the world tellurium market was not available, world tellurium consumption was estimated to have increased significantly in 2007. There was a sharp increase in demand for high-purity tellurium for cadmium telluride solar cells. Tellurium consumption also increased in thermal cooling applications. The price of tellurium increased in 2007 because growth in consumption worldwide was not matched by growth in production. World production of tellurium, a byproduct of copper refining, was believed to have increased owing to an increase in world copper production. Selenium, a coproduct which was in strong demand, experienced a slight increase in production from waste and anode slimes that contained tellurium.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[3]	Reserve base[3]
	2006	2007[e]		
United States	W	W	3,000	6,000
Canada	75	75	700	1,500
Japan	24	25	NA	NA
Peru	33	35	1,600	2,800
Other countries[4]	NA	NA	16,000	37,000
World total (rounded)	[5]132	[5]135	21,000	47,000

World Resources: The figures shown for reserves and reserve base 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.

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]See Appendix C for definitions. Estimates include tellurium contained in copper resources only.
[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.
[5]Excludes refinery production from the United States.

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:	2003	2004	2005	2006	2007[e]
Production, mine	([1])	([1])	([1])	([1])	([1])
Imports for consumption (gross weight)					
Unwrought powders	36	117	23	—	—
Formed and articles	45	98	212	530	1,100
Waste and scrap	—	110	—	—	—
Total	81	325	235	530	1,100
Exports (gross weight)					
Unwrought powders	490	224	209	—	230
Formed and articles	668	965	43	1,090	40
Waste and scrap	39	—	—	—	1,800
Total	1,200	1,190	252	1,090	2,070
Consumption[e]	NA	900	300	NA	NA
Price, metal, dollars per kilogram[2]	1,300	1,600	1,900	4,650	4,560
Net import reliance[e, 3] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2003-06): Russia, 52%; Netherlands, 25%; and Belgium, 23%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
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 2007 as the supply worldwide continued to be relatively tight. The average price for high-purity granules and rod was nearly three times higher than the average price during the previous 3 years. 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. Some of this import increase was in the form of thallium waste and scrap from the United States.

Research and development activities of both a basic and applied nature were conducted during 2007 that could expand the use of thallium. Activities included the development of HTS materials for such applications as magnetic resonance imaging, storage of magnetic energy, magnetic propulsion, more efficient electrical motors, and electric power generation and transmission. Experimental results showed that the superconductivity properties exhibited in a lead-tellurium (PbTe) semiconductor doped with thallium resulted from a simple exchange of paired electrons between two thallium valence states and the PbTe valence band. Doping with cations other than thallium in the concentration range of study did not yield superconductivity properties in the PbTe semiconductor. In other research, thallium sulfide thin films of several different compositions were formed on both glass and polyethylene plastic. The photoconductive properties of these thin films may find use in solar batteries and other devices.

Prepared by **Gerald R. Smith [(703) 648-4983, grsmith@usgs.gov, fax: (703) 648-7757]**

THALLIUM

A broad range of commercial applications would become available if HTS materials could be fabricated on a large scale into wires having a certain degree of flexibility and strength. Currently, HTS materials are relatively brittle metal-oxide ceramics. There are now more than 50 known HTS materials, but only a few (nonthallium) have been used successfully to form long-length wires.

In medical applications, dipyridamole-thallium imaging continued to be a useful preoperative procedure for assessing long-term cardiac risks in patients with coronary artery disease or diabetes who are undergoing peripheral vascular surgery. Further uses of radioactive thallium in clinical diagnostic applications include cardiovascular and oncological imaging.

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, Reserves, and Reserve Base:[4]

	Mine production		Reserves[5]	Reserve base[5]
	2006	**2007**[e]		
United States	([1])	([1])	32,000	120,000
Other countries	10,000	10,000	350,000	530,000
World total (rounded)	10,000	10,000	380,000	650,000

World Resources: World resources of thallium contained in zinc resources total about 17 million kilograms; most are located 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 electric 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. NA Not available. — Zero.
[1]No reported mine production; flue dust and residues from base-metal smelters, from which thallium metal and compounds may be recovered, are being 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.

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 2007, 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 high-temperature ceramics, catalysts, and welding electrodes. Thorium's use in most products has decreased because of its naturally occurring radioactivity. The value of thorium alloys, compounds, and metal used by the domestic industry was estimated to have decreased to about $250,000.

Salient Statistics—United States:	2003	2004	2005	2006	2007[e]
Production, refinery[1]	—	—	—	—	—
Imports for consumption:					
Thorium ore and concentrates (monazite), gross weight	—	—	—	10.0	—
Thorium ore and concentrates (monazite), ThO_2 content	—	—	—	0.70	—
Thorium compounds (oxide, nitrate, etc.), gross weight	4.10	5.32	4.93	48.6	6.25
Thorium compounds (oxide, nitrate, etc.), ThO_2 content	3.03	3.94	3.65	36.0	4.63
Exports:					
Thorium ore and concentrates (monazite), gross weight	23	18	—	—	1.00
Thorium ore and concentrates (monazite), ThO_2 content	0.92	0.72	—	—	0.04
Thorium compounds (oxide, nitrate, etc.), gross weight	0.59	0.73	0.74	1.09	1.93
Thorium compounds (oxide, nitrate, etc.), ThO_2 content	0.44	0.54	0.55	0.81	1.43
Shipments from Government stockpile excesses ($ThNO_3$)	—	—	—	—	—
Consumption:					
Reported, (ThO_2 content)	NA	NA	NA	NA	NA
Apparent	2.62	3.40	3.10	35.2	3.20
Price, yearend, dollars per kilogram:					
Nitrate, welding-grade[2]	5.46	5.46	5.46	5.46	5.46
Nitrate, mantle-grade[3]	27.00	27.00	27.00	27.00	27.00
Oxide, yearend:					
99.9% purity[4]	82.50	82.50	82.50	175.00	200.00
99.99% purity[4]	107.25	107.25	107.25	107.25	NA
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2003-06): Monazite: Canada, 100%. Thorium compounds: United Kingdom, 69.7%; France, 30.2%; and other, 0.1%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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.

Prepared by **James B. Hedrick [(703) 648-7725, jhedrick@usgs.gov, fax: (703) 648-7757]**

THORIUM

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 2007. Domestic demand for thorium ores, compounds, metals, and alloys has exhibited a long-term declining trend. No thorium consumption was reported in the United States in 2006, according to the U.S. Geological Survey's canvass of mines and processors. In 2007, consumption was believed to be primarily in catalysts, microwave tubes, and optical equipment and was estimated to have decreased. On the basis of data through August 2007, the average value of imported thorium compounds increased to $50.43 per kilogram from the 2006 average of $32.01 per kilogram (gross weight). The average value of exported thorium compounds decreased to $249.74 per kilogram based on data through August 2007, compared to the 2006 average value of $390.71. The use of thorium in the United States has decreased significantly since the 1980s, when consumption averaged 45 tons per year. Increased costs to monitor and dispose of thorium have caused domestic processors to switch to thorium-free materials. Real and potential costs related to compliance with State and Federal regulations, proper disposal, and monitoring of thorium's radioactivity have limited its commercial value. It is likely that thorium's use will continue to decline unless a low-cost disposal process is developed or new technology, such as a nonproliferative nuclear fuel, creates renewed demand.

World Refinery Production, Reserves, and Reserve Base:[6]

	Refinery production 2006	Refinery production 2007	Reserves[7]	Reserve base[7]
United States	—	—	160,000	300,000
Australia	—	—	300,000	340,000
Brazil	NA	NA	16,000	18,000
Canada	NA	NA	100,000	100,000
India	NA	NA	290,000	300,000
Malaysia	—	—	4,500	4,500
Norway	—	—	170,000	180,000
South Africa	—	—	35,000	39,000
Other countries	NA	NA	90,000	100,000
World total	NA	NA	1,200,000	1,400,000

Reserves and reserve base are contained primarily in the rare-earth ore mineral monazite. 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. No new demand, however, is expected. Reserves exist primarily in recent and ancient placer deposits. Lesser quantities of thorium-bearing monazite reserves occur in vein deposits and carbonatites.

