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

MINERAL COMMODITY SUMMARIES 2004

Abrasives
Aluminum
Antimony
Arsenic
Asbestos
Barite
Bauxite
Beryllium
Bismuth
Boron
Bromine
Cadmium
Cement
Cesium
Chromium
Clays
Cobalt
Columbium
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
Nitrogen
Peat
Perlite
Phosphate Rock
Platinum
Potash
Pumice
Quartz Crystal
Rare Earths
Rhenium
Rubidium
Salt
Sand and Gravel
Scandium
Selenium
Silicon
Silver
Soda Ash
Sodium Sulfate
Stone
Strontium
Sulfur
Talc
Tantalum
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Vanadium
Vermiculite
Yttrium
Zinc
Zirconium

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U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, Secretary

U.S. GEOLOGICAL SURVEY
CHARLES G. GROAT, Director

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CONTENTS

INSTANT INFORMATION

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

This publication has been prepared by the Minerals Information Team. Information about the team and its products is available from the Internet at URL <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 five metal industries (primary metals, steel, primary aluminum, aluminum mill products, 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.

Minerals and Materials Information CD-ROM—Published annually, the CD features the Minerals Yearbook chapters published since 1994, the Mineral Commodity Summaries published since 1996, and recently released Mineral Industry Surveys in a completely searchable format.

Historic Commodity Reviews—These periodic reports provide compilations of statistics on production, trade, and use of more than 60 mineral commodities during the past 100 years.

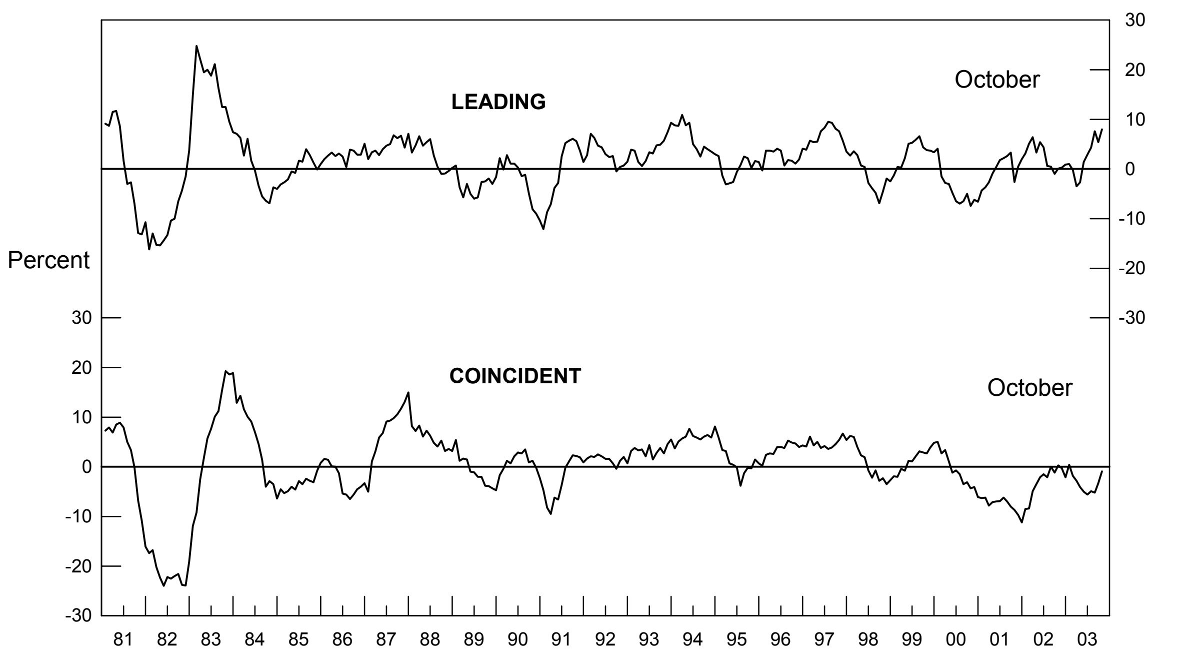
WHERE TO OBTAIN PUBLICATIONS

- *Mineral Commodity Summaries, Minerals and Materials Information CD-ROM,* and the *Minerals Yearbook* are sold by the U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954. To order by telephone, call (202) 512-1800.

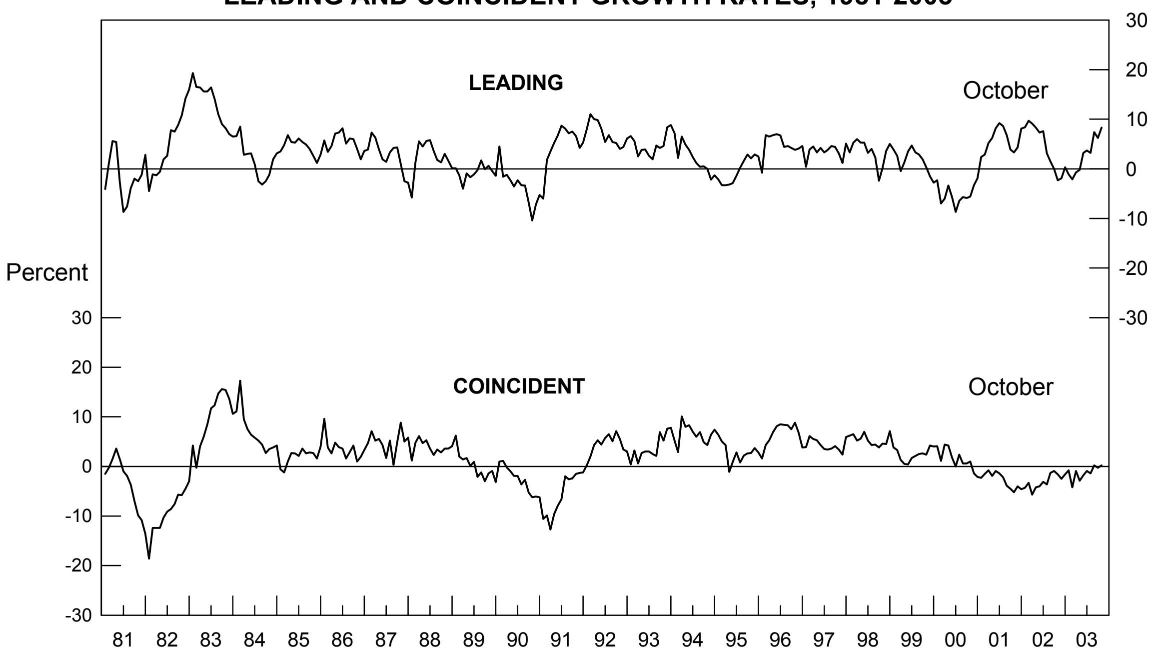
- All current and many past publications are available in PDF format through URL <http://minerals.usgs.gov/minerals>.

GROWTH RATES OF LEADING AND COINCIDENT INDEXES FOR MINERAL PRODUCTS

PRIMARY METALS: LEADING AND COINCIDENT GROWTH RATES, 1981-2003



NONMETALLIC MINERAL PRODUCTS: LEADING AND COINCIDENT GROWTH RATES, 1981-2003

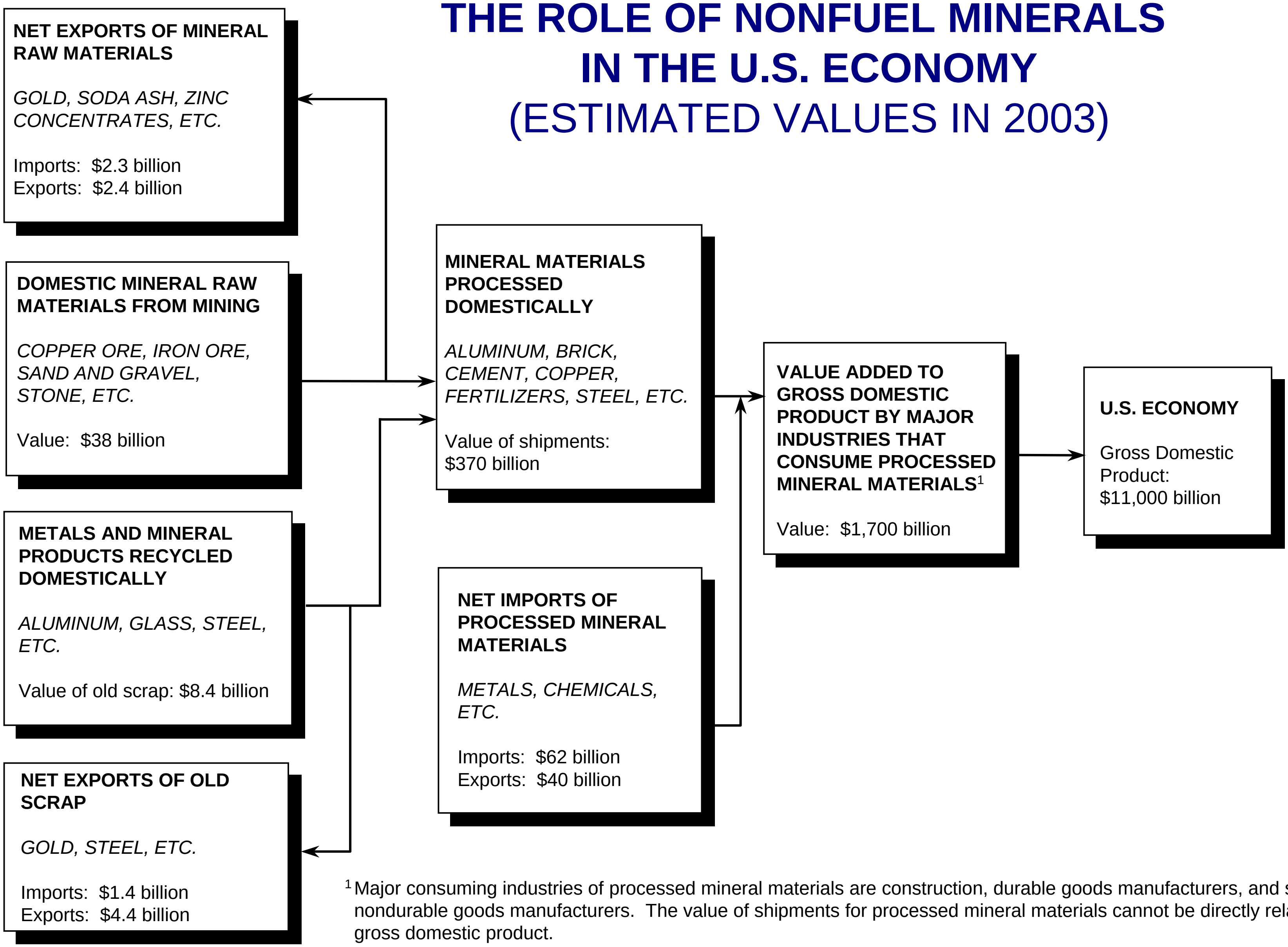


The leading indexes historically give signals several months in advance of major changes in the corresponding coincident index, which measures current industry activity. The growth rates, which can be viewed as trends, are expressed as compound annual rates based on the ratio of the current month's index 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 2003)



[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.

2003 U.S. NET IMPORT RELIANCE FOR SELECTED NONFUEL MINERAL MATERIALS

Commodity	Percent	Major Import Sources (1999-2002)[1]
ARSENIC (trioxide)	100	China, Chile, Mexico
ASBESTOS	100	Canada
BAUXITE and ALUMINA	100	Australia, Jamaica, Guinea, Suriname
COLUMBIUM (niobium)	100	Brazil, Canada, Estonia, Germany
FLUORSPAR	100	China, South Africa, Mexico
GRAPHITE (natural)	100	China, Mexico, Canada, Brazil
INDIUM	100	China, Canada, France, Russia
MANGANESE	100	South Africa, Gabon, Australia, Mexico
MICA, sheet (natural)	100	India, Belgium, China, Germany
QUARTZ CRYSTAL (industrial)	100	Brazil, Germany, Madagascar
RARE EARTHS	100	China, France, Japan, Estonia
RUBIDIUM	100	Canada
STRONTIUM	100	Mexico, Germany
THALLIUM	100	Belgium, Canada, France, Russia, United Kingdom
VANADIUM	100	South Africa, Czech Republic, Canada, China
YTTRIUM	100	China, Japan, Germany, Netherlands
GEMSTONES	99	Israel, India, Belgium
PLATINUM	96	South Africa, United Kingdom, Germany, Canada
BISMUTH	95	Belgium, Mexico, China, United Kingdom
TIN	91	Peru, China, Bolivia, Brazil, Indonesia
STONE (dimension)	86	Italy, Canada, India, Spain
BARITE	81	China, India, Morocco
DIAMOND (natural industrial stone)	80	Switzerland, Russia, United Kingdom, Ireland
POTASH	80	Canada, Russia, Belarus, Germany
TANTALUM	80	Australia, Canada, China, Kazakhstan
COBALT	78	Finland, Norway, Russia, Canada
RHENIUM	76	Chile, Kazakhstan, Germany
CHROMIUM	74	South Africa, Kazakhstan, Zimbabwe, Turkey, Russia
IODINE	74	Chile, Japan, Russia
PALLADIUM	74	Russia, South Africa, United Kingdom, Belgium
TITANIUM (sponge)	73	Japan, Kazakhstan, Russia
TITANIUM MINERAL CONCENTRATES	70	South Africa, Australia, Canada, Ukraine
TUNGSTEN	69	China, Russia, Canada
ZINC	57	Canada, Mexico, Peru
GARNET (industrial)	56	Australia, India, China
SILVER	56	Mexico, Canada, Peru, United Kingdom
PEAT	55	Canada
SILICON	54	Norway, South Africa, Russia, Canada
MAGNESIUM COMPOUNDS	51	China, Australia, Canada, Austria
NICKEL	48	Canada, Norway, Russia, Australia
BERYLLIUM	47	Japan, Kazakhstan, Russia, Brazil
MAGNESIUM METAL	47	Canada, China, Russia, Israel
NITROGEN (fixed), AMMONIA	42	Trinidad and Tobago, Canada, Russia
ALUMINUM	41	Canada, Russia, Venezuela, Mexico
DIAMOND (dust, grit and powder)	39	Ireland, China, Ukraine
COPPER	38	Canada, Peru, Chile, Mexico
PUMICE	29	Greece, Italy, Turkey
PERLITE	28	Greece
VERMICULITE	28	South Africa, China
GYPSUM	23	Canada, Mexico, Spain
SALT	23	Canada, Chile, Mexico, The Bahamas
CEMENT	20	Canada, Thailand, China, Venezuela, Greece
SULFUR	20	Canada, Mexico, Venezuela
IRON ORE	11	Canada, Brazil, Australia, Venezuela
LEAD	11	Canada, China, Mexico, Australia
PHOSPHATE ROCK	10	Morocco
IRON and STEEL	9	European Union, Canada, Mexico, Japan
TALC	8	China, Canada, France, Japan
MICA, scrap and flake (natural)	7	Canada, India, China, Argentina
IRON and STEEL SLAG	6	Italy, France, Japan, Canada

[1] In descending order of import share

SIGNIFICANT EVENTS, TRENDS, AND ISSUES[1]

The Mineral Sector of the U.S. Economy

The average growth rate of real gross domestic product (GDP) from the third quarter of 2001 through the second quarter of 2003 in the United States was about 2.6%; GDP growth rate in the third quarter was about 8%, and it was estimated to be about 5% in the fourth quarter. Many other indicators also reflected the rebounding U.S. economy—rising consumer confidence, higher retail sales, greater industrial production, and more new home starts; inflation also reached a 38-year low in December (Ahmann, 2003§).[2] The upward trends in many sectors of the U.S. economy were shared by few of the mineral materials industries, however; output declined in most nonfuel mining and mineral processing industries. Production from metal and industrial mineral mines in 2003 was down slightly compared with that of 2002. Manufacturing of industrial minerals (nonmetallic mineral products in table 2), aluminum, and iron and steel increased slightly, but other metal manufacturing declined. Factors that may improve U.S. mineral producers' competitive edge in the coming months include the leveling off of energy prices and the weakening U.S. dollar. Lifting of U.S. import tariffs on steel will help U.S. consumers of steel products by lowering their costs, but may reduce U.S. raw steel production. However, steel imports may be limited by the weak U.S. dollar, strong demand from China, and high ocean freight rates. U.S. minerals industries' responses to the burgeoning Chinese economy and international trade, the North America Free Trade Agreement, and other trade agreements that lower barriers to free trade are complex and unpredictable at this time.

Overall Performance

The estimated value of all mineral-based products manufactured in the United States during 2003 increased by about 1% over the revised figure for 2002 to $370 billion (page 4). The estimated total value of U.S. raw nonfuel mineral mine production alone was about $38 billion, essentially the same as in 2002. Metals accounted for about 22% of the total value, and industrial minerals accounted for 78%.

The value of net imports of raw and processed mineral materials during 2003 decreased by 4% from the 2002 level, mainly owing to the increased value of exports. This in turn may have been influenced by the lower value of the U.S. dollar. The United States is increasingly reliant on foreign sources for raw and processed mineral materials (page 5). Imports of raw and processed mineral materials increased by about 3% from the previous year's level to a value of about $64 billion. As in recent years, aluminum, copper, and steel were among the largest imports in terms of value. Exports of raw and processed mineral materials during 2003 rose about 10% to a value of about $42 billion. The value of total imports and exports of metal ore/concentrates and raw industrial minerals was less than $5 billion.

The construction industry led the demand for both metals and industrial minerals. The value of new highway construction increased by almost 2% to $61 billion, and housing starts increased by 7% to more than 1.8 million units, a trend supported by continued low mortgage rates. Construction accounted for most of the consumption of clay, cement, glass, sand and gravel, crushed and dimension stone, and steel. Aggregates (crushed stone and sand and gravel) production was estimated to be slightly below that of the previous year, but production in the third quarter was up. Increased aggregates production is anticipated to continue in 2004 to supply the rising demand of infrastructure renewal that will be financed by the new Safe, Accountable, Flexible, and Efficient Transportation Equity Act of 2003 (for highways), the new Flight 100-Century of Aviation Reauthorization Act (for airport improvements), and the expanding U.S. economy. Although automobile sales declined again in 2003, the industry continued to use large quantities of steel and other metals as well as glass and plastics (table 2). About 35% of aluminum is used in the transportation sector.

Metal mining continued to be depressed in the United States. Copper mine curtailments continued and production of copper semifabricated products declined. Global copper prices remained low during the first three quarters of the year (the basis for the copper commodity chapter), but rallied sharply during the last quarter to 6-year highs in response to strong demand in Asia, especially China, and producer restraints that led to a supply shortfall and drawdown of global inventories. Global consumption growth in 2004 is expected to be driven by continued strong Chinese demand, with only a modest recovery expected in the U.S. copper producing and consuming industries. Despite the slight increase in aluminum production, primary metal smelters in the Pacific Northwest continued to be idled owing to low prices and high energy costs. The 3% increase in aluminum consumption was essentially met by imported aluminum metal. Aluminum is increasingly produced offshore in areas with cheaper energy. Several steelmakers sought Chapter 11 bankruptcy protection in 2003. One of the reasons that some U.S. steel companies are losing profitability and are facing bankruptcy is that labor costs are higher (including "legacy" costs, such as pensions and benefits) in the United States than for many foreign steel producers.

U.S. production of mineral fertilizer materials retreated (8%) from the results posted in 2002 because phosphate rock and potash producers sought to reduce inventories of raw materials and finished products. Fixed nitrogen production was reduced significantly (14%) from the previous year's output because producers responded to high natural gas prices by idling capacity. Fertilizer consumption at the farm level was similar to the results of 2002. Exports of diammonium phosphate, the primary ammoniated phosphate, were down substantially (17%) because of lower sales to China.

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[1] Staff, U.S. Geological Survey.

[2] References that include a section mark (§) are found in the Internet References Cited section.

In 2003, 13 States each produced more than $1 billion worth of nonfuel mineral commodities. These States were, in descending order, California, Nevada, Arizona, Texas, Florida, Georgia, Michigan, Missouri, Utah, Pennsylvania, Minnesota, Alaska, and Wyoming; their production composed 60% of the U.S. total output value (table 3).

In fiscal year 2003, the Defense Logistics Agency (DLA) sold $272 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 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 more than $1.85 billion remained in the stockpile.

Outlook

At yearend 2003, most economists viewed the domestic economic recovery as robust but noted that the creation of new jobs, particularly in the manufacturing sector during the first three quarters, was still lagging (Berstein, 2003§). The U.S. mining and mineral processing industries continued to lose both jobs and, in many cases, production while productivity continued to improve. U.S. technological improvements and breakthroughs—such as in finding new niche markets outside the United States for products made by U.S. companies here and abroad—may translate into increased demand for mineral materials. Aggressive research to reduce production costs as well as find new uses for byproducts and for primary mineral products will be required to reinvigorate the U.S. mineral industries. Partnerships among U.S. and foreign enterprises may open new avenues for cooperative development of U.S. resources—including highly skilled but dwindling numbers of U.S. mining and mineral-processing company personnel.

TABLE 1.—U.S. MINERAL INDUSTRY TRENDS

	1999	2000	2001	2002	2003[e]
Total mine production:[1]					
Metals	9,800	10,100	8,530	8,200	8,200
Industrial minerals	29,300	29,200	29,800	29,700	29,400
Coal	18,300	18,000	19,600	19,700	19,300
Employment:[2]					
Coal mining	64	59	63	64	61
Metal mining	32	29	25	22	22
Industrial minerals, except fuels	87	87	83	80	78
Chemicals and allied products	595	588	562	533	529
Stone, clay, and glass products	426	439	427	401	382
Primary metal industries	492	490	447	397	375
Average weekly earnings of production workers:[3]					
Coal mining	953	945	957	934	963
Metal mining	875	871	866	879	953
Industrial minerals, except fuels	701	721	744	748	766
Chemicals and allied products	700	722	736	760	783
Stone, clay, and glass products	587	605	619	647	664
Primary metal industries	701	735	724	749	764

[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

	1999	2000	2001	2002	2003[e]
Gross domestic product (billion dollars)	9,268	9,817	10,101	10,480	11,000
Industrial production (1997=100):					
Total index	111	115	112	111	111
Manufacturing	112	117	113	112	112
Nonmetallic mineral products	106	106	101	100	101
Primary metals:	102	98	89	87	85
Iron and steel	100	99	88	89	90
Aluminum	105	99	87	88	90
Nonferrous metals (except aluminum)	101	93	86	75	65
Chemicals	104	105	104	105	105
Mining:	94	96	97	93	93
Coal	100	98	101	98	96
Oil and gas extraction	96	97	98	96	97
Metals	91	91	83	75	74
Nonmetallic minerals	107	107	107	107	106
Capacity utilization (percent):					
Total industry	82	83	77	76	75
Mining:	86	90	89	84	85
Metals	84	85	81	77	77
Nonmetallic minerals	86	86	86	86	85
Housing starts (thousands)	1,650	1,570	1,600	1,710	1,830
Automobile sales (thousands)[1]	6,990	6,840	6,480	5,940	5,600
Highway construction, value, put in place (billion dollars)	54	53	59	60	61

[e]Estimated.

[1]Excludes imports.

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

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2003[p, 1]

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$863,000	17	2.29	Cement (portland), stone (crushed), lime, sand and gravel (construction), cement (masonry).
Alaska	1,060,000	12	2.82	Zinc, gold, lead, sand and gravel (construction), silver.
Arizona	2,100,000	3	5.58	Copper, sand and gravel (construction), cement (portland), molybdenum concentrates, stone (crushed).
Arkansas	445,000	30	1.18	Stone (crushed), bromine, cement (portland), sand and gravel (construction), lime.
California	3,170,000	1	8.42	Sand and gravel (construction), cement (portland), stone (crushed), boron minerals, soda ash.
Colorado	672,000	22	1.79	Sand and gravel (construction), cement (portland), molybdenum concentrates, gold, stone (crushed).
Connecticut[2]	142,000	42	0.38	Stone (crushed), sand and gravel (construction), stone (dimension), clays (common), gemstones.
Delaware[2]	15,900	50	0.04	Sand and gravel (construction), magnesium compounds, gemstones.
Florida	2,000,000	5	5.33	Phosphate rock, stone (crushed), cement (portland), sand and gravel (construction), cement (masonry).
Georgia	1,670,000	6	4.45	Clays (kaolin), stone (crushed), clays (fuller’s earth), cement (portland), sand and gravel (construction).
Hawaii[2]	74,400	45	0.20	Stone (crushed), sand and gravel (construction), gemstones.

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2003[p, 1]—Continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Idaho	$294,000	36	0.78	Phosphate rock, sand and gravel (construction), molybdenum concentrates, silver, cement (portland).
Illinois	911,000	16	2.42	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), lime.
Indiana	734,000	18	1.95	Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry).
Iowa	477,000	29	1.27	Cement (portland), stone (crushed), sand and gravel (construction), gypsum (crude), lime.
Kansas	688,000	20	1.83	Cement (portland), helium (Grade-A), salt, stone (crushed), helium (crude).
Kentucky	559,000	24	1.49	Stone (crushed), lime, cement (portland), sand and gravel (construction), clays (ball).
Louisiana	331,000	34	0.88	Salt, sand and gravel (construction), stone (crushed), sand and gravel (industrial), lime.
Maine	100,000	43	0.27	Sand and gravel (construction), cement (portland), stone (crushed), stone (dimension), peat.
Maryland[2]	382,000	33	1.01	Cement (portland), stone (crushed), sand and gravel (construction), cement (masonry), stone (dimension).
Massachusetts[2]	186,000	39	0.49	Stone (crushed), sand and gravel (construction), lime, stone (dimension), clays (common).
Michigan	1,350,000	7	3.60	Cement (portland), sand and gravel (construction), iron ore (usable), stone (crushed), salt.
Minnesota[2]	1,230,000	11	3.28	Iron ore (usable), sand and gravel (construction), stone (crushed), sand and gravel (industrial), stone (dimension).
Mississippi	174,000	40	0.46	Sand and gravel (construction), clays (fuller's earth), stone (crushed), cement (portland), sand and gravel (industrial).
Missouri	1,290,000	8	3.43	Stone (crushed), cement (portland), lead, lime, sand and gravel (construction).
Montana	492,000	26	1.31	Gold, palladium, platinum, sand and gravel (construction), cement (portland).
Nebraska[2]	94,200	44	0.25	Cement (portland), stone (crushed), sand and gravel (construction), cement (masonry), lime.
Nevada	2,940,000	2	7.81	Gold, sand and gravel (construction), lime, stone (crushed), diatomite.
New Hampshire[2]	63,500	47	0.17	Sand and gravel (construction), stone (crushed), stone (dimension), gemstones.
New Jersey	272,000	37	0.72	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), greensand marl, peat.
New Mexico	533,000	25	1.42	Potash, copper, sand and gravel (construction), cement (portland), stone (crushed).
New York	978,000	14	2.60	Stone (crushed), cement (portland), salt, sand and gravel (construction), wollastonite.
North Carolina	676,000	21	1.80	Stone (crushed), phosphate rock, sand and gravel (construction), sand and gravel (industrial), feldspar.
North Dakota	37,700	48	0.10	Sand and gravel (construction), lime, stone (crushed), clays (common), sand and gravel (industrial).
Ohio	968,000	15	2.57	Stone (crushed), sand and gravel (construction), salt, lime, cement (portland).
Oklahoma	479,000	28	1.27	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), iodine (crude).
Oregon	311,000	35	0.83	Sand and gravel (construction), stone (crushed), cement (portland), diatomite, lime.
Pennsylvania[2]	1,260,000	10	3.35	Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry).
Rhode Island[2]	25,800	49	0.07	Sand and gravel (construction), stone (crushed), sand and gravel (industrial), gemstones.
South Carolina[2]	484,000	27	1.29	Cement (portland), stone (crushed), cement (masonry), sand and gravel (construction), clays (kaolin).

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2003[p, 1]—Continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
South Dakota	$206,000	38	0.55	Cement (portland), sand and gravel (construction), stone (crushed), gold, stone (dimension).
Tennessee	606,000	23	1.61	Stone (crushed), cement (portland), sand and gravel (construction), zinc, clays (ball).
Texas	2,030,000	4	5.39	Cement (portland), stone (crushed), sand and gravel (construction), lime, salt.
Utah	1,260,000	9	3.36	Copper, cement (portland), salt, gold, sand and gravel (construction).
Vermont[2]	73,000	46	0.19	Stone (dimension), stone (crushed), sand and gravel (construction), talc (crude), gemstones.
Virginia	727,000	19	1.93	Stone (crushed), cement (portland), sand and gravel (construction), lime, clays (fuller's earth).
Washington	430,000	31	1.14	Sand and gravel (construction), cement (portland), stone (crushed), diatomite, lime.
West Virginia	168,000	41	0.45	Stone (crushed), cement (portland), sand and gravel (industrial), lime, salt.
Wisconsin[2]	404,000	32	1.07	Stone (crushed), sand and gravel (construction), lime, sand and gravel (industrial), stone (dimension).
Wyoming	1,010,000	13	2.68	Soda ash, clays (bentonite), helium (Grade-A), cement (portland), sand and gravel (construction).
Undistributed	169,000	XX	0.45	
Total	37,600,000	XX	100	

[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

Economic Conditions

As 2003 began, many of the world's developed economies were experiencing very slow growth, which gave rise to concerns about global economic deflation. In the United States, growth in output (GDP) during the first quarter was only 2.0%, the German economy contracted by 0.9%, and growth in the Japanese economy was only 0.6%. In the developing countries, economic conditions varied widely. Economic output in China and parts of Asia, including Malaysia, Thailand, and Vietnam, continued to grow at robust rates. Iran and Turkey also were experiencing vigorous growth, as was Russia. Growth in Africa was moderate, while growth in Latin American economies was very slow to negative. During the first 6 months of the year, three crises threatened to undermine recovery in the developed economies and to slow growth in parts of the developing world.

The first crisis was the spread of the highly infectious Severe Acute Respiratory Syndrome (SARS) virus from China to parts of Southeast Asia and North America between February and June. The disease spread rapidly and had a 15% mortality rate. There was widespread concern that SARS would reduce economic growth in China and other countries in Southeast Asia. The second crisis that threatened economic growth was the issue of Iraq's possible possession and potential distribution of weapons of mass destruction. After a series of attempts to resolve the issue through the United Nations, the United States and its allies attacked Iraq on March 19. An end to major fighting was declared on May 1. The third crisis that threatened to undermine growth of the global economy happened on the Korean Peninsula when North Korea, which had previously agreed to forgo nuclear weapons development in exchange for economic and technical assistance, admitted to having a nuclear weapons program. The threat of a nuclear-armed North Korea and uncertainty about the U.S. response to it may have contributed to the slower growth in the South Korean economy in 2003 than in 2002.

As a result of the three crises, economic growth was slower during the first half of 2003 than it might have been otherwise. Economic effects of the SARS outbreak were largely overestimated, and growth in the Chinese economy looked like it would exceed 9% for the year, notwithstanding concerns about growing consumer debt in China, which reached almost $2 trillion (Chen and Leggett, 2003). In the United States, tax cuts and low interest rates encouraged consumer spending, and economic growth was estimated to be about 8% in the third quarter. So far, economic effects of budget deficits in the United States have been confined largely to a decline in the value of the dollar relative to most other currencies. This has caused difficulties for producers in other countries who have seen their costs, which are paid in local currency, rise, while the value of sales, which are denominated in dollars, have dropped.

Mineral Markets

Aluminum was in oversupply in early 2003. Estimates of the amount of oversupply range from 600,000 metric tons to more than 1 million metric tons (Mining Journal, 2003b). By mid-December 2003, London Metal Exchange (LME) stocks of aluminum were about 15% higher than those at the beginning of January 2003; nevertheless, the price of aluminum increased 16% during the period. There were indications that the market for aluminum became tighter as the alumina market shifted from a large surplus to a small deficit in the 12 months prior to October 2003 (Veitch, 2003).

The LME prices of copper, lead, and tin have increased by more than 40% during 2003, and stocks of those metals have declined by more than 30% during the same period as efforts by producers to reduce the amount of metal on the market have been successful. The price of copper hit a 6-year high in December on concerns about supplies that resulted from China's rapidly increasing demand, a threatened strike at a Canadian mine, and a reported accident at a Polish mine (Maguire, 2003). Zinc prices increased by 30%, while stocks increased by 9%. Analysts see a growing mismatch between concentrate supply and smelter capacity for copper, lead, and zinc, because reductions in mine capacity will result in insufficient feedstocks for increased processing capacity.