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, zirconium, and yttrium can substitute for magnesium-thorium alloys in aerospace applications.

[e]Estimated. NA Not available. — Zero.
[1]All domestically consumed thorium was derived from imported materials.
[2]Source: U.S. Department of Defense, Defense Logistics Agency. Based on sales from the National Defense Stockpile.
[3]Source: Rhodia Canada, Inc., and Rhodia Electronics and Catalysis, Inc., f.o.b. port of entry, duty paid, ThO_2 basis.
[4]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 99.99% purity thorium oxide.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]Estimates, based on thorium contents of rare-earth ores.
[7]See Appendix C for definitions.

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 2007. The major uses were as follows: cans and containers, 26%; electrical, 24%; construction, 10%; transportation, 10%; and other, 30%. On the basis of the average New York composite price, the estimated values of some critical items were as follows: primary metal consumed, $655 million; imports for consumption, refined tin, $791 million; and secondary production (old scrap), $226 million.

Salient Statistics—United States:	2003	2004	2005	2006[e]	2007[e]
Production:					
Secondary (old scrap)	5,500	5,240	11,800	12,000	12,200
Secondary (new scrap)	3,570	3,590	2,280	3,000	2,800
Imports for consumption, refined tin	37,100	47,600	37,500	43,300	42,600
Exports, refined tin	3,690	3,650	4,330	5,500	5,100
Shipments from Government stockpile excesses	8,880	10,600	8,368	8,409	8,600
Consumption, reported:					
Primary	32,900	36,700	32,200	34,600	35,300
Secondary	4,510	7,990	9,170	10,000	9,700
Consumption, apparent	48,700	58,800	54,700	57,500	58,600
Price, average, cents per pound:					
New York market	232	409	361	419	661
New York composite	340	547	483	565	842
London	222	385	334	398	628
Kuala Lumpur	222	385	334	398	628
Stocks, consumer and dealer, yearend	7,960	8,980	8,270	9,000	8,700
Net import reliance[1] as a percentage of apparent consumption	89	92	78	79	79

Recycling: About 15,000 tons of tin from old and new scrap was recycled in 2007. Of this, about 12,000 tons was recovered from old scrap at 2 detinning plants and 87 secondary nonferrous metal processing plants.

Import Sources (2003-06): Peru, 45%; Bolivia, 15%; China, 14%; Indonesia, 10%; and other, 16%.

Tariff: Most major imports of tin, including unwrought metal, waste and scrap, and unwrought tin alloys, enter the United States duty free.

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

Government Stockpile: The Defense National Stockpile Center (DNSC), Defense Logistics Agency, continued its tin sales program by offering material for sale under the Negotiated format (long-term sales) and the Basic Ordering Agreement (BOA) format (spot market sales). The DNSC Annual Materials Plan for tin sales for fiscal year 2007 (October 1, 2006, through September 30, 2007) remained at 12,000 tons, although current inventory levels are approximately 8,600 tons. DNSC plans one long-term negotiated “contract” sale for fiscal year 2007 and weekly offerings under the DNSC BOA. Under the BOA approach, DNSC posts the amount of tin that it wants to sell on its Web site every Tuesday. Interested parties submit a quote, and DNSC makes a sales determination by the end of the business day. Tin is held in Federal depots at two locations—Hammond, IN; and New Haven, IN.

Stockpile Status—9-30-07[2]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Pig tin	8,623	—	8,623	12,000	8,409

Prepared by **James F. Carlin, Jr. [(703) 648-4985, jcarlin@usgs.gov, fax: (703) 648-7757]**

TIN

Events, Trends, and Issues: Apparent consumption of tin in the United States increased an estimated 2% in 2007 compared with that of 2006. The average monthly dealer price of tin rose steadily during the first 7 months of 2007, rising from $5.31 per pound in January to $6.93 per pound in July. These represented generally higher prices than prevailed in 2006.

Developments accelerated in major tin-consuming countries in moving to new lead-free solders that usually contain greater amounts of tin than do leaded solders.

Tin producers responded to the higher tin prices and strong demand of the past several years with tin mine and tin smelter openings and expansions. Several closed or partially disabled tin mines were reopened. China continued to be the leading tin producer, from both mines and smelters. Indonesia, the world's second leading tin producer, was wracked by a series of events that served to interrupt tin output and create market uncertainty.

The world tinplate industry continued to experience major mergers and consolidations. The dominant one in 2007 involved the merger of one of Europe's leading steel producers and tinplate makers into one of India's leading suppliers of the same items. Worldwide, more than 5 million metric tons of steel cans, which were mostly made from tinplate, were recycled in 2005, representing an average recycling rate of 65%.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	2006	2007[e]		
United States	—	—	—	40,000
Australia	2,000	2,200	150,000	300,000
Bolivia	18,000	18,000	450,000	900,000
Brazil	12,000	12,000	540,000	2,500,000
China	125,000	130,000	1,700,000	3,500,000
Congo (Kinshasa)	2,800	3,000	NA	NA
Indonesia	90,000	85,000	800,000	900,000
Malaysia	3,000	3,000	1,000,000	1,200,000
Peru	38,000	38,000	710,000	1,000,000
Portugal	200	200	70,000	80,000
Russia	3,000	4,000	300,000	350,000
Thailand	200	200	170,000	200,000
Vietnam	3,500	3,500	NA	NA
Other countries	4,000	4,000	180,000	200,000
World total (rounded)	302,000	300,000	6,100,000	11,000,000

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.

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 2007 was about $530 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:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production[2] (rounded)	300	300	300	300	300
Imports for consumption	966	872	1,000	1,030	1,200
Exports,[e] all forms	7	6	14	21	7
Consumption, reported[3]	1,412	1,494	[e]1390	[e]1,420	[e]1,450
Price, dollars per metric ton, yearend:					
Ilmenite, bulk, minimum 54% TiO_2, f.o.b. Australia	90	81	80	80	80
Rutile, bulk, minimum 95% TiO_2, f.o.b. Australia	430	455	470	475	488
Slag, 80%-95% TiO_2[4]	385-444	347-466	390-555	402-454	402-571
Stocks, mine, consumer, yearend	274	369	NA	NA	NA
Employment, mine and mill, number[e]	344	300	286	246	229
Net import reliance[5] as a percentage of reported consumption	68	58	71	71	82

Recycling: None.

Import Sources (2003-06): South Africa, 51%; Australia, 29%; Canada, 12%; Ukraine, 4%; and other, 4%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
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.

Prepared by **Joseph Gambogi [(703) 648-7718, jgambogi@usgs.gov, fax: (703) 648-7975]**

TITANIUM MINERAL CONCENTRATES

Events, Trends, and Issues: Domestic consumption of titanium mineral concentrates was estimated to have increased moderately. Although cost-cutting measures ended mining in Green Cove Springs, FL, and Lulaton, GA, reprocessing of tailings continued in Green Cove Springs, FL.

Global production of titanium mineral concentrates was estimated to have increased 3% compared with that of 2006. Increased production and consumption of titanium dioxide pigment in China helped to stimulate the development of titanium mineral projects. In 2007, new mine production began in Australia (Goondicum, Murray Basin, and Tiwi Islands), Mozambique (Moma), and The Gambia (Sanyang). Projects that were nearing completion included those in Australia (Keysbrook), Russia (Kuranakh), and South Africa (Tormin). Projects also were being developed in Australia (Coburn Sands, Donald, Eucla Basin, and Murray Basin), Canada (Athabasca Oil Sands), Chile (White Mountain), India (Tamil Nadu), Kenya (Kwale), Madagascar (Fort Dauphin), Mozambique (Corridor Sands), Senegal (Grande Côte), and South Africa (Xolobeni). In Vietnam, new government policies were being implemented to control illegal mining and promote the development of upgraded products.

World Mine Production, Reserves, and Reserve Base: Reserve estimates for Brazil and Vietnam were revised based on information derived from government and industry reports.