The prices of gold and silver in U.S. dollars increased about 20% during 2003, just about equaling the drop in value experienced by the dollar against other major currencies. Whether gold will continue to hold its price may well depend upon whether the Central Bank Gold Agreement, which limits signatories to 400 metric tons of gold sales in a year (end of September to end of September), will expire in 2004. In March 2003, the Bundesbank Governor stated that there was a question about whether there would be another agreement (Mining Journal, 2003h). The prices of the two most traded platinum-group metals (PGMs), platinum and palladium, diverged in 2003. Platinum increased in price by more than 30%, while the price of palladium decreased by 15%. The use of PGMs in catalytic converters in automobile exhaust systems has varied considerably in the past as prices of the individual metals have changed. When the price of palladium rose to more than US$1,000 per troy ounce in 2002, vehicle manufacturers again began to favor platinum-base catalysts (Mining Journal, 2003o).

World iron ore production increased by 6% in 2002 and by 4% in 2003. Japan remained the largest importer of ore in 2002, followed closely by China, which surpassed Japan in 2003 (Mining Journal, 2003p). Chinese steel production rose by 20% in 2002 and was expected to increase an additional 10% in 2003. The growth in Chinese steel manufacture and consumption, which was expected to increase by 22% in 2003, has been a major factor in rising prices of steel and nickel, a key ingredient in stainless steel (Tejada, 2003). The price of nickel increased more than 100% during 2003 in spite of an almost 30% increase in LME stocks.

In December 2003, the United States ended the steel tariffs it had imposed in early 2002; prior to this action, the World Trade Organization had signaled that it would find that the tariffs violated world trade rules (King and Tejada, 2003). Tariffs had been imposed when excess steelmaking capacity worldwide, weak demand for steel globally, and the high value of the U.S. dollar had led to large imports of steel. The tariffs allowed the U.S. steel industry, which faced large pension obligations because of previous downsizing, an opportunity to reorganize. The value of the dollar decreased significantly since 2002, offering U.S. steel producers some relief from competition (Sweeney, 2003).

The end of the chloride slag long-term contractual relationship between E.I. du Pont de Nemours and Company and Richards Bay Minerals (Rio Tinto plc and BHP Billiton plc) and the large number of potential new mineral sands deposits appear to favor a reduction in the price of titanium feedstock (Mining Journal, 2003e).

Mergers and Acquisitions

The significant consolidation within the minerals industry in recent years continued in 2003. Some mergers and acquisitions seem to be designed to increase market share of a company, while others appeared to be directed to securing supplies of raw materials for downstream activities. In January, Hindalco Industries Ltd., a subsidiary of the Aditya Birla industrial group, agreed to purchase Straits (Nifty) Pty Ltd., the owner of the Nifty copper mine in Western Australia. Hindalco hopes to supply 25% of copper concentrates used by Birla (Mining Journal, 2003j). In April, Xstrata plc, a United Kingdom company, announced a takeover offer for MIM Holdings Ltd. of Australia. Xstrata is one of the largest producers of thermal coal for export from mines in Australia and South Africa. MIM produces coking and thermal coal, as well as copper, gold, lead, and zinc (Mining Journal, 2003m). At the end of October, the Ghanaian Government gave its approval to the merger of AngloGold Ltd. of South Africa and Ashanti Goldfields Ltd. of Ghana. The merger will raise AngloGold's production to nearly that of Newmont Mining Corp., which is currently the largest gold producer (Mining Journal, 2003f). In May, the Zambian Government announced that it had selected Indian-based metals producer Sterlite Industries Ltd. as the preferred bidder to take over as the lead investor in the Konkola Copper Mine plc (Mining Journal, 2003r). The proposed purchase of Stillwater Mining by NNC Norilsk Nickel moved several steps forward when stockholders of Stillwater Mining Co. voted to accept the offer and when the U.S. Federal Trade Commission ended the waiting period required under the Hart-Scott-Rodino Act (Mining Journal, 2003c). In September, Outokumpu Oyj and Boliden AB signed a letter of intent to undertake a major exchange of assets in which Boliden would nearly double in size by acquiring Outokumpu's mining operations and Outokumpu would acquire Boliden's downstream copper and minerals technology businesses (Mining Journal, 2003q). Finally, Alcan Inc., the second largest aluminum producer, received regulatory approval to proceed with the purchase of Pechiney, the fourth largest aluminum producer (Mining Journal, 2003i).

Although mergers may increase the size and political influence of individual firms, the cumulative effect of mergers reduces the number of firms and often the number of people employed in the sector and thus may reduce the political influence of the industry as a whole.

Exploration

According to the Metals Economics Group (MEG) of Halifax, Nova Scotia, spending on nonferrous mineral exploration globally was expected to increase about 27% in 2003 from 2002 exploration budget allocations. The largest increases in exploration budgets during the previous year took place in Canada (49%) and Africa (46%). Latin America's share of world exploration budgets (24%) continued to lead all other regions in the MEG survey, followed by Canada (21%), Africa (17%), and Australia (15%) (Mining Engineering, 2003). The increase came after 5 years of declining spending for mineral exploration (Mining Magazine, 2003). Part of the decline reflected a decreased interest in investing in junior mining companies following the Bre-X scandal. In addition, mining companies had difficulty attracting the attention of investors because of the high earnings potential of the technology sector in the near future.

Consolidation of companies reduced exploration expenditures because the consolidated entity generally budgets less for exploration than was budgeted by the entities that were consolidated (Mining Journal, 2003n). In addition, merged companies seek larger targets. Declines in exploration by major companies have been accompanied by reduced expenditures by junior companies that have had a difficult time raising capital. Concerns about the level of exploration expenditures have led some government and industry analysts to warn that unless major companies increase their exploration expenditures substantially, the identified resources of gold and some base metals may be depleted within 10 years (Mining Journal, 2003d). Since 2001, only 2 gold deposits have been discovered that contain more than 5 million ounces, while between 1994 and 1998, 10 such deposits were discovered (Mining Journal, 2003g).

Environment/Sustainability

A draft of the final report of the World Bank Group (WBG) Extractive Industries Review (EIR), a 2-year evaluation of the development effects of the bank's support for oil mining and gas projects, was released on November 26. The goal of the EIR is to develop policy recommendations that will guide involvement of the WBG in oil, gas, and mining sectors. The WBG has been criticized for its involvement in lending to extractive projects because of problems related to environmental protection, promotion of corruption, and treatment of indigenous peoples. Reports and comments on a wide range of issues related to the extractive industries were submitted by government organizations, prominent nongovernmental organizations, industry, indigenous peoples, and other interested parties. The report included recommendations that the World Bank immediately cease funding coal projects and phase out support for oil production projects by 2008, enhance protection of human rights, gain prior informed consent from peoples affected by extractive projects, and end support for destructive mining practices.

The importance of World Bank involvement in the extractive industries was recently highlighted when 10 large banks, including ABN Amro, Barclays, Citigroup, Credit Lyonnais, and Credit Suisse adopted voluntary guidelines related to social and environmental issues for development projects that they finance. The guidelines are based on policies of the World Bank and the International Finance Corp. These banks underwrote about 30% of worldwide project loans in 2002 (Mining Journal, 2003l).

A study by the Groupe de Recherche sur les Activités Minières en Afrique (GRAMA) criticized the reforms that have been instituted in African minerals laws since the 1980s. Many of these laws were adopted with the assistance of the World Bank. The study questioned whether deregulation and liberalization of the mining laws have led to a situation where governments cannot adequately enforce environmental laws and effectively pursue wider economic development, especially as it relates to trade issues (Mining Journal, 2003a).

The International Council on Mining and Metals (ICMM) continued to work on the Mining, Minerals, and Sustainable Development project. The ICMM comprises 15 corporate and 25 associate members. Project work is focused on seven areas—the sustainable development framework, biodiversity, tailings facility management, local-community involvement, integrated materials management, workplace health and safety, and international representation (Mining Journal, 2003k).

Outlook

For several years, China had been the prime driver in mineral consumption, accounting for two thirds of world growth in nickel consumption in 2002 and having similar effects on the consumption of aluminum, copper, and steel. With continuation of vigorous growth in China during 2003 and stronger growth in the United States, demand for minerals is rising, and prices, which generally have been at low levels for several years, have begun to increase. The longer term prospect is for significantly increased demand for mineral products contingent on continuation of vigorous economic growth in China, India, and other developing countries, as well as continued strong demand in the developed countries.

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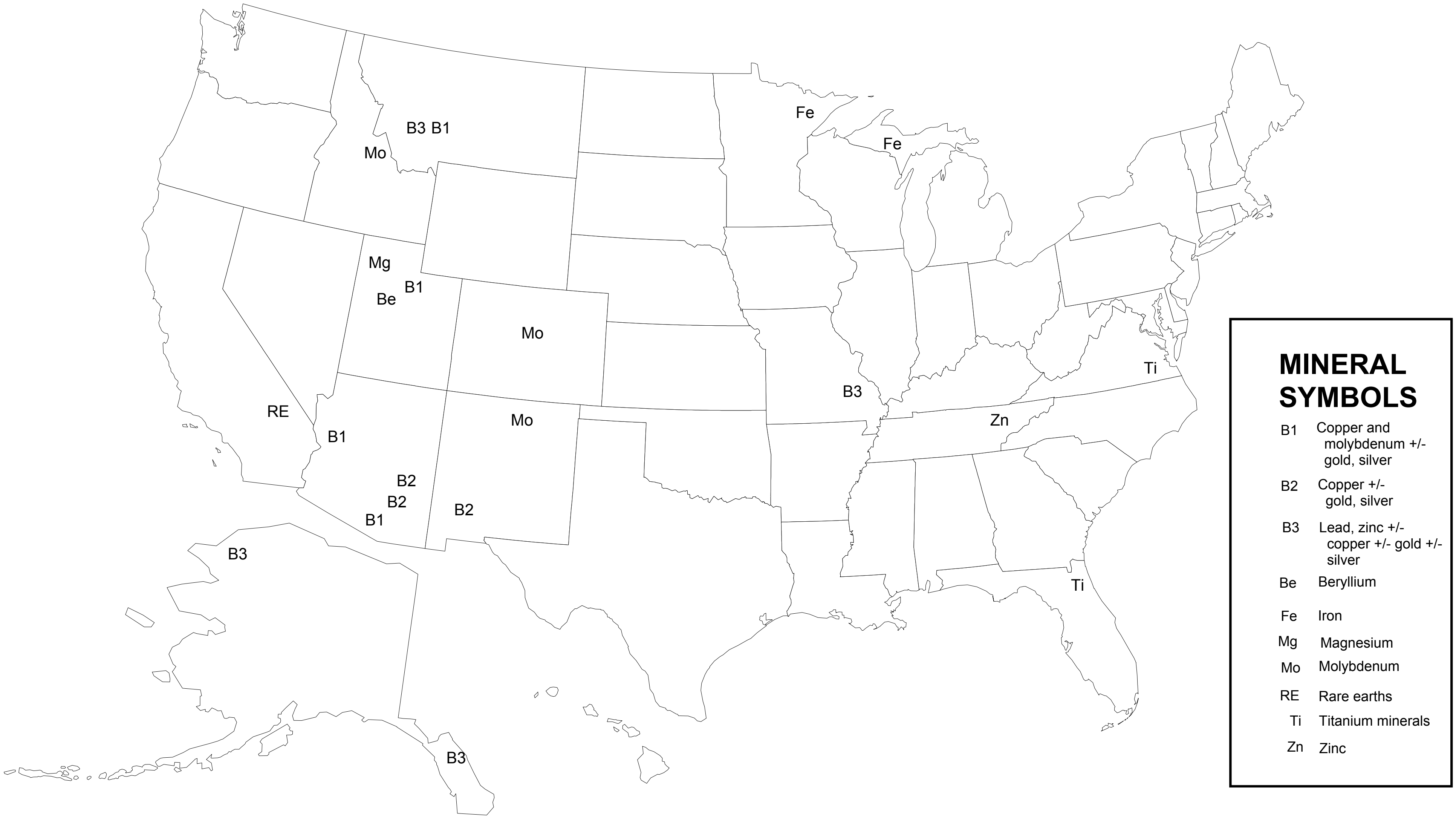
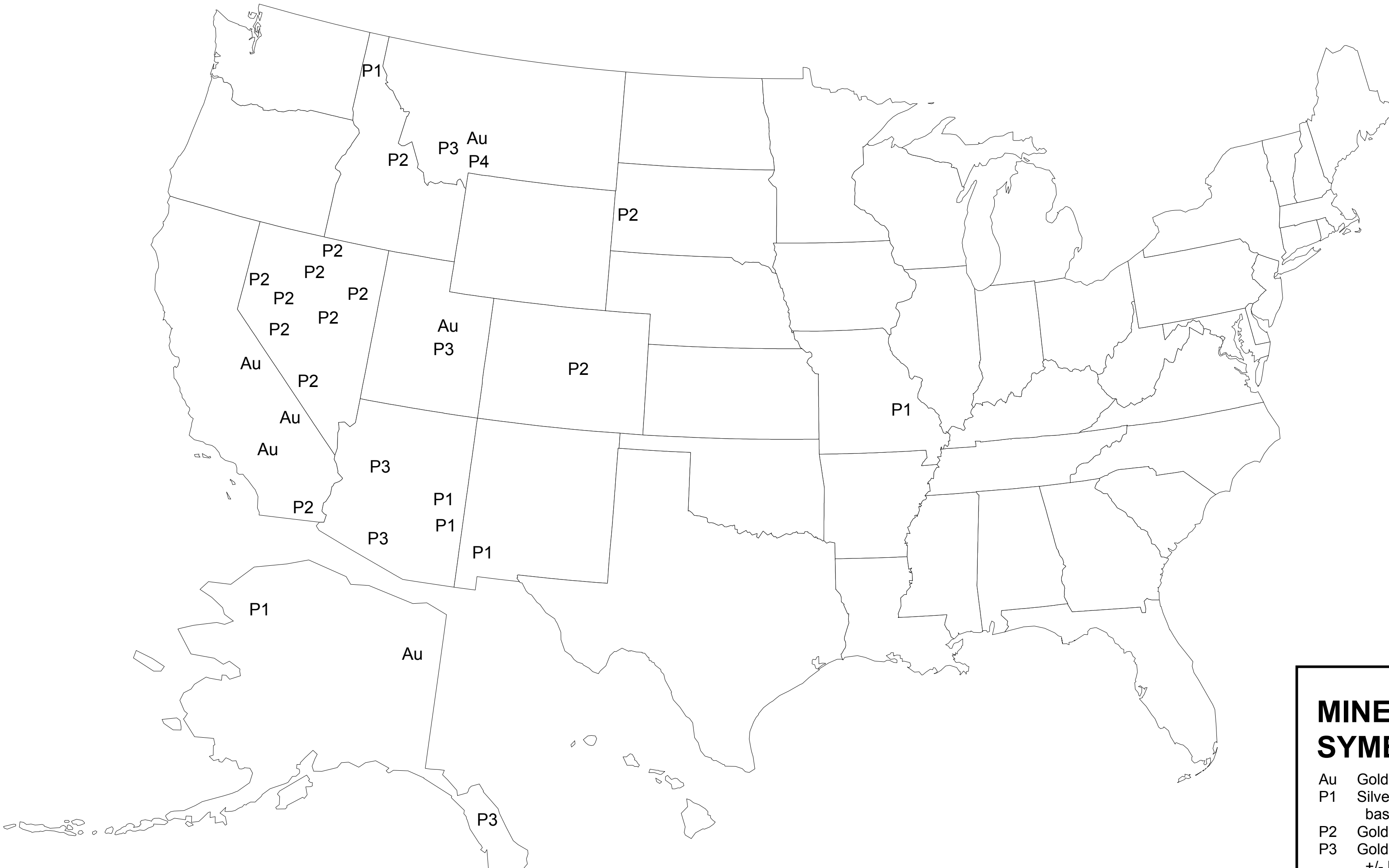
MAJOR BASE AND SPECIALTY METAL PRODUCING AREAS



MAJOR PRECIOUS METAL PRODUCING AREAS



MINERAL SYMBOLS

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

MAJOR INDUSTRIAL ROCK AND MINERAL PRODUCING AREAS - PART I

MINERAL SYMBOLS

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

MAJOR INDUSTRIAL ROCK AND MINERAL PRODUCING AREAS - PART II

MINERAL SYMBOLS

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

ABRASIVES (MANUFACTURED)

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

Domestic Production and Use: Fused aluminum oxide was produced by two companies at four plants in the United States and Canada. Production of regular-grade fused aluminum oxide had an estimated value of $8.6 million, and production of high-purity fused aluminum oxide was estimated at a value of more than $2.6 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 more than $19 million. Bonded and coated abrasive products accounted for most abrasive uses of fused aluminum oxide and silicon carbide.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production,[1] United States and Canada (crude):					
Fused aluminum oxide, regular	85,000	90,000	50,000	20,000	30,000
Fused aluminum oxide, high-purity	10,000	10,000	10,000	10,000	5,000
Silicon carbide	65,000	45,000	40,000	30,000	35,000
Imports for consumption (U.S.):					
Fused aluminum oxide	166,000	227,000	203,000	179,000	156,000
Silicon carbide	169,000	190,000	133,000	165,000	156,000
Exports (U.S.):					
Fused aluminum oxide	9,020	9,020	8,950	10,300	11,400
Silicon carbide	8,560	10,000	10,500	13,600	12,900
Consumption, apparent (U.S.):					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	NA	NA	NA	181,000	179,000
Price, dollars per ton United States and Canada:					
Fused aluminum oxide, regular	351	331	302	271	288
Fused aluminum oxide, high-purity	425	566	530	494	517
Silicon carbide	600	585	600	541	543
Net import reliance[2] as a percentage of apparent consumption (U.S.)					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	NA	NA	NA	83	80

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

Import Sources (1999-2002): Fused aluminum oxide, crude: China, 47%; Canada, 38%; and other, 15%. Fused aluminum oxide, grain: China, 49%; Canada, 22%; Austria, 8%; Germany, 7%; and other, 14%. Silicon carbide, crude: China, 85%; Canada, 10%; and other, 5%. Silicon carbide, grain: China, 36%; Brazil, 19%; Norway, 11%; Germany, 7%; and other, 27%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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 the first three quarters of 2003, the Department of Defense sold 2,339 tons of fused aluminum oxide abrasive grain from the National Defense Stockpile for $632,830.

Stockpile Status—9-30-03[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Fused aluminum oxide, grain	13,831	2,047	13,831	5,443	2,345

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. During 2003, two aluminum oxide plants that had been on strike for some time permanently closed down their operations. One of these plants was Canadian, and it closed in February. The other plant was in the United States, and it closed in July. 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	
	2002	2003[e]	2002	2003[e]
United States and Canada	142,000	87,600	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	460,000	600,000	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)	1,030,000	1,110,000	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 C for definitions.

ALUMINUM[1]

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

Domestic Production and Use: In 2003, 7 companies operated 15 primary aluminum reduction plants; 6 smelters were temporarily idled. Based upon published market prices, the value of primary metal production was $4 billion. Aluminum consumption was centered in the East Central United States. Transportation accounted for an estimated 35% of domestic consumption; the remainder was used in packaging, 24%; building, 16%; consumer durables, 8%; electrical, 7%; and other, 10%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:					
Primary	3,779	3,668	2,637	2,707	2,700
Secondary (from old scrap)	1,570	1,370	1,210	1,170	1,100
Imports for consumption	4,000	3,910	3,740	4,060	4,300
Exports	1,650	1,760	1,590	1,590	1,500
Consumption, apparent[2]	7,770	7,530	6,230	6,310	6,500
Price, ingot, average U.S. market (spot), cents per pound	65.7	74.6	68.8	64.9	67.0
Stocks:					
Aluminum industry, yearend	1,870	1,550	1,300	1,320	1,300
LME, U.S. warehouses, yearend[3]	14	([4])	28	45	200
Employment, number[5]	76,300	77,800	71,200	62,200	60,000
Net import reliance[6] as a percentage of apparent consumption	31	33	38	39	41

Recycling: In 2003, aluminum recovered from purchased scrap was about 2.8 million tons, of which about 60% came from new (manufacturing) scrap and 40% from old scrap (discarded aluminum products). Aluminum recovered from old scrap was equivalent to about 17% of apparent consumption.

Import Sources (1999-2002): Canada, 58%; Russia, 18%; Venezuela, 5%; Mexico, 2%; and other, 17%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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 **Patricia A. Plunkert [(703) 648-4979, pplunker@usgs.gov, fax: (703) 648-7757]**

ALUMINUM

Events, Trends, and Issues: Domestic primary aluminum production was relatively unchanged compared with that for the previous year. Most of the smelter capacity that was idled at the end of 2002 remained off line.

Imports for consumption continued to increase, filling some of the supply deficit created by increasing demand and a stagnant domestic supply. Canada and Russia accounted for approximately three-fourths of total imports. U.S. exports continued to decrease. Canada and Mexico received an estimated two-thirds of total U.S. exports.

The price of primary aluminum ingot fluctuated through September 2003. In January, the average monthly U.S. market price for primary ingot quoted by Platts Metals Week was 66.25 cents per pound; in September, the price was 66.94 cents 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 64.21 cents per pound. According to American Metal Market, prices in the aluminum scrap and secondary aluminum alloy markets fluctuated through September but closed the month slightly higher than the prices at the end of 2002.

World production continued to increase as capacity expansions, most notably those in China, India, Mozambique, and Norway, were brought onstream. Inventories of metal held by producers, as reported by the International Aluminium Institute, increased slightly through the end of August to more than 3 million tons. Inventories of metal held by the LME exceeded 1.37 million tons at the end of September, reaching levels not seen since February 1995.

World Smelter Production and Capacity:

	Production		Yearend capacity	
	2002	2003[e]	2002	2003[e]
United States	2,707	2,700	4,120	4,120
Australia	1,836	1,850	1,820	1,850
Brazil	1,318	1,390	1,330	1,400
Canada	2,709	2,800	2,730	2,800
China	4,300	5,200	5,300	6,500
France	450	430	480	440
Norway	1,096	1,150	1,050	1,180
Russia	3,347	3,400	3,350	3,400
South Africa	676	690	690	690
Venezuela	570	580	640	640
Other countries	6,910	7,150	7,830	8,110
World total (rounded)	25,900	27,300	29,300	31,100

World Resources: Domestic aluminum requirements cannot be met by domestic bauxite resources. Potential 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 21st century.

Substitutes: Copper can replace aluminum in electrical applications; magnesium, titanium, and steel can substitute for aluminum in structural and ground transportation uses. Composites, steel, and wood can substitute for aluminum in construction. Glass, paper, plastics, and steel can substitute for aluminum in packaging.

[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]Less than ½ unit.
[5]New data series, alumina and aluminum production workers (North American Industry Classification System – 3313). Source: U.S. Bureau of Labor Statistics.
[6]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 2003. 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 two companies in Montana and Texas using imported feedstock. The estimated value of primary antimony metal and oxide produced in 2003 was $41 million. Secondary antimony was recovered, mostly in alloy form, at lead smelters; its value, based on the price of antimony metal, was about $2 million. The estimated distribution of antimony uses was as follows: flame retardants, 55%; transportation, including batteries, 18%; chemicals, 10%; ceramics and glass, 7%; and other, 10%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:					
Mine (recoverable antimony)	450	W	—	—	—
Smelter:					
Primary	15,300	13,300	9,100	W	W
Secondary	8,220	7,700	5,380	5,350	4,200
Imports for consumption	36,800	41,600	37,900	28,500	25,400
Exports of metal, alloys, oxide, and waste and scrap[1]	3,660	7,120	7,610	4,250	3,300
Shipments from Government stockpile	5,790	4,540	4,620	4,627	2,530
Consumption, apparent[2]	36,500	49,400	45,200	W	W
Price, metal, average, cents per pound[3]	63	66	65	88	110
Stocks, yearend	10,900	6,780	4,990	5,490	5,000
Employment, plant, number[e]	75	40	40	35	30
Net import reliance[4] as a percentage of apparent consumption	82	84	61	W	W

Recycling: Traditionally, the bulk of secondary antimony has been recovered as antimonial lead, most of which was generated and then also consumed by the battery industry. However, changing trends in that industry in recent years have caused lesser amounts of secondary antimony to be produced.

Import Sources (1999-2002): Metal: China, 83%; Mexico, 7%; Hong Kong, 5%; and other, 5%. Ore and concentrate: China, 36%; Australia, 25%; Austria, 9%; and other, 30%. Oxide: China, 41%; Mexico, 25%; Belgium, 13%; South Africa, 13%; Bolivia, 3%; Hong Kong, 2%; and other, 3%. Total: China, 54%; Mexico, 19%; Belgium, 8%; South Africa, 8%; Hong Kong, 3%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Ore and concentrates	2617.10.0000	Free.
Antimony and articles thereof, including waste and scrap	8110.00.0000	Free.
Antimony oxide	2825.80.0000	Free.

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

Government Stockpile: Sales of antimony from the Defense National Stockpile Center (DNSC) proceeded for the 11th consecutive year. Sales were conducted bimonthly on the first Thursday of each month on a negotiated bid basis through a Basic Ordering Agreement (BOA) sales plan. There was no maximum limit to the quantity for which a company could submit a bid. The materials offered were grade B ingots, cakes, and broken pieces. At the start of calendar year 2003, the antimony inventory in the DNSC was 2,534 metric tons, all held at the Center's Somerville, NJ, depot. The DNSC sold the entire antimony inventory in 2003.

Stockpile Status—9-30-03[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Antimony	—	—	—	2,618	2,618

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

ANTIMONY

Events, Trends, and Issues: In 2003, 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 demand. In recent years, the number of primary antimony smelters has been cut in half, as smelters in New Jersey and Texas were closed.

The price of antimony metal held fairly steady at about $1.19 per pound through May, and then declined to $0.95 per pound by August.

During 2003, the United States and most major antimony-consuming countries experienced a continuing trend toward sharply lower demand. It affected virtually all consumption categories, and observers attributed it mostly to the economic slowdown of recent years.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	2002	2003[e]		
United States	—	—	80,000	90,000
Bolivia	2,000	2,400	310,000	320,000
China	130,000	125,000	790,000	2,400,000
Russia (recoverable)	5,000	4,500	350,000	370,000
South Africa	5,800	5,700	34,000	250,000
Tajikistan	3,000	2,500	50,000	150,000
Other countries	2,000	2,000	150,000	330,000
World total (rounded)	148,000	142,000	1,800,000	3,900,000

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

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

[e]Estimated. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Gross weight.
[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 B for definitions.
[6]See Appendix C for definitions.

ARSENIC

(Data in metric tons of arsenic content, unless otherwise noted)

Domestic Production and Use: Arsenic has not been produced in the United States since 1985, and domestic needs are satisfied by imported arsenic trioxide and arsenic metal. Arsenic trioxide is recovered from roasting arsenopyrite, the most abundant ore mineral of arsenic, as well as from copper, lead, and gold smelter flue dusts. Most of the arsenic used was in compound form as arsenic trioxide, which was then converted to arsenic acid for use in the production of chromated copper arsenate (CCA), the main preservative for wood products that are used outdoors. Arsenic trioxide is also used in fertilizers, herbicides, and insecticides. Arsenic metal is used in ammunition and solders, as an anti-friction additive to bearings, and to strengthen grids in storage batteries. Semiconductor applications in the computer and electronics industry require high-purity (99.9999%-pure) arsenic metal. The value of arsenic metal and compounds consumed domestically in 2003 was estimated to be less than $20 million.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Imports for consumption:					
Metal	1,300	830	1,030	880	1,000
Compounds	22,100	23,600	23,900	18,800	18,000
Exports, metal	1,350	41	57	100	100
Estimated consumption[1]	22,000	24,400	24,900	19,600	19,000
Value, cents per pound, average:[2]					
Metal (China)	59	51	75	120	87
Trioxide (Mexico)	29	32	28	33	34
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: Arsenic was not recovered from consumer end-product scrap. However, process water and contaminated runoff collected at wood treatment plants were reused in pressure treatment, and gallium arsenide scrap from the manufacture of semiconductor devices was reprocessed for gallium and arsenic recovery. Domestically, no arsenic was recovered from arsenical residues and dusts at nonferrous smelters, although some of these materials were processed for recovery of other metals.

Import Sources (1999-2002): Metal: China, 84%; Japan, 12%; Hong Kong, 2%; and other, 2%. Trioxide: China, 55%; Chile, 21%; Mexico, 5%; and other, 19%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/03**
Metal	2804.80.0000	Free.
Trioxide	2811.29.1000	Free.
Sulfide	2813.90.1000	Free.
Acid[4]	2811.19.1000	2.3% 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]**

ARSENIC

Events, Trends, and Issues: Research indicates that exposure to arsenic increases the risk of several types of cancer and can affect breathing and heart rhythm. Therefore, regulation of its use will continue to be increasingly stringent, and this will adversely affect the long-term demand for arsenic. With the voluntary decision by the wood-preserving industry to eliminate CCA wood preservatives from residential use by yearend 2003, arsenic consumption is expected to decline significantly in subsequent years. Mitigation of the health hazards and pollution effects of arsenic in ground water, mine drainage, and from coal burning will continue as important research and regulatory issues.

World Production, Reserves, and Reserve Base:

	Production (arsenic trioxide)		Reserves and reserve base[5] (arsenic content)
	2002	2003[e]	
Belgium	1,000	1,000	
Chile	8,000	8,000	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.
China	16,000	16,500	
France	1,000	1,000	
Kazakhstan	1,500	1,500	
Mexico	2,300	2,500	
Peru	2,000	2,000	
Russia	1,500	1,500	
Other countries	1,700	1,000	
World total (rounded)	35,000	35,000	

World Resources: Approximately 11 million tons of arsenic are contained in global resources of copper and lead. Arsenic resources occur in copper ores in northern Peru and the Philippines. Copper-gold ores in Chile also contain arsenic, and arsenic is also associated with gold occurrences in Canada.

Substitutes: Substitutes for CCA include copper azole, copper citrate, alkaline copper quaternary, ammoniacal copper zinc arsenate, and ammoniacal copper quaternary. Biocides that contain silver are being studied as a possible wood preservative treatment. Concrete, steel, plasticized wood scrap, or plastic composites may be substituted for CCA-treated wood; however, arsenic compounds may be preferred because of lower cost and known performance.

[e]Estimated.
[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]No tariff for Canada, Israel, Caribbean Basin countries, and designated Beneficiary Andean and developing countries.
[5]See Appendix C for definitions.

ASBESTOS

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: There was no asbestos production in the United States in 2003. Asbestos was consumed in roofing products, 80%; gaskets, 8%; friction products, 4%; and other, 8%.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production (sales), mine	7	5	5	3	—
Imports for consumption	16	15	13	7	6
Exports[1]	22	19	22	8	4
Shipments from Government stockpile excesses	5	—	—	—	—
Consumption, estimated	16	15	13	7	6
Price, average value, dollars per ton[2]	210	210	160	220	220
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number	20	19	15	15	—
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: None.

Import Sources (1999-2002): Canada, 96%; and other, 4%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/03**
Asbestos	2524.00.0000	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: The asbestos industry continues to be affected by liability issues and public opposition to the use of asbestos. Debate in Congress is focusing on a proposed ban on the use of asbestos in the United States and a bill to limit the liability from asbestos litigation on companies in the United States.

Exports and imports declined to 4,000 tons and 6,000 tons, respectively. Estimated consumption declined to 6,000 tons from 7,000 tons in 2002. Some reported exports were likely to have been reexports, asbestos-containing products, or nonasbestos products. Any exports of domestically produced asbestos were from stocks owing to the closure of the last U.S. asbestos mine in 2002. All the asbestos used in the United States was chrysotile. Canada remained the largest supplier of asbestos for domestic consumption.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2002	2003[e]		
United States	3	—	Small	Large
Brazil	209	200	Moderate	Moderate
Canada	272	270	Large	Large
China	360	360	Large	Large
Kazakhstan	291	250	Large	Large
Russia	750	750	Large	Large
Zimbabwe	130	120	Moderate	Moderate
Other countries	120	110	Moderate	Large
World total (rounded)	2,130	2,060	Large	Large

World Resources: The world has 200 million tons of identified resources and an additional 45 million tons classified as hypothetical resources. The U.S. resources are large, but are composed mostly of short fibers.

Substitutes: Numerous materials substitute for asbestos in products. The 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 were considered to be possible asbestos substitutes for products in which the reinforcement properties of fibers were not required. No single substitute was as versatile as asbestos.