	Mine production		Reserves[6]	Reserve base[6]
	2006	2007[e]		
Ilmenite:				
United States[2]	[7]300	[7]300	6,000	59,000
Australia	1,330	1,340	130,000	160,000
Brazil	130	130	43,000	84,000
Canada[8]	791	816	31,000	36,000
China	500	500	200,000	350,000
India	313	340	85,000	210,000
Mozambique	—	100	16,000	21,000
Norway[8]	380	380	37,000	60,000
South Africa[8]	1,050	1,060	63,000	220,000
Ukraine	273	280	5,900	13,000
Vietnam	230	200	1,600	14,000
Other countries	108	109	66,000	150,000
World total (ilmenite, rounded)	5,400	5,600	680,000	1,400,000
Rutile:				
United States	([9])	([9])	400	1,800
Australia	207	209	19,000	31,000
Brazil	3	3	1,200	2,500
India	18	18	7,400	20,000
Mozambique	—	3	480	570
Sierra Leone	13	80	2,500	3,600
South Africa	117	121	8,300	24,000
Ukraine	57	57	2,500	2,500
Other countries	—	—	400	1,000
World total (rutile, rounded)	[9]415	[9]491	42,000	87,000
World total (ilmenite and rutile, rounded)	5,800	6,100	730,000	1,500,000

World Resources: Ilmenite supplies about 92% of the world's demand for 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 nearest 0.1 million tons to avoid disclosing company proprietary data.
[3]Excludes ilmenite used to produce synthetic rutile.
[4]Landed duty-paid value based on U.S. imports for consumption.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]See Appendix C for definitions.
[7]Includes rutile.
[8]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. Ingot was produced by eight operations in eight States. Numerous firms consumed ingot to produce wrought products and castings. In 2007, 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 $563 million, assuming an average selling price of $15.90 per kilogram.

In 2007, titanium dioxide (TiO_2) pigment, which was valued at about $3.6 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), 57%; plastic, 26%; paper, 13%; and other, 4%. Other uses of TiO_2 included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Titanium sponge metal:					
Production	W	W	W	W	W
Imports for consumption	9,590	11,900	15,800	24,400	24,200
Exports	5,000	2,410	1,910	1,380	2,310
Shipments from Government stockpile excesses	6,820	3,910	2,510	—	—
Consumption, reported	17,100	21,200	26,100	28,400	35,400
Price, dollars per kilogram, yearend	6.50	8.50	9.23	13.58	16.00
Stocks, industry yearend[e]	8,180	7,660	4,330	8,240	7,600
Employment, number[e]	300	300	300	350	400
Net import reliance[2] as a percentage of reported consumption	87	66	73	67	64
Titanium dioxide:					
Production	1,420,000	1,540,000	1,310,000	1,400,000	1,450,000
Imports for consumption	240,000	264,000	341,000	288,000	260,000
Exports	584,000	635,000	524,000	581,000	600,000
Consumption, apparent	1,070,000	1,170,000	1,130,000	1,110,000	1,110,000
Producer price index, yearend	144	158	172	165	163
Stocks, producer, yearend	156,000	NA	NA	NA	NA
Employment, number[e]	4,500	4,400	4,300	4,300	4,300
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 23,200 tons in 2007. Estimated use of titanium as scrap and ferrotitanium by the steel industry was about 8,300 tons; by the superalloy industry, 1,300 tons; and, in other industries, 1,700 tons. Old scrap reclaimed totaled about 600 tons.

Import Sources (2003-06): Sponge metal: Kazakhstan, 51%; Japan, 37%; Russia, 7%; Ukraine, 3%; and other, 2%. Titanium dioxide pigment: Canada, 30%; China, 12%; Germany, 9%; France, 7%; and other, 42%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
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.
Titanium waste and scrap metal	8108.30.0000	Free.
Unwrought titanium metal	8108.20.0000	15.0% ad val.
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.

Prepared by **Joseph Gambogi [(703) 648-7718, jgambogi@usgs.gov, fax: (703) 648-7975]**

TITANIUM AND TITANIUM DIOXIDE

Events, Trends, and Issues: Domestic production of TiO_2 pigment was an estimated 1.45 million tons, a moderate increase compared with that of 2006. Global production of TiO_2 was estimated to have increased 2% compared with that of 2006. TiO_2 pigment capacity expansions that were underway and soon to be commissioned included those in Kwinana, Australia (50,000 tons per year), Yanbu, Saudi Arabia (92,000 tons per year), and Greatham, United Kingdom (50,000 tons per year). In New Johnsonville, TN, capacity to produce titanium tetrachloride—the chemical intermediate used to produce titanium metal, TiO_2 pigment, and other compounds—was being expanded by 45,000 tons per year. A Saudi Arabian producer of TiO_2 pigment with 100,000 tons per year of capacity acquired a U.S. TiO_2 producer with 670,000 tons per year of global capacity. The acquisition made the Saudi Arabian producer the second largest TiO_2 pigment producer in the world. A U.S.-based company planned to construct a 200,000 ton-per-year chloride-route TiO_2 pigment plant in Dongying, China, by 2010.

Domestic consumption of titanium sponge used to produce titanium ingot increased 25% compared with that of 2006. Titanium metal producers were adding capacity to keep pace with rising demand from commercial aerospace. In Albany, OR, sponge capacity was expected to reach 7,260 tons per year by yearend 2007. In Rowley, UT, a new 10,900-ton-per-year sponge plant was expected to begin producing in 2008. In Henderson, NV, sponge capacity was expected to increase to 12,600 tons per year by yearend. China's sponge capacity was expected to rise to 50,000 tons per year by 2008. Japan's sponge capacity was expected to rise to 52,000 tons per year by 2009. Russian production capacity was expected to increase to 44,000 tons per year by 2008 and 56,000 tons per year by 2012. Several concerted efforts to develop a low-cost method for producing titanium metal were ongoing.

World Sponge Metal Production and Sponge and Pigment Capacity: In 2007, capacity for China, Kazakhstan, Russia, Ukraine, and the United States was increased based on new published information and presentations.

	Sponge production		Capacity 2007[3]	
	2006	2007[e]	Sponge	Pigment
United States	W	W	20,200	1,580,000
Australia	—	—	—	241,000
Belgium	—	—	—	74,000
Canada	—	—	—	90,000
China[e]	18,000	32,000	45,000	500,000
Finland	—	—	—	130,000
France	—	—	—	225,000
Germany	—	—	—	440,000
Italy	—	—	—	80,000
Japan	37,800	39,000	39,000	317,000
Kazakhstan[e]	23,000	25,000	26,000	1,000
Mexico	—	—	—	125,000
Russia[e]	32,000	32,000	32,000	20,000
Spain	—	—	—	80,000
Ukraine[e]	10,000	10,000	10,000	120,000
United Kingdom	—	—	—	290,000
Other countries	—	—	—	670,000
World total (rounded)	[4]121,000	[4]138,000	170,000	5,000,000

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]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 restarted operations and made its first shipment of tungsten concentrates in October 2007. In 2007, approximately nine 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. One of these companies expanded the ammonium paratungstate capacity of its tungsten processing plant in Alabama. Approximately 60 industrial consumers were surveyed on a monthly or annual basis. Data reported by these consumers indicate 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 metalworking, mining, oil- and gas-drilling, and construction 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 2007 was $520 million.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production:					
Mine	—	—	—	—	W
Secondary	4,130	4,000	4,650	4,460	4,400
Imports for consumption:					
Concentrate	4,690	2,310	2,080	2,290	4,100
Other forms	7,620	8,240	9,070	9,700	9,500
Exports:					
Concentrate	20	43	52	130	140
Other forms	5,070	3,730	5,890	6,310	5,900
Government stockpile shipments:					
Concentrate	710	979	2,310	3,120	1,900
Other forms	182	80	404	16	—
Consumption:					
Reported, concentrate	W	W	W	W	W
Apparent,[1] all forms	10,100	12,600	11,600	13,200	14,400
Price, concentrate, dollars per mtu WO_3,[2] average:					
U.S. spot market, Platts Metals Week	50	49	146	200	190
European market, Metal Bulletin	45	55	123	166	165
Stocks, industry, yearend:					
Concentrate	W	W	W	W	W
Other forms	1,820	1,780	2,300	2,130	1,600
Net import reliance[3] as a percentage of apparent consumption	63	73	68	68	70

Recycling: In 2007, the tungsten contained in scrap consumed by processors and end users represented approximately 31% of apparent consumption of tungsten in all forms.