[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 essentially 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 totaled about 480,000 tons in 2003, an increase of about 14% from 2002, and the value was about $14 million. Sales were from mines in two States; most sales came from Nevada operations followed by a significantly smaller sales volume from Georgia. In 2002, an estimated 2 million tons of ground barite was sold by crushers and grinders from seven States from domestic production and imports. Nearly 95% of the barite sold in the United States was used as a weighting agent in gas- and oil-well-drilling fluids. Shipments went mostly to the gas-drilling industry in the Gulf of Mexico (GOM) and onshore in Louisiana and Texas, which had slightly less than 70% of total gas production in the conterminous United States. The GOM rig count fell to about 110 rigs in October 2002 and stayed near that level through August 2003, while the onshore rig count expanded strongly through 2003. Smaller amounts of barite were used for exploration and development drilling in the western United States, which accounted for about 20% of gas production in the conterminous United States, and in western Canada and Alaska. Examples of industrial end uses include adding weight to rubber mudflaps on trucks and to the cement jacket around petroleum pipelines under water. Because barite significantly reduces X-rays and gamma rays, it is the gastrointestinal X-ray contrast medium; it is used in cement vessels that contain radioactive materials, and the faceplate and funnelglass of cathode-ray tubes used for television sets and computer monitors to protect the user from radiation. In the metal casting industry, barite forms part of the mold-release compounds. Barite also has become part of automotive and truck brake pads and clutch pads. Barite is also used in automobile paint primer for metal protection and gloss, and as the raw material for barium chemicals, such as barium carbonate. Barium carbonate goes into "leaded" glass and ceramic frits.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Sold or used, mine	434	392	400	420	480
Imports for consumption:					
Crude barite	836	2,070	2,470	1,510	2,000
Ground barite	17	16	6	5	20
Other	18	15	35	31	15
Exports	22	36	45	47	50
Consumption, apparent[1] (crude barite)	1,280	2,460	2,870	1,920	2,470
Consumption[2] (ground and crushed)	1,370	2,100	2,670	1,980	2,120
Price, average value, dollars per ton, mine	25.60	25.10	25.00	28.80	28.90
Employment, mine and mill, number[e]	300	330	340	320	340
Net import reliance[3] as a percentage of apparent consumption	66	84	86	78	81

Recycling: None.

Import Sources (1999-2002): China, 87%; India, 9%; Morocco, 1%; and other, 3%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/03**
Crude barite	2511.10.5000	$1.25/t.
Ground barite	2511.10.1000	Free.
Oxide, hydroxide, and peroxide	2816.30.0000	2% ad val.
Other chlorides	2827.38.0000	4.2% ad val.
Other sulfates	2833.27.0000	0.6% ad val.
Other nitrates	2834.29.5000	3.5% ad val.
Carbonate	2836.60.0000	2.3% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **James P. Searls [(703) 648-7724, jsearls@usgs.gov, fax: (703) 648-7975]**

BARITE

Events, Trends, and Issues: In 2003 U.S. barite consumption was about 2.46 million tons, up from about 1.62 million tons in 2002. Barite imports for consumption increased by an estimated 30% compared with 2002 levels. Major foreign sources of barite have high-grade deposits, relatively low labor costs, and relatively inexpensive transportation costs to U.S. Gulf Coast grinding plants. The Nevada producers were competitive in the California market, the Great Plains, and the Canadian markets, and will probably continue mining for more than 10 years.

On the demand side, onshore barite consumption increased as the U.S. onshore drill rig count rose about 32% to 965 in August. Two major domestic barite suppliers reported flat offshore GOM sales. In August 2003 the sum of North American and Latin American drill rigs was 1,744, about 35% more than August 2002. Drill rig activity for Africa in August 2003 was less than August 2002, while the count for the combined Asian Pacific, Europe, and Middle East areas had a nearly 5% increase.

Historically, in the United States, petroleum-well drilling has been a driving force in the demand for barite, but oil-well drilling has become much less important to that demand since early 1998. In 2003, oil-directed drill rig counts declined to about 14% of active U.S. drill rigs in contrast to about 40% of the count in early 1998. It is not clear that the U.S. barite demand will be strongly affected by the decline in oil-directed drill rigs.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	2002	2003[e]		
United States	420	480	26,000	60,000
Algeria	45	50	9,000	15,000
Brazil	55	55	2,100	5,000
China	3,100	3,500	62,000	360,000
France	75	75	2,000	2,500
Germany	120	125	1,000	1,500
India	600	900	53,000	80,000
Iran	220	250	NA	NA
Korea, North	70	70	NA	NA
Mexico	150	180	7,000	8,500
Morocco	470	470	10,000	11,000
Russia	60	60	2,000	3,000
Thailand	24	30	9,000	15,000
Turkey	120	100	4,000	20,000
United Kingdom	60	60	100	600
Other countries	420	290	12,000	160,000
World total (rounded)	6,000	6,700	200,000	740,000

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 are identified.

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

[e]Estimated. NA Not available.

[1]Sold or used by domestic mines – exports + imports.

[2]Domestic and imported crude barite sold or used by domestic grinding establishments.

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

[5]See Appendix C for definitions.

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, about 95% was converted to alumina. However, the United States also imported approximately one-half of the alumina it required. 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 in operation and one temporarily idled at midyear. Domestic bauxite was used in the production of nonmetallurgical products, such as abrasives, chemicals, and refractories.

Salient Statistics—United States:[2]	1999	2000	2001	2002	2003[e]
Production, bauxite, mine	NA	NA	NA	NA	NA
Imports of bauxite for consumption[3]	10,400	9,030	8,670	7,710	8,300
Imports of alumina[4]	3,810	3,820	3,100	3,010	2,300
Exports of bauxite[3]	168	147	88	52	140
Exports of alumina[4]	1,230	1,090	1,250	1,270	1,000
Shipments of bauxite from Government stockpile excesses[3]	4,180	1,100	3,640	297	1,710
Consumption, apparent, bauxite and alumina (in aluminum equivalents)[5]	4,870	3,840	3,670	2,860	3,000
Price, bauxite, average value U.S. imports (f.a.s.) dollars per ton	22	23	23	20	20
Stocks, bauxite, industry, yearend[3]	1,440	1,300	1,740	1,260	1,000
Net import reliance,[6] bauxite and alumina, as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1999-2002):[7] Bauxite: Guinea, 38%; Jamaica, 31%; Brazil, 12%; Guyana, 11%; and other, 8%. Alumina: Australia, 61%; Suriname, 18%; Jamaica, 9%; and other, 12%. Total: Australia, 29%; Jamaica, 21%; Guinea, 21%; Suriname, 8%; and other, 21%.

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 non-normal-trade-relations. However, all countries that supplied commercial quantities of bauxite or alumina to the United States during the first 8 months of 2003 had normal-trade-relations status.

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

Government Stockpile:

Stockpile Status—9-30-03[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Bauxite, metal grade:					
Jamaica-type	—	5,760	—	2,030	1,710
Suriname-type	—	719	—	—	—
Bauxite, refractory-grade, calcined	42	—	42	44	—

Prepared by **Patricia A. Plunkert [(703) 648-4979, pplunker@usgs.gov, fax: (703) 648-7757]**

BAUXITE AND ALUMINA

Events, Trends, and Issues: World production of bauxite was essentially unchanged from that for 2002. Based on production data from the International Aluminium Institute, world alumina production during the first 2 quarters of 2003 increased 6% compared with that for the same period in 2002.

The 2004 fiscal year Annual Materials Plan (AMP) submitted to Congress by the Defense National Stockpile Center proposed the sale of 43,700 calcined metric tons of refractory-grade bauxite from the National Defense Stockpile during the period October 1, 2003, to September 30, 2004. This or the remaining inventory, whichever is lower, is the maximum amount that could be sold under the new AMP and not necessarily the amount that would actually be offered for sale.[9]

Spot prices for metallurgical-grade alumina, as published by Metal Bulletin, trended upward during the year. The published price range began the year at $175 to $190 per ton. By the end of April, the price range had increased to $280 to $300 per ton. At the end of September, the price range was holding at $275 to $295 per ton.

World Bauxite Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[10]	Reserve base[10]
	2002	2003[e]		
United States	NA	NA	20,000	40,000
Australia	54,000	55,000	4,400,000	8,700,000
Brazil	13,900	13,500	1,900,000	2,500,000
China	12,000	12,000	700,000	2,300,000
Guinea	15,700	16,000	7,400,000	8,600,000
Guyana	2,000	1,500	700,000	900,000
India	9,270	9,000	770,000	1,400,000
Jamaica	13,100	13,400	2,000,000	2,500,000
Russia	3,800	3,800	200,000	250,000
Suriname	4,500	4,500	580,000	600,000
Venezuela	5,000	5,000	320,000	350,000
Other countries	11,200	10,700	4,300,000	5,000,000
World total (rounded)	144,000	144,000	23,000,000	33,000,000

World Resources: Bauxite resources are estimated to be 55 to 75 billion tons, located in South America (33%), Africa (27%), Asia (17%), Oceania (13%), and elsewhere (10%). Domestic resources of bauxite are inadequate to meet long-term 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 anorthosite, alunite, coal wastes, and oil shales, offer additional potential alumina sources. Although it would require new plants using new 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-base refractories. Although more costly, silicon carbide and alumina-zirconia substitute for bauxite-base abrasives.

[e]Estimated. NA Not available. — 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 U.S. Virgin Islands.
[3]Includes all forms of bauxite, expressed as dry equivalent weights.
[4]Calcined equivalent weights.
[5]The sum of U.S. bauxite production and net import reliance.
[6]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 22% for alumina in 2003. For the years 1999-2002, the net import reliance was 100% for bauxite and ranged from 29% to 36% for alumina.
[7]Aluminum equivalents.
[8]See Appendix B for definitions.
[9]Defense Logistics Agency, 2003, FY 2004 Annual Materials Plan announced: Fort Belvoir, VA, Defense Logistics Agency news release, October 1, 2 p.
[10]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 and recovered beryllium hydroxide from this ore and from imported beryl. The beryllium hydroxide was shipped to a plant in Ohio, where it was converted into beryllium metal, alloys, and oxide. Beryllium consumption of 190 tons was valued at about $70 million, based on the quoted producer price for beryllium-copper master alloy. The use of beryllium (as an alloy, metal, and oxide) in electronic and electrical components and aerospace and defense applications accounted for an estimated 80% of total consumption.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, mine shipments	200	180	100	80	100
Imports for consumption, ore and metal	20	20	115	150	140
Exports, metal	40	35	60	120	120
Government stockpile releases[e, 1]	145	220	60	60	40
Consumption:					
Apparent	385	300	230	180	190
Reported, ore	260	240	170	120	NA
Price, dollars (yearend):					
Domestic, metal, vacuum-cast ingot, per pound	327	421	338	NA	NA
Domestic, metal, powder blend, per pound[2]	385	492	375	375	375
Domestic, beryllium-copper master alloy, per pound of contained beryllium	160	160	160	160	160
Domestic, beryllium oxide, powder, per pound	77	100	100	NA	NA
Stocks, consumer, yearend	20	115	100	90	NA
Net import reliance[3] as a percentage of apparent consumption	48	37	57	56	47

Recycling: Beryllium was recycled mostly from new scrap that was generated during the manufacture of beryllium-related components. Detailed data on the quantities of beryllium recycled are not available but may compose as much as 10% of apparent consumption.

Import Sources (1999-2002): Ore, metal, scrap, and master alloy: Japan, 28%; Kazakhstan, 24%; Russia, 10%; Brazil, 9%; and other, 29%.

Tariff:

Item	Number	Normal Trade Relations 12/31/03
Beryllium ores and concentrates	2617.90.0030	Free.
Beryllium oxide or hydroxide	2825.90.1000	3.7% ad val.
Beryllium-copper master alloy	7405.00.6030	Free.
Beryllium:		
Unwrought 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:

Stockpile Status—9-30-03[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Beryl ore (11% BeO)	227	34	227	[5]145	—
Beryllium-copper master alloy	41	9	41	[5]36	—
Beryllium metal:					
Vacuum-cast	96	234	132	36	43
Hot-pressed powder	155	—	—	—	—

Prepared by **Larry D. Cunningham [(703) 648-4977, lcunning@usgs.gov, fax: (703) 648-7757]**

BERYLLIUM

Events, Trends, and Issues: For the first half of 2003, sales of alloy products (strip and bulk) were reported to have increased compared with those of the previous year, owing to improved demand from the appliance, automotive, and computer sectors, particularly in Southeast Asia. Sales of beryllium products, mostly for defense applications, increased. In 2003, U.S. imports for consumption of beryllium increased; Brazil, China, Germany, Kazakhstan, Nigeria, and Spain were the leading suppliers. Beryllium exports were unchanged; Canada, France, Germany, Japan, Singapore, and the United Kingdom were the major recipients of the materials.

For fiscal year 2003, the Defense National Stockpile Center (DNSC) disposed of about 43 tons of vacuum-cast beryllium metal from the National Defense Stockpile. There were no sales of beryl ore, BCMA, and hot-pressed beryllium metal powder in fiscal year 2003. For fiscal year 2004, the DNSC announced maximum disposal limits of about 3,630 tons[5] of beryl ore (about 145 tons of beryllium content), about 1,090 tons[5] of BCMA (about 44 tons of beryllium content), and about 36 tons of beryllium metal.

Because of the toxic nature of beryllium, the industry must maintain careful control over the quantity of beryllium dust and fumes in the workplace. The U.S. Environmental Protection Agency issues standards for certain hazardous air pollutants, including beryllium, under the Clean Air Act, and the Occupational Safety and Health Administration (OSHA) issues standards for airborne beryllium particles. To comply with these standards, plants are required to install and maintain pollution-control equipment. In beryllium-processing plants, harmful effects are prevented by maintaining clean workplaces; requiring the use of safety equipment, such as personal respirators; collecting dust, fumes, and mists at the source of deposition; establishing medical programs; and implementing other procedures to provide safe working conditions. Standards for exposure to beryllium were under review by OSHA and private standard-setting organizations.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e] 2002	Mine production[e] 2003
United States	80	100
China	15	15
Kazakhstan	4	4
Russia	40	40
Other countries	1	2
World total (rounded)[7]	140	160

Reserves and reserve base[6]

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 16,000 tons of beryllium. The world reserves and reserve base are not sufficiently well delineated to report consistent figures for all countries.

World Resources: World resources of beryllium have been estimated to be more than 80,000 tons (contained mostly in known nonpegmatite deposits). About 65% of the beryllium resources is concentrated 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. Graphite, steel, and titanium may be substituted for beryllium metal in some applications, and phosphor bronze may be substituted for beryllium-copper alloys, but these substitutions can result in substantial loss in performance. In some applications, aluminum nitride may be substituted for beryllium oxide.

[e]Estimated. NA Not available. — Zero.
[1]Net quantity (uncommitted inventory).
[2]This price quotation was discontinued in February 2003.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]Actual quantity limited to remaining sales authority or inventory.
[6]See Appendix C for definitions.
[7]Other beryllium-producing countries include Brazil, Madagascar, Mozambique, Portugal, and Zambia.

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, although a minor amount of secondary bismuth is still recovered from scrap by some domestic firms. Bismuth is contained in some lead ores mined domestically, but the bismuth-containing residues are not currently refined. Approximately 30 companies, mostly in the eastern United States, accounted for more than three-fourths of estimated bismuth consumption in 2003. The value of bismuth consumed was approximately $14 million. About 46% of the bismuth was used in fusible alloys, solders, and ammunition cartridges; 35% in pharmaceuticals and chemicals; 17% in metallurgical additives; and 2% in other uses.

The Safe Drinking Water Act Amendment of 1996 required that all new and repaired fixtures and pipes for potable water be lead-free after August 1998. Bismuth use in water meters was one particular application that increased. 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.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, refinery	—	—	—	—	—
Imports for consumption, metal	2,110	2,410	2,220	1,930	2,300
Exports, metal, alloys, scrap	257	491	541	131	110
Consumption, reported	2,050	2,130	2,200	2,320	2,200
Price, average, domestic dealer, dollars per pound	3.85	3.70	3.74	3.14	2.90
Stocks, yearend, consumer	121	118	95	111	100
Net import reliance[1] as a percentage of apparent consumption[e]	95	95	95	95	95

Recycling: Bismuth was recovered from fusible alloy scrap, but contributes less than 5% of the U.S. supply.

Import Sources (1999-2002): Belgium, 35%; Mexico, 22%; China, 22%; United Kingdom, 14%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Articles thereof, including waste and scrap	8106.00.0000	Free.

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

Government Stockpile: None.