Import Sources (2003-06): Tungsten contained in ores and concentrates, intermediate and primary products, wrought and unwrought tungsten, and waste and scrap: China, 43%; Canada, 16%; Germany, 9%; Portugal, 6%; and other, 26%.

Tariff: Item	Number	Normal Trade Relations[4] 12-31-07
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).

Prepared by **Kim B. Shedd [(703) 648-4974, kshedd@usgs.gov, fax: (703) 648-7757]**

TUNGSTEN

Government Stockpile:

Stockpile Status—9-30-07[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Ferrotungsten	—	—	—	[6]136	—
Metal powder	268	—	268	136	34
Ores and concentrates	21,300	—	21,300	3,630	1,280

Events, Trends, and Issues: World tungsten supply was dominated by Chinese production and exports. China's Government restricted the amounts of tungsten that could be produced and exported, increased the resource tax on tungsten mining, banned foreign investment in Chinese mines, banned tolling of tungsten concentrate, introduced regulations to limit the building or expansion of tungsten processing plants, continued to shift the balance of export quotas towards value-added downstream tungsten materials and products, and imposed export duties on most 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.

Various companies worked towards developing tungsten deposits or reopening inactive tungsten mines in Australia, Canada, China, Kyrgyzstan, Mexico, Spain, Thailand, the United States, Uzbekistan, and Vietnam.

Health, safety, and environmental issues are becoming increasingly significant to the production and use of metals such as tungsten.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for Portugal were revised upward based on new information from that country.

	Mine production		Reserves[7]	Reserve base[7]
	2006	2007[e]		
United States	—	W	140,000	200,000
Austria	1,300	1,300	10,000	15,000
Bolivia	870	870	53,000	100,000
Canada	2,560	2,600	260,000	490,000
China	79,000	77,000	1,800,000	4,200,000
Korea, North	600	600	NA	35,000
Portugal	780	800	4,700	62,000
Russia	4,000	4,400	250,000	420,000
Other countries	1,680	2,040	420,000	740,000
World total (rounded)	90,800	89,600	2,900,000	6,300,000

World Resources: World tungsten resources are geographically widespread. China ranks number one 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 include cemented carbides based on molybdenum carbide and titanium carbide, ceramics, ceramic-metallic composites (cermets), diamond tools, and tool steels for cemented tungsten carbides; 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. NA Not available. 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]Actual quantity limited to remaining inventory.
[7]See Appendix C for definitions.

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 91% of the domestic vanadium consumption in 2007. 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:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production, mine, mill[1]	—	—	—	—	—
Imports for consumption:					
Ash, ore, residues, slag	3,060	2,350	1,690	1,000	1,050
Vanadium pentoxide, anhydride	474	1,040	1,370	1,920	2,240
Oxides and hydroxides, other	74	120	186	129	28
Aluminum-vanadium master alloys (gross weight)	232	19	1	102	817
Ferrovanadium	1,360	3,020	11,900	2,140	2,260
Exports:					
Vanadium pentoxide, anhydride	185	240	254	341	361
Oxides and hydroxides, other	284	584	899	832	582
Aluminum-vanadium master alloys (gross weight)	677	887	1,500	1,930	1,590
Ferrovanadium	397	285	504	389	165
Consumption, reported	3,240	4,050	3,910	4,030	4,180
Price, average, dollars per pound V_2O_5	2.21	5.99	16.28	7.86	7.40
Stocks, consumer, yearend	252	336	371	330	340
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 (2003-06): Ferrovanadium: Czech Republic, 77%; Swaziland, 9%; Canada, 6%; Austria, 3%; and other, 5%. Vanadium pentoxide: South Africa, 72%; China, 15%; Russia, 9%; and other, 4%.

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

Item	**Number**	**Normal Trade Relations 12-31-07**
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.

Prepared by **Michael J. Magyar [(703) 648-4964, mmagyar@usgs.gov, fax: (703) 648-7757]**

VANADIUM

Events, Trends, and Issues: Preliminary data indicate that U.S. vanadium consumption in 2007 increased about 4% 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 25%, 30%, and 32% of domestic consumption, respectively. In 2007, U.S. steel production was expected to be 2% to 3% lower than that of 2006.

Vanadium pentoxide prices ranged from $5.70 to $8.30 and averaged $7.40 for the year, about 6% lower than that of 2006. Ferrovanadium prices ranged from $15.25 to $38.50 and averaged an estimated $19.60 for the year, about 4% higher than that of 2006. Stable demand in the steel and aerospace industries and increased production of vanadium in Russia and China kept world supply and demand in balance in 2007.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	2006	2007[e]		
United States	—	—	45,000	4,000,000
China	17,500	18,500	5,000,000	14,000,000
Russia	15,100	16,000	5,000,000	7,000,000
South Africa	22,000	23,000	3,000,000	12,000,000
Other countries	1,100	1,100	NA	1,000,000
World total (rounded)	55,700	58,600	13,000,000	38,000,000

World Resources: World resources of vanadium exceed 63 million tons. Vanadium occurs in deposits of titaniferous magnetite, phosphate rock, 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 crude oil, coal, 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 niobium (columbium), manganese, molybdenum, 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 production stopped in 1999.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions.

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 agricultural, insulation, and other, 75%; and lightweight concrete aggregates (including cement premixes, concrete, and plaster), 25%.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production[e, 1]	110	[2]100	100	100	100
Imports for consumption[e]	37	69	91	65	75
Exports[e]	15	10	5	5	5
Consumption, apparent, concentrate[e]	[3]130	[3]160	[3]185	160	170
Consumption, exfoliated[e]	95	90	85	90	95
Price, average, concentrate, dollars per ton, ex-plant	143	[4]143	[5]143	[6]138	140
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number[e]	90	[7]100	[7]100	[7]100	[7]95
Net import reliance[8] as a percentage of apparent consumption[e]	20	35	45	40	40

Recycling: Insignificant.

Import Sources (2003-06): South Africa, 54%; China, 45%; and other, 1%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-07**
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.

Prepared by **Michael J. Potter [(703) 648-7723, mpotter@usgs.gov, fax: (703) 648-7757]**

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 51,000 tons for the first 8 months of 2007. China provided 67% and South Africa, 32%.[9]

IBI Corporation of Toronto, Ontario, Canada, signed an agreement with a subsidiary of Rio Tinto plc for the conditional sale of IBI's Namekara vermiculite property in southeast Uganda. In March 2007, Rio Tinto made an initial payment to IBI. The development of a mine by Rio Tinto at Namekara was to be conditional upon the results of a study, in progress during 2007, into the magnitude of the resource. The study also will include the prospective financial viability of future operations at the scale contemplated.[10]

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[11]	Reserve base[11]
	2006	2007[e]		
United States[e]	100	100	25,000	100,000
Brazil	25	25	NA	NA
China	110	110	NA	NA
Russia	25	25	NA	NA
South Africa	198	200	14,000	80,000
Zimbabwe	20	13	NA	NA
Other countries	42	47	NA	NA
World total (rounded)	520	520	NA	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, reserve information comes from many sources, and in most cases it is not clear whether the numbers refer to vermiculite alone or vermiculite plus host rock and overburden.[12]

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]Dickson, Ted, 2006, Vermiculite, Countries and Commodities Reports. (Accessed March 17, 2006, via http://www.mining-journal.com.)
[3]Rounded.
[4]Industrial Minerals, 2004, Prices: Industrial Minerals, no. 442, July, p. 64-65.
[5]Moeller, Eric, 2006, Vermiculite: Mining Engineering, v. 58, no. 6, June, p. 61. (Average of prices from range of sized grades.)
[6]Moeller, Eric, 2007, Vermiculite: Mining Engineering, v. 59, no. 6, June, p. 61-62. (Average of prices from range of sized grades.)
[7]Mine, mill, and office.
[8]Defined as imports – exports + adjustments for Government and industry stock changes.
[9]Commonwealth Business Media, Inc., 2007, Port Import/Export Reporting Service. (Accessed November 15, 2007, at http://www.piers.com.)
[10]Industrial Minerals, 2007, Rio Tinto expands vermiculite business with IBI buy: Industrial Minerals, no. 473, February, p. 8.
[11]See Appendix C for definitions.
[12]Roskill Information Services, Ltd., 2004, The economics of vermiculite (8th ed.): London, United Kingdom, Roskill Information Services Ltd., 126 p. plus appendices.

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 2007. All yttrium metal and compounds used in the United States were imported. Principal uses were in phosphors for color televisions and computer monitors, trichromatic fluorescent lights, temperature sensors, and X-ray-intensifying screens. Yttrium also was used as a stabilizer in zirconia, in alumina-zirconia abrasives, wear-resistant and corrosion-resistant cutting tools, seals and bearings, high-temperature refractories for continuous-casting nozzles, jet engine coatings, oxygen sensors in automobile engines, and simulant gemstones. 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 industrial cutting and welding, medical and dental surgical procedures, temperature and distance sensing, photoluminescence, photochemistry, digital communications, and nonlinear optics. Yttrium also was used in heating-element alloys, superalloys, and high-temperature superconductors. The approximate distribution in 2006 by end use was as follows: lamp and cathode-ray-tube phosphors, 84%; electronics, 7%; ceramics, 7%; and metallurgical, 2%.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production, mine	—	—	—	—	—
Imports for consumption:					
In monazite	—	—	—	—	—
Yttrium, alloys, compounds, and metal[e, 2]	380	619	582	742	650
Exports, in ore and concentrate	NA	NA	NA	NA	NA
Consumption, estimated[3]	380	619	582	742	650
Price, dollars:					
Monazite concentrate, per metric ton[4]	275	326	300	300	300
Yttrium oxide, per kilogram, 99.0% to 99.99% purity[5]	22-88	22-85	10-85	10-85	10-85
Yttrium metal, per kilogram, 99.9% purity[5]	95-115	96	96	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 (2003-06):[e] Yttrium compounds, >19% to < 85% weight percent yttrium oxide equivalent: China, 94.1%; Japan, 3.9%; France, 1.1%; and Austria, 0.9%. Import sources based on Journal of Commerce data (2006 only): China, 94%; Japan, 3%; Belgium, 2%; Austria, 0.5%; and other, 0.5%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed	2805.30.0000	5.0% ad val.
Yttrium-bearing materials and compounds containing by weight >19% to < 85% Y_2O_3	2846.90.4000	Free.
Other rare-earth compounds, including yttrium oxide $\geq$ 85% Y_2O_3, yttrium nitrate, and other individual compounds	2846.90.8000	3.7% ad val.

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

Government Stockpile: None.

Prepared by **James B. Hedrick [(703) 648-7725, jhedrick@usgs.gov, fax: (703) 648-7757]**

YTTRIUM

Events, Trends, and Issues: Estimated yttrium consumption in the United States increased in 2006 and was expected to decrease in 2007. The United States required increased amounts of yttrium for use in various phosphors and in electronics, especially those used in defense applications. Yttrium production and marketing within China continued to be competitive; however, prices remained steady. China was the source of most of the world's supply of yttrium from its weathered clay ion-absorption ore deposits in the southern Provinces of Guangdong and Jiangxi. Processing was primarily at facilities in Guangdong, Jiangsu, and Jiangxi Provinces. Yttrium was consumed primarily in the form of high-purity oxide and nitrate compounds.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e, 7] 2006	Mine production[e, 7] 2007	Reserves[8]	Reserve base[8]
United States	—	—	120,000	130,000
Australia	—	—	100,000	110,000
Brazil	15	15	2,200	6,200
China	8,800	8,800	220,000	240,000
India	55	55	72,000	80,000
Malaysia	4	4	13,000	21,000
Sri Lanka	—	—	240	260
Other	—	—	17,000	20,000
World total (rounded)	8,900	8,900	540,000	610,000

World Resources: Large resources of yttrium in monazite and xenotime are available worldwide in ancient and recent placer deposits, weathered clay deposits (ion-adsorption ore), carbonatites, and uranium ores. Additional large subeconomic resources of yttrium occur in other monazite-bearing deposits, apatite-magnetite rocks, sedimentary phosphate deposits, deposits of niobium-tantalum minerals, and certain uranium ores, especially those of the Blind River District near Elliot Lake, Ontario, Canada, which contain yttrium in monazite, brannerite, 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.

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 have 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).
[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 2003 and 2004 and estimated for 2005 through 2007.
[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]Includes yttrium contained in rare-earth ores.
[8]See Appendix C for definitions.

ZINC

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

Domestic Production and Use: The value of zinc mined in 2007, based on zinc contained in concentrate, was about $2.59 billion. It was produced in 7 States at 14 mines operated by 8 companies. Alaska, Missouri, Montana, and Washington accounted for about 99% of domestic mine output; the Red Dog Mine in Alaska accounted for about 77% of total U.S. production. One primary and 12 large- and medium-sized secondary smelters refined zinc metal of commercial grade in 2007. 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, in order of decreasing tonnage, were lead, sulfuric acid, cadmium, silver, gold, and germanium.

Salient Statistics—United States:	**2003**	**2004**	**2005**	**2006**	**2007[e]**
Production:					
Mine, zinc in ore[1]	768	739	748	727	740
Primary slab zinc	187	188	182	113	120
Secondary slab zinc[2]	150	139	139	139	128
Imports for consumption:					
Ore and concentrate	164	231	156	383	380
Refined zinc	758	812	668	851	693
Exports:					
Ore and concentrate	841	745	786	825	789
Refined zinc	2	3	1	3	11
Shipments from Government stockpile[3]	7	32	27	30	7
Consumption:					
Apparent, refined zinc	1,110	1,170	1,020	1,130	936
Apparent, all forms	1,340	1,410	1,260	1,380	1,180
Price, average, cents per pound:					
Domestic producers[4]	40.6	52.5	67.1	158.9	159.0
London Metal Exchange (LME), cash	37.5	47.5	62.7	148.5	151.0
Producer and consumer stocks, slab zinc, yearend	64	63	61	56	58
Employment:					
Mine and mill, number[5]	860	935	978	1,120	1,470
Smelter primary, number[e]	600	600	600	246	246
Net import reliance[6] as a percentage of apparent consumption:					
Refined zinc	70	72	68	78	73
All forms of zinc	58	60	55	64	58

Recycling: In 2007, an estimated 420,000 tons of zinc was recovered from waste and scrap; about 30% was recovered in the form of slab zinc and the remainder in alloys, oxide, and chemicals. Of the total amount of scrap recycled, 370,000 tons was derived from new scrap, and 50,000 tons was derived from old scrap. About 103,000 tons of scrap was exported, mainly to China (80%), and 23,000 tons was imported, most of which came from Canada (60%).

Import Sources (2003-06): Ore and concentrate: Peru, 67%; Mexico, 14%; Ireland, 9%; Australia, 9%; and other, 1%. Metal: Canada, 64%; Mexico, 17%; Australia, 4%; and other, 15%. Waste and scrap: Canada, 83%; Mexico, 15%; and other, 2%. Combined total: Canada, 50%; Peru, 17%; Mexico, 16%; Australia, 5%; and other, 12%.

Tariff: Item	Number	Normal Trade Relations[7] 12-31-07
Zinc ores and concentrates	2608.00.0030	Free.
Hard zinc spelter	2620.11.0000	Free.
Zinc oxide and zinc peroxide	2817.00.0000	Free.
Unwrought metal containing 99.99% or more of zinc	7901.11.0000	1.5% ad val.
Alloys, casting-grade	7901.12.1000	3% ad val.
Alloys	7901.20.0000	3% ad val.
Waste and scrap	7902.00.0000	Free.