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

BISMUTH

Events, Trends, and Issues: The outlook for bismuth indicates that demand will probably continue to grow during this decade. Demand for bismuth in the steel sector, although relatively minor compared with other use sectors, appears to be rising. The chemical sector is increasingly turning to bismuth as Japan increases use of the metal as a nontoxic replacement for lead in pigments and lead-free solders.

World lead mine and primary refinery production has remained essentially constant in recent years, limiting the amount of bismuth that can be produced as a lead byproduct. Much of the increase in bismuth production has been associated with the processing of tungsten ores, especially in Asia. The dealer price remained fairly steady throughout 2003, about 7% lower on average than that of 2002.

In February 2002, the Bismuth Institute, headquartered in Brussels, Belgium, discontinued operations and ceased to exist after almost 30 years of service. The Institute had provided bismuth statistics and encouraged research and development as well as new uses for the metal. It had helped open trade with China, now the leader in world bismuth reserves and production. By late 2002, the Bismuth Producers Association had been formed by companies representing more than 85% of the world's annual bismuth production and had taken over many of the Institute's former roles.

World Mine Production, Reserves, and Reserve Base: Production held back from markets, shifts in Government policy, and work stoppages caused significant fluctuations in annual bismuth production in Bolivia.

	Mine production		Reserves[2]	Reserve base[2]
	2002	2003[e]		
United States	W	W	9,000	14,000
Bolivia	70	50	10,000	20,000
Canada	189	200	5,000	30,000
China	1,300	1,200	240,000	470,000
Kazakhstan	150	150	5,000	10,000
Mexico	1,200	1,000	10,000	20,000
Peru	1,000	1,000	11,000	42,000
Other countries	160	150	39,000	74,000
World total (rounded)	4,070	3,750	330,000	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 a byproduct of processing lead ores; in China, it is a byproduct of tungsten ore processing. Bismuth minerals rarely occur in sufficient quantities to be mined as principal products; the Tasna mine in Bolivia is the only mine that produced bismuth from a bismuth ore. This mine has been on standby status since the mid-1990s awaiting a significant rise in the metal price. Several bismuth-containing deposits are in varying stages of mining feasibility review. These polymetallic deposits include NICO in Canada, Nui Phao in Vietnam, and Bonfim in Brazil.

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 be composed of 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. 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.

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 2003 was $275 million. Domestic production of boron minerals, primarily as sodium borates, by four companies was centered in southern California. The largest producer operated an open pit tincal and kernite mine and associated compound plants. The majority of the remaining output was produced using saline brines as raw material. A third company continued to process small amounts of calcium and calcium sodium borates, and a fourth company used an in situ process to produce synthetic colemanite. Principal consumption of boron minerals and chemicals was in the production of ceramics by firms in the North Central United States and the Eastern United States. The reported distribution pattern for boron compounds consumed in the United States in 2001 was as follows: glass and ceramics, 78%; soaps and detergents, 6%; agriculture, 4%; fire retardants, 3%; and other, 9%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production[1]	618	546	536	518	536
Imports for consumption, gross weight:					
Borax	8	1	1	([2])	16
Boric acid	30	39	56	49	45
Colemanite	42	26	35	32	14
Ulexite	178	127	109	125	99
Exports, gross weight:					
Boric acid	107	119	85	84	79
Colemanite	NA	NA	NA	5	23
Refined sodium borates	370	413	221	150	142
Consumption:					
Apparent	534	356	482	492	488
Reported	416	360	347	359	NA
Price, dollars per ton, granulated pentahydrate borax in bulk, carload, works[3]	376	376	376	376	400-425
Stocks, yearend[4]	NA	NA	NA	NA	NA
Employment, number	900	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 (1999-2002): Boric acid: Turkey, 43%; Chile, 22%; Canada, 14%; Bolivia, 7%; and other, 14%.

Tariff:

Item	Number	Normal Trade Relations 12/31/03
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.
Other:		
Calcium	2528.90.0010	Free.
Other	2528.90.0050	Free.

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

Government Stockpile: None.

Prepared by **Phyllis A. Lyday [(703) 648-7713, plyday@usgs.gov, fax: (703) 649-7757]**

BORON

Events, Trends, and Issues: The United States was the world's largest producer of refined boron compounds during 2003, and about one-half of domestic production was exported. The largest company produced and processed ore from an open pit mine in California. A second company produced boron, sodium carbonate, and sodium sulfate from brines. The second company continued with plans to sell its boron assets. At the beginning of 2003, the third company suspended operations at its in situ operation. The fourth company that operated an underground mine in California continued to process the ore in Nevada for overseas export. U.S. processed products had fewer impurities, lower emissions, and higher productivity per worker hour worked than boron minerals produced in other countries.

It was reported that a leading indicator for demand for refined borates was a strong housing market. Domestic market sectors for boron minerals and chemicals are fiberglass, 69%; soaps and detergents, 6%; borosilicate glass, 5%; agriculture, 4%; frits and ceramics, 4%; cellulose insulation, 3%; and other uses, 9%.

The second largest company in the United States also produced specialty borates in Tuscany, Italy, where production was curtailed in 2002 because of a lack of colemanite feedstock from Turkey. Turkey was using the colemanite to make value added derivatives for export. The Italian plant was able to continue producing high-purity boric acid during 2003 by importing boron compounds from Russia.

A fuel-cell vehicle that used recyclable sodium borohydride fuel participated in a ride-and-drive display at the Pentagon as part of Earth Day celebrations. A nonflammable fuel cell could improve safety in battle zones, reduce logistic demands of refueling, reduce emissions, and reduce dependence on imported oil. The company that is producing the vehicle received a $3.5 million grant from the Department of Energy to develop the borohydride-base method of hydrogen generation for fuel uses.

In India, the first herbal contraceptive pill, based on a 2,500-year-old medical text, was being tested. The ancient formulation to control female fertility contained borax.

Exported U.S. borate materials competed with borax, boric acid, colemanite, and ulexite primarily from Turkey, the largest producer of boron ore in the world.

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

	Production—all forms		Reserves[7]	Reserve base[7]
	2002	2003[e]		
United States	1,050	1,060	40,000	80,000
Argentina	510	170	2,000	9,000
Bolivia	35	33	NA	NA
Chile	330	430	NA	NA
China	145	140	25,000	47,000
Iran	4	4	1,000	1,000
Peru	9	9	4,000	22,000
Russia	1,000	1,000	40,000	100,000
Turkey	1,500	1,500	60,000	150,000
World total (rounded)	4,580	4,350	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.
[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.
[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: The quantity of bromine sold or used in the United States from three companies operating in Arkansas and Michigan accounted for 100% of elemental bromine production, which was valued at an estimated $155 million. Arkansas, with six plants, led the Nation in bromine production, and bromine was the leading mineral commodity in terms of value produced in the State. In Michigan bromine was produced as a byproduct of magnesium production. Three bromine companies in the United States accounted for 38% of world production.

Primarily bromine was used in fire retardants (40%), drilling fluids (24%), brominated pesticides (12%), water-treatment chemicals (7%), and other products, including photographic chemicals and rubber additives (17%). 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:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production[1]	239	228	212	222	216
Imports for consumption, elemental bromine and compounds[2]	10	20	16	7	7
Exports, elemental bromine and compounds	10	10	11	13	12
Consumption, apparent[3]	238	238	214	216	211
Price, cents per kilogram, bulk, purified bromine	87.0	90.0	67.0	99.2	72.0
Employment, number	1,700	1,700	1,700	1,700	1,700
Net import reliance[4] as a percentage of apparent consumption	E	4	—	—	E

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.

Import Sources (1999-2002): Israel, 88%; United Kingdom, 4%; China, 1%; Indonesia, 1%; Netherlands, 1%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Bromine	2801.30.2000	5.5% ad val.
Bromides and bromide oxides	2827.59.5000	3.6% ad val.
Bromochloromethane	2903.49.1000	Free.
Ammonium, calcium, or zinc bromide	2827.59.2500	Free.
Decabromodiphenyl and octabromodiphenyl oxide	2909.30.0700	7.0% ad val.
Ethylene dibromide	2903.30.0500	5.4% ad val.
Hydrobromic acid	2811.19.3000	Free.
Potassium bromate	2829.90.0500	Free.
Potassium or sodium bromide	2827.51.0000	Free.
Sodium bromate	2829.90.2500	Free.
Tetrabromobisphenol A	2908.10.2500	0.2¢/kg + 6.9% ad val.
Vinyl bromide, methylene dibromide	2903.30.1520	Free.

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

Government Stockpile: None.

Prepared by **Phyllis A. Lyday [(703) 648-7713, plyday@usgs.gov, fax: (703) 648-7757]**

BROMINE

Events, Trends, and Issues: Israel ranked second behind the United States in world bromine production. 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. Exports from Israel were used to produce bromine compounds at a plant in the Netherlands for export to other countries.

Jordan officially inaugurated a new bromine producer on June 23, 2003. The new firm is a joint venture between two companies located in Jordan and the United States. The $123 million venture started operations in November 2002 and reportedly has 10% of the world market. About 80 Jordanians were employed in the plant. The production was targeted to markets in Europe and the Far East.

Negotiations were in final discussions for a U.S. company to acquire the bromine fine chemicals business of a French producer located at Port-de-Bouc.

Under the Montreal Protocol, the U.S. phase of the global elimination of methyl bromide as a crop pesticide will begin during 2001-5 for those uses not exempted. Imports of crops grown and treated with methyl bromide in Mexico are expected to continue, however, because Mexico is not required to phase out methyl bromide use until 2015. As the United States phases out production, imports of methyl bromide from undeveloped countries have increased.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	2002	2003[e]		
United States[1]	222	216	11,000	11,000
Azerbaijan	2	2	300	300
China	42.0	42	130	3,500
France	2	2	1,600	1,600
Germany	0.5	0.5	([6])	([6])
India	1.5	1.5	([7])	([7])
Israel	206	206	([8])	([8])
Italy	0.3	0.3	([7])	([7])
Japan	5	25	([9])	([9])
Jordan	5	20	([8])	([8])
Spain	0.1	0.1	1,400	1,400
Turkmenistan	0.15	0.15	700	700
Ukraine	3	3	400	400
United Kingdom	50	50	([7])	([7])
World total (rounded)	540	570	Large	Large

World Resources: Resources of bromine are virtually unlimited. 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. The bromine content of underground water in Poland has been estimated at 36 million tons.

Substitutes: Chlorine and iodine may be substituted for bromine in a few chemical reactions and for sanitation purposes. Aniline and some of its derivatives, methanol, ethanol, and gasoline-grade tertiary butyl alcohol, are effective nonleaded substitutes for ethylene dibromide and lead in gasoline for cars. Farm equipment and airplanes still used leaded as an octane booster in fuels that require ethylene dibromide as a "scavenger" to remove the lead after the gasoline is burned. There are no comparable substitutes for bromine in various oil and gas well completion and packer applications. Alumina, magnesium hydroxide, organic chlorine compounds, and phosphorous compounds can be substituted for bromine as fire retardants in some uses.

[e]Estimated. E Net exporter. NA Not available. — 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]From waste bitterns associated with potash production.
[7]From waste bitterns associated with solar salt.
[8]From the Dead Sea. See World Resources section.
[9]From seawater. See World Resources section.

CADMIUM

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

Domestic Production and Use: Only two companies produced cadmium in the United States in 2003. One company produced primary cadmium in Tennessee as a byproduct of smelting and refining zinc metal from sulfide ore while the other company produced cadmium from scrap in Pennsylvania, mainly from spent nickel-cadmium (NiCd) batteries. Based on the average New York dealer price, the combined output of primary and secondary metal was valued at about $430,000 in 2003. Consumption of cadmium during the past 3 years declined by about 70% in response to environmental concerns. About 78% of total apparent consumption was for batteries. The remaining 22% was distributed as follows: pigments, 12%; coatings and plating, 8%; stabilizers for plastics, 1.5%; and nonferrous alloys and other, 0.5%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, refinery[1]	1,190	1,890	680	700	640
Imports for consumption, metal	294	425	107	25	30
Exports of metal, alloys, scrap	20	314	272	194	250
Shipments from Government stockpile excesses	550	319	34	693	80
Consumption, apparent	1,850	2,010	659	560	530
Price, metal, dollars per pound[2]	0.14	0.16	0.23	0.29	0.30
Stocks, yearend, producer and distributor	893	1,200	1,090	1,750	1,720
Employment, smelter and refinery	NA	NA	NA	NA	NA
Net import reliance[3] as a percentage of apparent consumption	9	6	E	E	E

Recycling: Cadmium recycling thus far has been practical only for NiCd batteries, some alloys, and dust from electric arc furnaces (EAF). The exact amount of recycled cadmium is unknown. In 2003, the U.S. steel industry generated more than 0.6 million ton of EAF dust, typically containing 0.003% to 0.07% cadmium.

Import Sources (1999-2002): Metal: Australia, 36%; Belgium, 30%; Canada, 24%; and other, 10%.

Tariff: Item	Number	Normal Trade Relations[4] 12/31/03
Cadmium sulfide	2830.30.0000	3.1% ad val.
Pigments and preparations based on cadmium compounds	3206.30.0000	3.1% ad val.
Unwrought cadmium; waste and scrap; powders	8107.10.0000	Free.

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

Government Stockpile: After record sales from the Government stockpile in 2002, remaining 270 tons of cadmium metal held by the U.S. Defense Logistic Agency was sold in 2003.

Stockpile Status—9-30-03[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Cadmium	—	—	—	270	270

Prepared by **Jozef Plachy [(703) 648-4982, jplachy@usgs.gov, fax: (703) 648-7757]**

CADMIUM

Events, Trends, and Issues: Cadmium production continued to decline in 2003. During the past decade, regulatory pressure to reduce or even eliminate the use of cadmium has gained momentum in many developed countries. In the United States, Federal and State environmental agencies regulate the production and use of heavy metals such as cadmium. To help unify different standards used by these agencies, the U.S. Environmental Protection Agency created a list of persistent and bioaccumulative toxic pollutants. Cadmium is 1 of 11 metals on the list, and its use is targeted for a 50% reduction by 2005. The European Union (EU) is evaluating a proposal to ban all Ni-Cd batteries containing more than 0.002% cadmium beginning on January 1, 2008, and to increase the collection rate for all spent industrial and automotive batteries to 95% by weight by December 31, 2003. According to some cadmium experts, the EU proposal fails to differentiate among different forms of cadmium with disparate toxicity and fails to consider the environmental effect of metals and chemicals that are expected to replace cadmium in all applications.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[6]	Reserve base[6]
	2002	2003[e]		
United States	700	640	90,000	270,000
Australia	350	380	110,000	300,000
Belgium	117	100	—	—
Canada	896	900	55,000	100,000
China	2,500	2,600	90,000	380,000
Germany	422	300	6,000	8,000
India	450	450	3,000	5,000
Japan	2,500	2,700	10,000	15,000
Kazakhstan	600	600	50,000	100,000
Korea, Republic of	1,900	1,850	—	—
Mexico	1,200	1,300	35,000	40,000
Russia	950	950	16,000	30,000
Other countries	3,220	2,200	140,000	550,000
World total (rounded)	15,800	15,000	600,000	1,800,000

World Resources: Zinc-bearing coals of the central United States and Carboniferous-age coals of other countries also contain large subeconomic resources of cadmium.

Substitutes: NiCd batteries are being replaced in some applications with lithium-ion and nickel-metal hydride batteries. However, the higher cost of these substitutes restricts their use. Except where the surface characteristics of a coating are critical (e.g., fasteners for aircraft), coatings of zinc or vapor-deposited aluminum can substitute for cadmium in many plating applications. Cerium sulfide is used as a replacement for cadmium pigments, mostly in plastics.

[e]Estimated. E Net exporter. NA Not available. — Zero.
[1]Primary and secondary metal.
[2]Average New York dealer price for 99.95% purity in 5-short-ton lots. Source: Platts Metals Week.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]No tariff for Canada and Mexico for items shown.
[5]See Appendix B for definitions.
[6]See Appendix C for definitions. Significant changes from previous reports are based on new information.

CEMENT

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: In 2003, almost 87 million tons of portland cement and 4.5 million tons of masonry cement were produced at 116 plants in 37 States and at 2 plants in Puerto Rico. The value of cement production, excluding Puerto Rico, was about $7 billion, and the value of total sales (including imported cement) was about $8.3 billion. Most of the cement was used to make concrete, worth at least $40 billion. Imported cement and clinker (to make cement) accounted for about 21% of the cement sold; total imports declined significantly, owing to higher domestic production capacity and flattening of overall demand. Clinker, the main intermediate product in cement manufacture, was produced at 109 plants, with a combined apparent annual capacity of about 101 million tons. Including several facilities that merely ground clinker produced elsewhere, total finished cement (grinding) capacity was about 110 million tons. California, Texas, Pennsylvania, Michigan, Missouri, and Alabama, in descending order, were the six largest producing States and accounted for about one-half of U.S. production. 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.

Salient Statistics—United States:[1]	1999	2000	2001	2002	2003[e]
Production:					
Portland and masonry cement[2]	85,952	87,846	88,900	89,732	91,000
Clinker	76,003	78,138	78,451	81,517	82,000
Shipments to final customers, includes exports	108,862	110,048	113,136	108,778	109,000
Imports of hydraulic cement for consumption	24,578	24,561	23,694	22,198	21,000
Imports of clinker for consumption	4,164	3,673	1,782	1,603	1,600
Exports of hydraulic cement and clinker	694	738	746	834	900
Consumption, apparent[3]	108,862	110,470	112,810	110,020	112,000
Price, average mill value, dollars per ton	78.27	78.56	76.50	76.00	76.00
Stocks, cement, yearend	6,367	7,566	6,600	7,680	6,500
Employment, mine and mill, number[e]	18,000	18,000	18,000	18,100	18,100
Net import reliance[4] as a percentage of apparent consumption	25	24	21	20	20

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. Fly ash and granulated blast furnace slag also can be incorporated in blended cements and in the cement paste in concrete. Cement itself generally is not recycled, but there is a small amount of recycling of concrete for use as aggregate.

Import Sources (1999-2002):[5] Canada, 19%; Thailand, 18%; China, 12%; Venezuela, 7%; Greece, 6%; and other (31 countries), 38%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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: Record low interest rates and continued strong public sector and residential construction spending in 2003 partially offset wet weather conditions and general economic weakness to yield flat sales levels relative to 2002. Cement consumption in 2004 is expected to remain similar to levels in 2003; a key determinant is likely to be continued tenuous State cofunding of public sector projects.

Concern continued over the environmental impact of cement manufacture, particularly the emission of carbon dioxide, handling of cement kiln dust (CKD), emissions of trace metals, and emissions of nitrogen oxides. The cement industry is one of the largest sources of carbon dioxide emissions, and U.S. cement producers were voluntarily seeking ways to reduce emissions.

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

CEMENT

Carbon dioxide reduction strategies by the cement industry were aimed at lowering emissions per ton of cement product rather than by plant. Emissions reduction strategies included installation of more fuel-efficient kiln technologies, partial substitution of noncarbonate sources of calcium oxide in the kiln raw materials, and partial substitution of cementitious additives for portland cement in the finished cement products.

Higher fossil fuel costs were of concern to the cement industry; the resulting increased production costs were not easily passed on to customers given stagnant cement prices. Oceanic shipping charges were increasing, making imported cement less attractive to consumers. 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(s) burned hinge on current and future environmental regulations and their associated costs. The trend appears to be toward increased use of waste fuels.

Although little used by cement companies themselves in the United States, there is growing direct use by concrete manufacturers of cementitious extenders, such as pozzolans, as partial replacements for portland cement. The United States lags behind many foreign countries in this practice. Pozzolans are materials that, in the presence of free lime, have hydraulic cementitious properties; examples include some volcanic ashes and industrial byproducts such as granulated blast furnace slag, fly ash, and silica fume. Inclusion of these materials in concrete mixes can yield performance advantages over straight portland cement concretes for certain applications. Because pozzolans do not require the energy-intensive clinker manufacturing (kiln) phase of cement production, their use reduces the monetary and environmental costs per ton of cement manufactured.

World Production and Capacity:

	Cement production		Yearend clinker capacity[e]	
	2002[e]	2003[e]	2002	2003
United States (includes Puerto Rico)	[6]91,300	92,600	[6]101,000	103,000
Brazil	39,500	40,000	45,000	45,000
China	[6]705,000	750,000	700,000	730,000
Egypt	23,000	26,000	35,000	35,000
France	20,000	20,000	22,000	22,000
Germany	30,000	28,000	31,000	31,000
India	100,000	110,000	120,000	120,000
Indonesia	33,000	34,000	50,000	50,000
Iran	30,000	31,000	30,000	33,000
Italy	40,000	40,000	46,000	46,000
Japan	[6]71,800	72,000	80,300	80,000
Korea, Republic of	[6]55,500	56,000	62,000	62,000
Mexico	[6]31,100	31,500	40,000	40,000
Russia	[6]37,700	40,000	65,000	65,000
Saudi Arabia	21,000	23,000	24,000	24,000
Spain	42,500	40,000	40,000	40,000
Thailand	[6]31,700	35,000	47,000	50,000
Turkey	[6]32,600	33,000	35,000	35,000
Other countries (rounded)	360,000	360,000	330,000	340,000
World total (rounded)	1,800,000	1,860,000	1,900,000	1,950,000

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 utilized 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. Pozzolans and similar materials, especially fly ash and ground granulated blast furnace slag, are 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 and industry stock changes.
[5]Hydraulic cement and clinker.
[6]Reported data rounded to three significant digits.

CESIUM

(Data in kilograms of cesium content, unless otherwise noted)

Domestic Production and Use: Cesium is not mined in the United States; however, there are cesium occurrences in South Dakota and Maine. One U.S. company imports pollucite, the principal ore of cesium, from Canada to produce specialty, high-density drilling fluids for use in the global oil and gas exploration industry. Cesium is also used in photoelectric cells, traffic controls, infrared detectors, DNA separation, and night vision devices; it may have applications in the aerospace industry as a rocket fuel. At the U.S. Naval Observatory, cesium is used in atomic clocks that are accurate to a few hundred trillionths of a second. Internet and cell phone transmissions rely on the accuracy of cesium atomic clocks; military missiles, global positioning satellites, and jet aircraft that track the returning U.S. space shuttles are synchronized using cesium clocks. Cesium-137, which is a reactor-produced radioactive isotope of cesium, is used for cancer treatment, in industrial gauges, and for sterilization of food, sewage, and surgical equipment.

Salient Statistics—United States: Data on cesium production, consumption, imports, and exports are not available. World mine production and U.S. consumption data have not been available since the late 1980s. The cesium market is small and annual consumption amounts to a few thousand kilograms. As a result, there is no trading of the metal, and, therefore, no official market price. Several companies publish their prices for cesium and cesium compounds, and these prices have remained relatively stable for several years. In 2003, one company offered 1-gram ampoules of 99.8% (metals basis) cesium for $39.50 and 99.98% (metals basis) cesium for $52.00. The price for 100 grams of 99.8% (metals basis) cesium was $1,038.00, and the same quantity of 99.98% (metals basis) cesium was priced at $1,425.00.

Recycling: None.

Import Sources (1999-2002): The United States is 100% import reliant; Canada is the major source of the cesium ore, pollucite, imported by the United States.

Tariff:

Item	Number	Normal Trade Relations 12/31/03
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: The United States will continue to depend on foreign sources of cesium, primarily Canada, unless the cesium market changes enough to make domestic deposits economic or if technology that uses low-grade raw materials is developed. Applications for cesium are limited by its high cost and extreme reactivity. Cesium drilling muds, which are used in the petroleum industry, are readily biodegradable and have minimal environmental impact. No other environmental or human health issues have been associated with stable cesium.

World Mine Production, Reserves, and Reserve Base: Data on mine production of cesium are not available, and data on resources are limited. Estimates of reserves and reserve base are based on occurrences of pollucite, the cesium-bearing aluminosilicate mineral that is found in some zoned pegmatites in association with the lithium minerals lepidolite and petalite. Pollucite is mined as a byproduct with other pegmatite minerals; commercial concentrates of pollucite may contain about 20% cesium by weight.

	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 pegmatites worldwide; cesium resources have been found in pegmatites 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: The properties of rubidium and its compounds are similar to those of cesium and its compounds; thus, they 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 2003, the United States consumed about 12% of world chromite ore production in various forms of imported materials, such as chromite ore, chromium chemicals, chromium ferroalloys, and chromium metal. Imported chromite was consumed by one chemical firm to produce chromium chemicals. Consumption of chromium ferroalloys and metal was predominantly for the production of stainless and heat-resisting steel and superalloys, respectively. The value of chromium material consumption was about $188 million.

Salient Statistics—United States:[1]	1999	2000	2001	2002	2003[e]
Production, secondary	118	139	122	139	129
Imports for consumption	476	453	239	263	344
Exports	60	86	38	29	16
Government stockpile releases	19	85	9	119	37
Consumption:					
Reported[2] (excludes secondary)	298	206	196	225	224
Apparent[3] (includes secondary)	558	589	332	500	492
Price, chromite, yearend:					
South African, dollars per metric ton, South Africa	63	63	NA[4]	NA[4]	NA[4]
Turkish, dollars per metric ton, Turkey	145	141	NA[4]	NA[4]	NA[4]
Unit value, average annual import (dollars per metric ton):					
Chromite ore (gross weight)	62	64	61	60	45
Ferrochromium (chromium content)	732	797	709	646	704
Chromium metal (gross weight)	6,267	5,976	6,116	5,770	5,550
Stocks, industry, yearend[5]	54	16	17	8	10
Net import reliance[6] as a percentage of apparent consumption	79	67	63	68	74

Recycling: In 2003, chromium contained in purchased stainless steel scrap accounted for 26% of apparent consumption.

Import Sources (1999-2002): Chromium contained in chromite ore and chromium ferroalloys and metal: South Africa, 48%; Kazakhstan, 23%; Zimbabwe, 9%; Turkey, 7%; Russia, 6%; and other, 7%.

Tariff:[7] Item	Number	Normal Trade Relations 12/31/03
Ore and concentrate	2610.00.0000	Free.
Ferrochromium:		
Carbon over 4%	7202.41.0000	1.9% ad val.
Carbon over 3%	7202.49.1000	1.9% ad val.
Other:		
Carbon over 0.5%	7202.49.5010	3.1% ad val.
Other	7202.49.5090	3.1% ad val.
Chromium metal:		
Unwrought powder	8112.21.000	3% ad val.
Waste and scrap	8112.22.000	Free.
Other	8112.29.000	3% ad val.
Ferrosilicon Chromium	7202.50.000	10% ad val.

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

Government Stockpile: The Defense Logistics Agency, U.S. Department of Defense, submitted the Annual Materials Plan for fiscal year (FY) 2004 in February 2003. Quantity available for sale will be limited to sales authority or inventory. The Agency reported sales in FY 2003 of 6,810 tons of chemical-grade chromite ore, 51,800 tons of refractory-grade chromite ore, 45,300 tons of high-carbon ferrochromium, 12,000 tons of low-carbon ferrochromium, and 103 tons of chromium metal.

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

CHROMIUM

Stockpile Status—9-30-03[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003	Average chromium content
Chromite ore:						
Chemical-grade	70.9	7.64	70.9	90.7	7.45	28.6%
Metallurgical-grade	—	51.9	—	90.7	—	28.6%
Refractory-grade	82.6	73.5	82.6	90.7	30.1	[e]23.9%
Ferrochromium:						
High-carbon	482	2.31	482	136	62.0	71.4%
Low-carbon	218	0.642	218	—	15.7	71.4%
Chromium metal	7.10	0.042	7.10	0.454	0.116	100%

Events, Trends, and Issues: Rising cost of ferrochromium production and a strengthening South African rand, along with increased demand for ferrochromium and tightness in supply of stainless steel scrap, have caused the price of ferrochromium to reach historically high levels. Increased demand for ferrochromium resulted from increased world stainless steel production, the major end use for ferrochromium. World stainless steel production responded to world demand led by China. With strong economic growth, China's importance as a consumer of raw materials has increased significantly. The high price of ferrochromium resulted in the reentry of China and India, two of the world's higher cost ferrochromium producers, in that commodity's export market. It also fueled ferrochromium production expansion in Kazakhstan and bolstered its interest in moving into stainless steel production. Kazakhstan is geographically well placed and endowed with mineral and energy resources to meet China's growing demand for stainless steel. The high cost and tight supply of stainless steel scrap resulted from increasing production of stainless steel and the cost of nickel, which reached its highest level in at least 14 years despite increased nickel production. High chromium and nickel prices result in increasing stainless steel price, which may cause the use of less costly stainless steel grades, other metals, or nonmetallic materials. If stainless users shift to less costly stainless grades, nickel demand would fall without depressing chromium demand. If stainless consumers shift to other metals or materials, demand for both chromium and nickel would decrease.

World Mine Production, Reserves, and Reserve Base: The reserves and reserve base estimates have been revised from those previously published based on new information.

	Mine production		Reserves[9]	Reserve base[9]
	2002	2003[e]	(shipping grade)[10]	
United States	—	—	—	7,000
India	1,900	1,900	25,000	57,000
Kazakhstan	2,370	2,400	290,000	470,000
South Africa	6,440	6,500	100,000	200,000
Other countries	2,790	3,000	390,000	1,100,000
World total (rounded)	13,500	14,000	810,000	1,800,000

World Resources: World resources exceed 12 billion tons of shipping-grade chromite, sufficient to meet conceivable demand for centuries. About 95% of chromium resources is geographically concentrated in southern Africa. Reserves and reserve base are geographically concentrated in Kazakhstan and southern Africa. The largest U.S. chromium resource is in the Stillwater Complex in Montana.

Substitutes: Chromium has no substitute in stainless steel, the largest 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. — Zero.
[1]Data in thousand metric tons of contained chromium, unless noted otherwise.
[2]The year 1998 includes chromite ore; 1999 through 2003 exclude chromite ore.
[3]Calculated demand for chromium is production + imports – exports + stock adjustment.
[4] This price series was discontinued.
[5]Includes producer and consumer stocks before 2000; consumer stocks after 1999.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]In addition to the tariff items listed, certain imported chromium materials (see U.S. Code, chapter 26, sections 4661 and 4672) are subject to excise tax.
[8]See Appendix B for definitions.
[9] See Appendix C for definitions.
[10]Shipping-grade chromite ore 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 2003, clay and shale production was reported in all States except Alaska, Delaware, Hawaii, Idaho, New Hampshire, New Jersey, Rhode Island, Vermont, and Wisconsin. About 240 companies operated approximately 760 clay pits or quarries. The leading 20 firms supplied about 50% of the tonnage and 79% of the value for all types of clay sold or used in the United States. U.S. production, essentially unchanged from 2002, was about 39.3 million tons and was valued at $1.6 billion. Major domestic uses for specific clays were estimated to be as follows: ball clay—41% floor and wall tile, 25% sanitaryware, and 34% other uses; bentonite—25% pet waste absorbent, 21% drilling mud, 21% foundry sand bond, 15% iron ore pelletizing, and 18% other uses; common clay—56% brick, 17% cement, 17% lightweight aggregate, and 10% other uses; fire clay—75% refractories and 25% other uses; fuller's earth—74% absorbent uses and 26% other uses; and kaolin—54% paper, 17% refractories, and 29% other uses.

Salient Statistics—United States:[1]	**1999**	**2000**	**2001**	**2002**	**2003**[e]
Production, mine:					
Ball clay	1,200	1,140	1,100	1,120	1,120
Bentonite	4,070	3,760	3,970	3,970	3,970
Common clay	24,800	23,700	23,200	23,000	23,000
Fire clay[2]	402	476	383	446	446
Fuller's earth	2,560	2,910	2,890	2,730	2,730
Kaolin	9,160	8,800	8,110	8,010	8,010
Total[3]	42,200	40,800	39,600	39,300	39,300
Imports for consumption:					
Artificially activated clay and earth	17	18	21	27	20
Kaolin	57	63	114	158	275
Other	16	16	13	32	50
Total[3]	90	96	148	217	325
Exports:					
Ball clay	107	100	174	127	150
Bentonite	719	761	628	722	680
Fire clay[2]	189	216	238	251	275
Fuller's earth	152	136	146	60	50
Kaolin	3,310	3,690	3,440	3,350	3,400
Clays, not elsewhere classified	329	357	344	449	420
Total[3]	4,800	5,260	4,970	4,960	4,980
Consumption, apparent	37,500	35,600	34,800	34,600	34,600
Price, average, dollars per ton:					
Ball clay	40	42	42	42	42
Bentonite	43	41	42	45	45
Common clay	6	6	6	6	6
Fire clay	16	16	16	24	23
Fuller's earth	90	87	89	90	90
Kaolin	104	106	103	119	119
Stocks, yearend[4]	NA	NA	NA	NA	NA
Employment, number:[e]					
Mine	1,500	1,500	1,500	1,350	1,300
Mill	5,700	5,800	5,800	5,200	5,100
Net import reliance[5] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1999-2002): Brazil, 61%; United Kingdom, 12%; Mexico, 11%; Canada, 4%; and other, 12%.