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

Prepared by **Amy C. Tolcin [(703) 648-4940, atolcin@usgs.gov, fax: (703) 648-7757]**

ZINC

Government Stockpile:

Stockpile Status—9-30-07[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2007	Disposals FY 2007
Zinc	8	3	8	[9]45	3

Events, Trends, and Issues: The average monthly LME cash settlement price of zinc began the year at 171.74 cents per pound in January. The price fell during the months of February and March, rose during April and May, and then continued to decline through September. Strong demand for zinc, largely supported by China's growing economy and infrastructure, continued to outpace refined zinc production in 2007. The supply deficit for refined zinc, however, narrowed in 2007 from that of 2006, and a surplus was forecast for 2008. Rising refinery production continued to be driven by increases in production from China and India.

Zinc mine production in the United States was expected to increase during the next few years owing to recent mine restarts. Around mid-2007, a company reopened three zinc mines in eastern Tennessee. Another company planned to reopen a zinc mining complex in mid-Tennessee by the end of 2007. The zinc mines in eastern and mid-Tennessee were previously shut down in 2001 and 2003, respectively, owing to low zinc prices.

Prefeasibility studies for a United States zinc and iron recycling project were completed in early 2007. The project included plans to construct an electric arc furnace (EAF) dust processing plant in Ohio and to modify an existing primary zinc smelter in Illinois. The Ohio plant was to recover zinc and lead in an oxide concentrate (HZO) from EAF dust generated by the steel industry. The HZO will be sent to the modified Illinois facility to recover the zinc. The Illinois facility will be designed to produce 90,000 metric tons per year of Special High Grade zinc.

World Mine Production, Reserves, and Reserve Base: Reserves data, and where appropriate, reserve base data were revised based on updated resource information published by companies with mines in Australia, Canada, Kazakhstan, Mexico, Peru, and the United States.

	Mine production[10]		Reserves[11]	Reserve base[11]
	2006	2007[e]		
United States	727	740	14,000	90,000
Australia	1,380	1,400	42,000	100,000
Canada	710	680	5,000	30,000
China	2,600	2,800	33,000	92,000
Kazakhstan	400	400	14,000	35,000
Mexico	480	480	7,000	25,000
Peru	1,200	1,500	18,000	23,000
Other countries	2,500	2,500	49,000	87,000
World total (rounded)	10,000	10,500	180,000	480,000

World Resources: Identified zinc resources of the world are about 1.9 billion metric tons.

Substitutes: Aluminum, steel, and plastics substitute for galvanized sheet. Aluminum, plastics, and magnesium are major competitors as diecasting materials. Plastic coatings, paint, and cadmium and aluminum alloy 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]Zinc recoverable after smelting and refining was reported for mine production prior to Mineral Commodity Summaries 2001.
[2]Revisions to secondary slab zinc production reflect new company information.
[3]Revised basis of calculation; based on changes in yearend inventory from the previous year.
[4]Platts Metals Week price for North American Special High Grade zinc.
[5]Includes mine and mill employment at lead-zinc-, zinc-, and zinc-lead-producing mines only. Source: Mine Safety and Health Administration.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]No tariff for Canada and Mexico for items shown.
[8]See Appendix B for definitions.
[9]Actual quantity will be limited to remaining inventory.
[10]Zinc content of concentrate and direct shipping ore.
[11]See Appendix C for definitions.

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 11 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, opacifiers, refractories, and foundry applications 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:	2003	2004	2005	2006	2007[e]
Production, zircon (ZrO_2 content)	W	W	W	W	W
Imports:					
Zirconium, ores and concentrates (ZrO_2 content)	24,300	22,900	24,800	23,500	19,000
Zirconium, unwrought, powder, and waste and scrap	75	89	283	256	223
Zirconium, wrought	468	708	741	492	484
Zirconium oxide[1]	2,350	3,960	3,160	2,820	3,800
Hafnium, unwrought, waste and scrap	5	4	4	4	4
Exports:					
Zirconium ores and concentrates (ZrO_2 content)	45,900	44,700	65,600	49,600	48,100
Zirconium, unwrought, powder, and waste and scrap	204	233	321	271	287
Zirconium, wrought	1,490	1,470	1,650	1,610	1,720
Zirconium oxide[1]	1,520	1,600	2,260	3,340	2,270
Consumption, zirconium ores and concentrates, apparent (ZrO_2 content)	W	W	W	W	W
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic[2]	360	557	570	785	840
Imported, f.o.b.[3]	396	477	674	791	900
Zirconium, unwrought, dollars per kilogram[3]	44	31	22	23	25
Hafnium, unwrought, dollars per kilogram[3]	195	223	235	194	232
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 were 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 (2003-06): Zirconium ores and concentrates: Australia, 61%; South Africa, 32%; China, 4%; Canada, 2%; and other, 1%. Zirconium, unwrought, including powder: France, 60%; Germany, 25%; China, 10%; and other, 5%. Hafnium, unwrought: France, 73%; Canada, 23%; Germany, 2%; Austria, 1%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-07
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.

Prepared by **Joseph Gambogi [(703) 648-7718, jgambogi@usgs.gov, fax: (703) 648-7757]**

ZIRCONIUM AND HAFNIUM

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

Government Stockpile: None.

Events, Trends, and Issues: Domestic consumption of zirconium mineral concentrates decreased slightly compared with that of 2006. Although consumption of zircon for use in television glass decreased significantly, consumption of zircon increased for ceramic, refractory, and chemical uses. Cost-cutting measures ended mining in Green Cove Springs, FL, and Lulaton, GA; however, reprocessing of tailings for zircon continued.

Global production of zirconium concentrates increased to 1.24 million tons, a 5% increase compared with that of 2006. Prices for zircon concentrate increased to record-high levels. Global consumption of zircon was forecast to increase an average of 3% per year through 2015. Consumption growth in China was expected to be somewhat higher than the global average. In 2007, new mine production began in Australia (Murray Basin, Tiwi Islands), Indonesia (Kalimantan), Mozambique (Moma), and The Gambia (Sanyang). Projects that were nearing completion included those in Australia (Keysbrook) and South Africa (Tormin). Projects were also being developed in Australia (Coburn Sands, Donald, Eucla Basin, and Murray Basin), Canada (Athabasca Oil Sands), India (Tamil Nadu), Kenya (Kwale), Madagascar (Fort Dauphin), Mozambique (Corridor Sands), Senegal (Grande Côte), and South Africa (Xolobeni). The availability of hafnium, produced as a byproduct during zirconium metal processing, continued to exceed demand.

World Mine Production, Reserves, and Reserve Base: World primary hafnium production statistics are not available. Hafnium occurs with zirconium in the minerals zircon and baddeleyite.

	Zirconium				Hafnium	
	Mine production (thousand metric tons)		Reserves[5]	Reserve base[5]	Reserves[5]	Reserve base[5]
	2006	2007[e]	(million metric tons, ZrO_2)		(thousand metric tons, HfO_2)	
United States	W	W	3.4	5.7	68	97
Australia	491	550	9.1	30	180	600
Brazil	26	26	2.2	4.6	44	91
China	170	170	0.5	3.7	NA	NA
India	21	21	3.4	3.8	42	46
South Africa	398	405	14	14	280	290
Ukraine	35	35	4.0	6.0	NA	NA
Other countries	38	32	0.9	4.1	NA	NA
World total (rounded)	1,180	1,240	38	72	610	1,100

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]E.I. du Pont de Nemours & Co. and Iluka Resources, Inc., average price.
[3]Unit value based on U.S. imports for consumption.
[4]Defined as imports – exports.
[5]See Appendix C for definitions.

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.

Committed inventory refers to materials that have been sold or traded from the stockpile, either in fiscal year 2007 (FY 2007) or in prior years, but not yet removed from stockpile facilities as of September 30, 2007. FY 2007 is the period October 1, 2006, through September 30, 2007.

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 2007 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. 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 2007 refers to material sold or traded from the stockpile in FY 2007.

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*

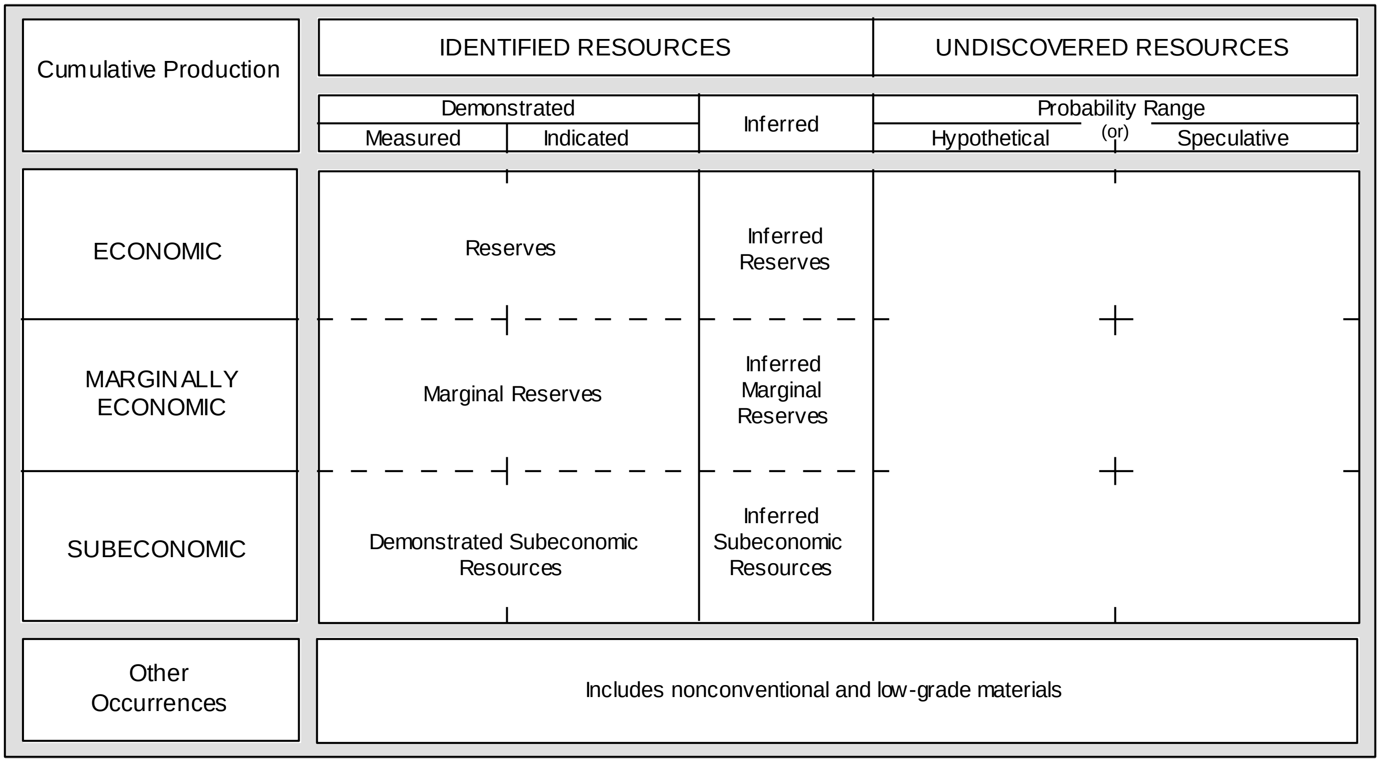
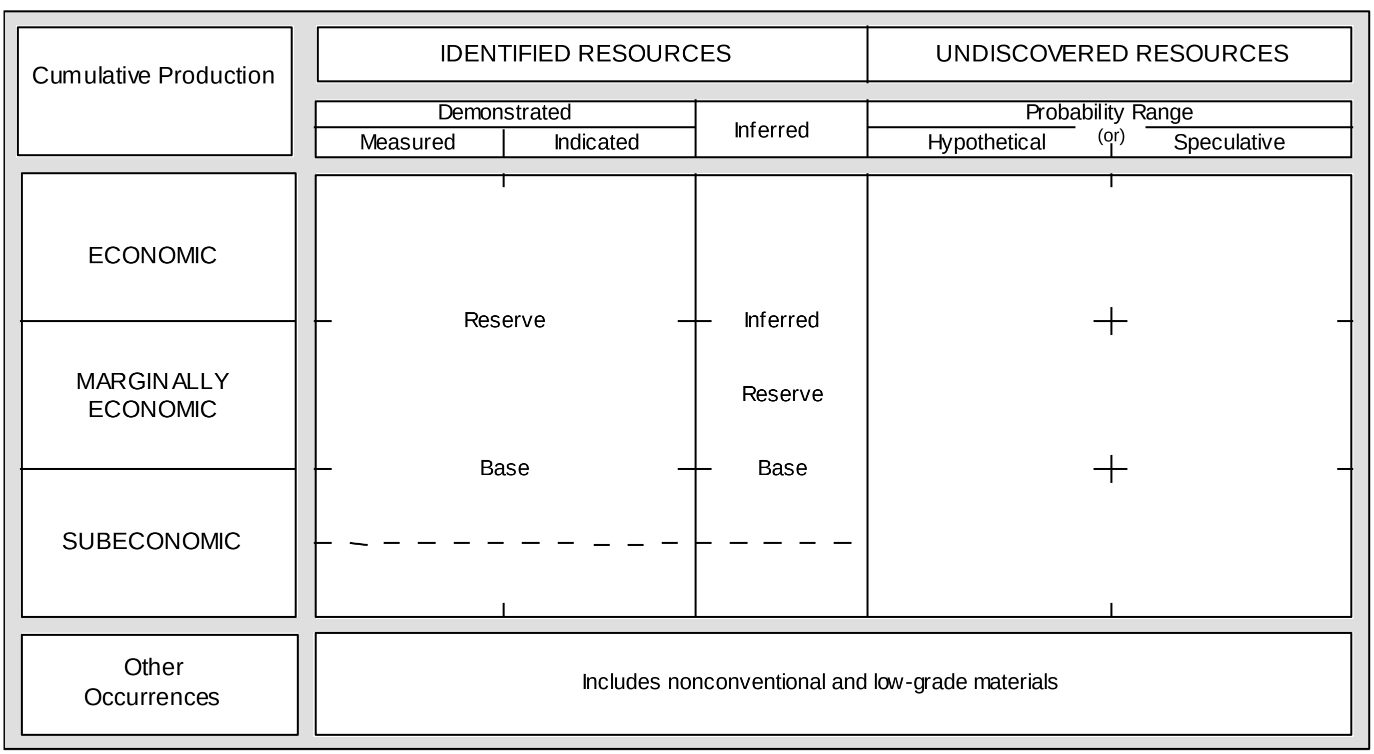


FIGURE 2.—*Reserve Base* and *Inferred Reserve Base* Classification Categories



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	Philip M. Mobbs
Angola	Omayra Bermúdez-Lugo
Bahrain	Philip M. Mobbs
Benin	Omayra Bermúdez-Lugo
Botswana	Harold R. Newman
Burkina Faso	Omayra Bermúdez-Lugo
Burundi	Thomas R. Yager
Cameroon	Omayra Bermúdez-Lugo
Cape Verde	Harold R. Newman
Central African Republic	Omayra Bermúdez-Lugo
Chad	Philip M. Mobbs
Comoros	Thomas R. Yager
Congo (Brazzaville)	Philip M. Mobbs
Congo (Kinshasa)	Thomas R. Yager
Côte d'Ivoire	Omayra Bermúdez-Lugo
Djibouti	Thomas R. Yager
Egypt	Harold R. Newman
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	Philip M. Mobbs
Israel	Thomas R. Yager
Jordan	Thomas R. Yager
Kenya	Thomas R. Yager
Kuwait	Philip M. Mobbs
Lebanon	Thomas R. Yager
Lesotho	Harold R. Newman
Liberia	Omayra Bermúdez-Lugo
Libya	Philip M. Mobbs
Madagascar	Thomas R. Yager
Malawi	Thomas R. Yager
Mali	Omayra Bermúdez-Lugo
Mauritania	Omayra Bermúdez-Lugo
Mauritius	Thomas R. Yager
Morocco & Western Sahara	Harold R. Newman
Mozambique	Thomas R. Yager
Namibia	Philip M. Mobbs
Niger	Omayra Bermúdez-Lugo
Nigeria	Philip M. Mobbs
Oman	Philip M. Mobbs
Qatar	Philip M. Mobbs
Reunion	Thomas R. Yager
Rwanda	Thomas R. Yager
São Tomé & Principe	Harold R. Newman
Saudi Arabia	Philip M. Mobbs
Senegal	Omayra Bermúdez-Lugo
Seychelles	Thomas R. Yager
Sierra Leone	Omayra Bermúdez-Lugo
Somalia	Thomas R. Yager
South Africa	Thomas R. Yager
Sudan	Thomas R. Yager
Swaziland	Harold R. Newman
Syria	Thomas R. Yager
Tanzania	Thomas R. Yager
Togo	Harold R. Newman
Tunisia	Philip M. Mobbs
Turkey	Philip M. Mobbs
Uganda	Harold R. Newman
United Arab Emirates	Philip M. Mobbs
Yemen	Philip M. Mobbs
Zambia	Philip M. Mobbs
Zimbabwe	Philip M. Mobbs

Asia and the Pacific

Afghanistan	Chin S. Kuo
Australia	Pui-Kwan Tse
Bangladesh	Chin S. Kuo
Bhutan	Chin S. Kuo
Brunei	Pui-Kwan Tse
Burma	Yolanda Fong-Sam
Cambodia	John C. Wu
China	Pui-Kwan Tse
Christmas Island	Pui-Kwan Tse
Fiji	John C. Wu
India	Chin S. Kuo
Indonesia	Chin S. Kuo
Japan	John C. Wu
Korea, North	John C. Wu
Korea, Republic of	John C. Wu
Laos	John C. Wu
Malaysia	Pui-Kwan Tse
Mongolia	Pui-Kwan Tse
Nepal	Chin S. Kuo
New Caledonia	John C. Wu
New Zealand	Pui-Kwan Tse
Pakistan	Chin S. Kuo
Papua New Guinea	John C. Wu
Philippines	Yolanda Fong-Sam
Singapore	Pui-Kwan Tse
Solomon Islands	Chin S. Kuo
Sri Lanka	Chin S. Kuo
Taiwan	Pui-Kwan Tse
Thailand	John C. Wu
Timor, East	Pui-Kwan Tse
Tonga	Chin S. Kuo
Vanuatu	Chin S. Kuo
Vietnam	John C. Wu

Europe and Central Eurasia

Albania	Walter G. Steblez
Armenia[1]	Richard M. Levine
Austria[2]	Harold R. Newman
Azerbaijan[1]	Richard M. Levine
Belarus[1]	Richard M. Levine

Europe and Central Eurasia—continued

Belgium[2]	Harold R. Newman
Bosnia and Herzegovina	Walter G. Steblez
Bulgaria[2]	Walter G. Steblez
Croatia	Walter G. Steblez
Cyprus[2]	Harold R. Newman
Czech Republic[2]	Walter G. Steblez
Denmark, Faroe Islands, and Greenland[2]	Harold R. Newman
Estonia[2]	Richard M. Levine
Finland[2]	Harold R. Newman
France[2]	Walter G. Steblez
Georgia[1]	Richard M. Levine
Germany[2]	Steven T. Anderson
Greece[2]	Harold R. Newman
Hungary[2]	Walter G. Steblez
Iceland	Harold R. Newman
Ireland[2]	Harold R. Newman
Italy[2]	Walter G. Steblez
Kazakhstan[1]	Richard M. Levine
Kyrgyzstan[1]	Richard M. Levine
Latvia[2]	Richard M. Levine
Lithuania[2]	Richard M. Levine
Luxembourg[2]	Harold R. Newman
Macedonia	Walter G. Steblez
Malta[2]	Harold R. Newman
Moldova[1]	Richard M. Levine
Montenegro	Walter G. Steblez
Netherlands[2]	Harold R. Newman
Norway	Harold R. Newman
Poland[2]	Walter G. Steblez
Portugal[2]	Alfredo C. Gurmendi
Romania[2]	Walter G. Steblez
Russia[1]	Richard M. Levine
Serbia	Walter G. Steblez
Slovakia[2]	Walter G. Steblez
Slovenia[2]	Walter G. Steblez
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]	Walter G. Steblez
Uzbekistan[1]	Richard M. Levine

North America, Central America, and the Caribbean

Antigua and Barbuda	Omayra Bermúdez-Lugo
Aruba	Omayra Bermúdez-Lugo
The Bahamas	Omayra Bermúdez-Lugo
Barbados	Omayra Bermúdez-Lugo
Belize	Steven T. Anderson
Bermuda	Omayra Bermúdez-Lugo
Canada	Alfredo C. Gurmendi
Costa Rica	Steven T. Anderson
Cuba	Omayra Bermúdez-Lugo
Dominica	Omayra Bermúdez-Lugo
Dominican Republic	Omayra Bermúdez-Lugo
El Salvador	Steven T. Anderson
Grenada	Omayra Bermúdez-Lugo
Guadeloupe	Omayra Bermúdez-Lugo
Guatemala	Steven T. Anderson
Haiti	Omayra Bermúdez-Lugo
Honduras	Steven T. Anderson
Jamaica	Omayra Bermúdez-Lugo
Martinique	Omayra Bermúdez-Lugo
Mexico	Omayra Bermúdez-Lugo
Montserrat	Omayra Bermúdez-Lugo
Netherlands Antilles	Omayra Bermúdez-Lugo
Nicaragua	Steven T. Anderson
Panama	Steven T. Anderson
St. Kitts and Nevis	Omayra Bermúdez-Lugo
St. Lucia	Omayra Bermúdez-Lugo
St. Vincent & the Grenadines	Omayra Bermúdez-Lugo
Trinidad and Tobago	Omayra Bermúdez-Lugo

South America

Argentina	Steven T. Anderson
Bolivia	Steven T. Anderson
Brazil	Alfredo C. Gurmendi
Chile	Steven T. Anderson
Colombia	Steven T. Anderson
Ecuador	Steven T. Anderson
French Guiana	Yolanda Fong-Sam
Guyana	Yolanda Fong-Sam
Paraguay	Alfredo C. Gurmendi
Peru	Alfredo C. Gurmendi
Suriname	Yolanda Fong-Sam
Uruguay	Alfredo C. Gurmendi
Venezuela	Yolanda Fong-Sam

[1]Member of Commonwealth of Independent States.
[2]Member of European Union.

Country specialist	Telephone	E-mail
Steven T. Anderson	(703) 648-7744	sanderson@usgs.gov
Omayra Bermúdez-Lugo	(703) 648-4946	obermude@usgs.gov
Yolanda Fong-Sam	(703) 648-6689	yfong-sam@usgs.gov
Alfredo C. Gurmendi	(703) 648-7745	agurmend@usgs.gov
Chin S. Kuo	(703) 648-7748	ckuo@usgs.gov
Richard M. Levine	(703) 648-7741	rlevine@usgs.gov
Philip M. Mobbs	(703) 648-7740	pmobbs@usgs.gov
Harold R. Newman	(703) 648-7742	hnewman@usgs.gov
Walter G. Steblez	(703) 648-7743	wsteblez@usgs.gov
Pui-Kwan Tse	(703) 648-7750	ptse@usgs.gov
John C. Wu	(703) 648-7751	jwu@usgs.gov
Thomas R. Yager	(703) 648-7739	tyager@usgs.gov