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

CLAYS

Tariff: Item	**Number**	**Normal Trade Relations 12/31/03**
Kaolin and other kaolinitic clays, whether or not calcined	2507.00.0000	Free.
Bentonite	2508.10.0000	Free.
Fuller's and decolorizing earths	2508.20.0000	Free.
Fire clay	2508.30.0000	Free.
Common blue and other ball clays	2508.40.0010	Free.
Other clays	2508.40.0050	Free.
Chamotte or dina's earth	2508.70.0000	Free.
Activated clays and earths	3802.90.2000	2.5% ad val.
Expanded clays and 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); clays used in the manufacture of drain and roofing tile, flower pots, and kindred products, 5% (Domestic and foreign); clay used for alumina and aluminum compounds, 22% (Domestic).

Government Stockpile: None.

Events, Trends, and Issues: The amount of clay and shale sold or used by domestic producers was unchanged in 2003. Imports for consumption increased significantly to an estimated 325,000 tons. Imports of kaolin from Brazil accounted for almost all of this increase. The major sources of imported clay were Brazil (kaolin), Greece (bentonite), Mexico (activated clay), and the United Kingdom (kaolin). Exports increased slightly to 4.98 million tons. Major markets for exported clays, by descending order of tonnage, were Canada, Japan, Mexico, the Netherlands, Finland, and Taiwan.

World Mine Production, Reserves, and Reserve Base: New information resulted in revisions to production estimates in 2002 for Brazil (bentonite and kaolin), the Czech Republic (bentonite and kaolin), Greece (bentonite), and Turkey (bentonite and kaolin). Reserves and reserve base are large in major producing countries, but data are not available.

	Mine production					
	Bentonite		Fuller's earth		Kaolin	
	2002	2003[e]	2002	2003[e]	2002	2003[e]
United States (sales)	3,970	3,970	2,730	2,730	8,010	8,010
Brazil (beneficiated)	175	175	—	—	1,710	1,800
Commonwealth of Independent States (crude)	750	750	—	—	[6]5,800	8,000
Czech Republic (crude)	174	200	—	—	3,650	4,000
Germany (sales)	500	500	500	500	3,770	3,800
Greece (crude)	1,150	1,200	—	—	60	60
Italy	500	500	30	30	100	100
Korea, Republic of (crude)	—	—	—	—	2,380	2,850
Mexico	400	400	150	150	680	680
Turkey	559	600	—	—	372	350
United Kingdom (sales)	—	—	140	150	2,400	2,400
Other countries	1,820	1,830	340	335	14,300	13,000
World total (rounded)	10,000	10,100	3,890	3,900	43,200	45,100

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. NA Not available. — Zero.
[1]Excludes Puerto Rico.
[2]Refractory uses only.
[3]Data may not add to total shown because of independent rounding.
[4]Data on stocks are not available and are assumed to be zero for apparent consumption and net import reliance calculations.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]Uzbekistan produced approximately 5.5 million tons of kaolin in 2001 and 2002.

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 2003; 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 superalloy scrap, cemented carbide scrap, and spent catalysts. There were two domestic producers of extra-fine cobalt powder: one produced powder from imported primary metal and another produced powder from cemented carbide scrap. In addition to the powder producers, six companies were known to produce cobalt compounds. Nearly 90 industrial consumers were surveyed on a monthly or annual basis. Data reported by these consumers indicate that approximately 47% of U.S. cobalt use was in superalloys, which are used primarily in aircraft gas turbine engines; 8% was in cemented carbides for cutting and wear-resistant applications; 20% was in various other metallic uses; and the remaining 25% was in a variety of chemical uses. The total estimated value of cobalt consumed in 2003 was $200 million.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production:					
Mine	—	—	—	—	—
Secondary	2,720	2,550	2,780	2,800	2,200
Imports for consumption	8,150	8,770	9,410	8,450	8,000
Exports	1,550	2,630	3,210	2,080	2,500
Shipments from Government stockpile excesses	1,530	2,960	3,050	524	2,200
Consumption:					
Reported (includes secondary)	8,660	8,980	9,540	7,930	8,000
Apparent (includes secondary)	10,700	11,600	11,800	9,860	10,000
Price, average annual spot for cathodes, dollars per pound	17.02	15.16	10.55	6.91	9.40
Stocks, industry, yearend	1,160	1,180	1,370	1,200	1,100
Net import reliance[1] as a percentage of apparent consumption	75	78	76	72	78

Recycling: An estimated 2,200 tons of cobalt was recycled from purchased scrap in 2003. This represented 28% of estimated reported consumption for the year.

Import Sources (1999-2002): Cobalt content of metal, oxide, and salts: Finland, 24%; Norway, 18%; Russia, 13%; Canada, 10%; and other, 35%.

Tariff: Item	**Number**	**Normal Trade Relations[2] 12/31/03**
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 sulfates	2833.29.1000	1.4% ad val.
Cobalt chlorides	2827.34.0000	4.2% ad val.
Cobalt carbonates	2836.99.1000	4.2% ad val.
Cobalt acetates	2915.23.0000	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 Annual Materials Plan of the Defense Logistics Agency, U.S. Department of Defense, includes a cobalt disposal limit of 2,720 tons (6 million pounds) during fiscal year 2004.

Stockpile Status—9-30-03[3]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2003**	**Disposals FY 2003**
Cobalt	4,620	306	4,620	2,720	2,060

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

COBALT

Events, Trends, and Issues: World production of refined cobalt has steadily increased since 1993. Some of the increase has been from new operations, and some has been from a net increase in production by established producers. During this period, sales of cobalt from the National Defense Stockpile and cobalt in recycled scrap have also contributed to supply. Estimated availability of refined cobalt increased in 2003. World refinery production during the first half of the year was slightly higher than that of the first half of 2002 and shipments of cobalt from the Defense National Stockpile Center were significantly higher during the first 9 months of 2003 than during the entire year of 2002.

World demand for cobalt is strongly influenced by general economic conditions and by demand from industries that consume large quantities of cobalt, such as superalloy melters and manufacturers of rechargeable batteries. In 2003, demand for cobalt was affected by continued weak general economic conditions and depressed demand from the superalloy sector, which used cobalt to make turbine engine parts for jet aircraft and land-based energy-generating turbines. Demand for cobalt to manufacture rechargeable batteries for portable electronic devices such as cellular phones increased, however.

Cobalt prices increased in 2003, reportedly as a result of tightness in supply. The estimated annual average price of cobalt for 2003 was higher than that of 2002, reversing the steady downward trend in annual average cobalt prices that began in 1996.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2002	2003[e]		
United States	—	—	NA	860,000
Australia	6,700	6,600	1,500,000	1,700,000
Brazil	1,200	1,300	35,000	40,000
Canada	5,100	4,700	90,000	300,000
Congo (Kinshasa)	12,500	10,000	3,400,000	4,700,000
Cuba	3,400	3,200	1,000,000	1,800,000
Morocco	1,300	1,300	20,000	NA
New Caledonia[5]	1,400	1,400	230,000	860,000
Russia	4,600	5,000	250,000	350,000
Zambia	10,000	12,000	270,000	680,000
Other countries	1,400	1,400	200,000	1,500,000
World total (may be rounded)	47,600	46,900	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; 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; iron, manganese, or nickel in batteries; and manganese, iron, cerium, or zirconium in paints.

[e]Estimated. NA Not available. — Zero.
[1]Defined as imports – exports + adjustments for Government and industry stock changes.
[2]No tariff for Canada or Mexico.
[3]See Appendix B for definitions.
[4]See Appendix C for definitions.
[5]Overseas territory of France.

COLUMBIUM (NIOBIUM)

(Data in metric tons of columbium content, unless otherwise noted)

Domestic Production and Use: There has been no significant domestic columbium mining since 1959. Domestic columbium resources are of low grade, some mineralogically complex, and most are not commercially recoverable. Most metal, ferrocolumbium, other alloys, and compounds were produced by five companies. Feed for these plants included imported concentrates, columbium oxide, and ferrocolumbium. Consumption was mainly as ferrocolumbium by the steel industry and as columbium alloys and metal by the aerospace industry, with plants in the Eastern and Midwestern United States, California, and Washington. The estimated value of reported columbium consumption, in the form of ferrocolumbium and nickel columbium, in 2003, was about $72 million. Major end-use distribution of reported columbium consumption was as follows: superalloys, 25%; carbon steels, 21%; high-strength low-alloy steels, 20%; stainless and heat-resisting steels, 18%; alloy steels, 15%; and other, 1%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, mine	—	—	—	—	—
Imports for consumption:					
Mineral concentrates[e]	140	300	290	290	220
Columbium metal and alloys[e]	468	607	1,050	673	870
Columbium oxide[e]	1,200	1,190	1,360	660	760
Ferrocolumbium[e]	4,450	4,400	4,480	4,030	4,000
Exports, concentrate, metal, alloys[e]	160	100	110	100	140
Government stockpile releases[e, 1]	280	217	(4)	9	182
Consumption, reported, ferrocolumbium[e, 2]	3,460	4,090	4,230	3,150	3,500
Consumption, apparent	4,100	4,300	4,400	4,100	4,300
Price:					
Columbite, dollars per pound[3]	3.00	6.25	NA	NA	NA
Ferrocolumbium, dollars per pound[4]	6.88	6.88	6.88	6.60	6.58
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Columbium was mostly recycled from products of columbium-bearing steels and superalloys; little was recovered from products specifically for their columbium content. Detailed data on the quantities of columbium recycled are not available but may compose as much as 20% of apparent consumption.

Import Sources (1999-2002): Brazil, 71%; Canada, 9%; Estonia, 5%; Germany, 4%; and other, 11%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Columbium ores and concentrates	2615.90.6030	Free.
Columbium oxide	2825.90.1500	3.7% ad val.
Ferrocolumbium:		
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.
Columbium, unwrought:		
Waste and scrap	8112.92.0500	Free.
Alloys, metal, powders	8112.92.4000	4.9% ad val.
Columbium, other	8112.99.0100	4.0% ad val.

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

Government Stockpile: For fiscal year 2003, the Defense National Stockpile Center (DNSC) disposed of about 182 tons of columbium contained in columbium-tantalum mineral concentrates from the National Defense Stockpile (NDS). There were no sales of columbium metal in fiscal year 2003. The DNSC's ferrocolumbium inventory was exhausted in fiscal year 2001, and its columbium carbide inventory was exhausted in fiscal year 2002. The DNSC announced maximum disposal limits in fiscal year 2004 of about 254 tons of columbium contained in columbium concentrates and about 9 tons of columbium metal ingots. The NDS uncommitted inventories shown below include about 96 tons of columbium contained in nonstockpile-grade columbium concentrates.

Prepared by **Larry D. Cunningham [(703) 648-4977, lcunning@usgs.gov, fax: (703) 648-7757]**

COLUMBIUM (NIOBIUM)

Stockpile Status—9-30-03[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Columbium:					
Carbide powder	—	—	—	[7]10	—
Concentrates	412	113	412	254	182
Ferrocolumbium	—	—	—	—	—
Metal	37	—	37	9	—

Events, Trends, and Issues: For the first half of 2003, domestic demand for columbium ferroalloys in steelmaking and demand for columbium in superalloys (mostly for aircraft engine components) increased compared with the same period of 2002. For the same period, overall columbium imports increased; Brazil accounted for about 60% of quantity and about 40% of value. Exports also increased; Brazil, Canada, China, Mexico, and Japan were the major recipients of the columbium materials. There were no published price quotes for columbium-bearing columbite and pyrochlore concentrates. The published price for standard-grade (steelmaking-grade) ferrocolumbium was quoted at a range of $6.45 to $6.70 per pound of columbium content. The published price for high-purity ferrocolumbium was discontinued in February-March 2002 at a range of $17.50 to $18 per pound of columbium content. Industry sources indicated in December 1999 that nickel columbium sold at about $18.50 per pound of columbium content, columbium metal products sold in the range of about $24 to $100 per pound in ingot and special shape forms, and columbium oxide for master alloy production sold for about $8.80 per pound. Public information on current prices for these columbium products was not available; pricing is normally established by negotiation between buyer and seller.

World Mine Production, Reserves, and Reserve Base: The reserves estimate for Canada has been revised based on new information from that country.

	Mine production		Reserves[8]	Reserve base[8]
	2002	2003[e]		
United States	—	—	—	Negligible
Australia	290	250	29,000	NA
Brazil	26,000	26,000	4,300,000	5,200,000
Canada	3,410	3,400	110,000	NA
Congo (Kinshasa)	50	50	NA	NA
Ethiopia	6	5	NA	NA
Mozambique	5	5	NA	NA
Nigeria	30	30	NA	NA
Rwanda	76	80	NA	NA
Uganda	3	3	NA	NA
Other countries[9]	—	—	NA	NA
World total (rounded)	29,900	29,800	4,400,000	5,200,000

World Resources: Most of the world's identified resources of columbium are outside the United States and occur mainly as pyrochlore in carbonatite deposits. On a worldwide basis, resources are more than adequate to supply projected needs. The United States has approximately 150,000 tons of columbium resources in identified deposits, all of which were considered uneconomic at 2003 prices for columbium.

Substitutes: The following materials can be substituted for columbium, 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]Net quantity (uncommitted inventory). Parentheses indicate negative number (increase in inventory).
[2]Includes nickel columbium.
[3]Yearend average value, contained pentoxides for material having a Nb_2O_5 to Ta_2O_5 ratio of 10 to 1.
[4]Yearend average value, contained columbium, standard (steelmaking) grade.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]See Appendix B for definitions.
[7]Actual quantity limited to remaining sales authority or inventory.
[8]See Appendix C for definitions.
[9]Bolivia, Burundi, China, Russia, Zambia, and Zimbabwe also produce (or are believed to produce) columbium mineral concentrates, but available information is inadequate to make reliable estimates of output levels.

COPPER

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

Domestic Production and Use: Domestic mine production in 2003 declined to 1.12 million tons and was valued at about $2.0 billion. The principal mining States, in descending order, Arizona, Utah, and New Mexico, accounted for 99% of domestic production; copper was also recovered at mines in three other States. Although copper was recovered at 22 mines operating in the United States, just 13 mines accounted for more than 99% of production. Three primary smelters, 4 electrolytic and 3 fire refineries, and 12 solvent extraction-electrowinning facilities operated during the year. Refined copper and direct melt scrap were consumed at about 30 brass mills; 15 rod mills; and 500 foundries, chemical plants, and miscellaneous consumers. Copper and copper alloy products were used in building construction, 46%; electric and electronic products, 23%; transportation equipment, 10%; industrial machinery and equipment, 10%; and consumer and general products, 11%.[1]

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production:					
Mine	1,600	1,450	1,340	1,140	1,120
Refinery:					
Primary	1,890	1,590	1,630	1,440	1,270
Secondary	230	209	172	70	60
Copper from all old scrap	381	357	316	207	210
Imports for consumption:					
Ores and concentrates	143	([2])	46	72	10
Refined	837	1,060	991	927	860
Unmanufactured	1,280	1,350	1,400	1,230	1,100
Exports:					
Ores and concentrates	64	116	45	23	14
Refined	25	94	23	26	80
Unmanufactured	395	650	556	506	680
Consumption:					
Reported refined	2,980	3,030	2,620	2,370	2,270
Apparent unmanufactured[3]	3,130	3,100	2,500	2,610	2,370
Price, average, cents per pound:					
Domestic producer, cathode	75.9	88.2	76.9	75.8	82
London Metal Exchange, high-grade	71.3	82.2	71.6	70.7	78
Stocks, yearend, refined, held by U.S. producers, consumers, and metal exchanges	565	334	952	1,030	740
Employment, mine and mill, thousands	10.3	9.1	8.2	7.0	6.8
Net import reliance[4] as a percentage of apparent consumption	27	37	22	37	38

Recycling: Old scrap, converted to refined metal and alloys, provided 210,000 tons of copper, equivalent to 9% of apparent consumption. Purchased new scrap, derived from fabricating operations, yielded 770,000 tons of contained copper; about 87% 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-base scrap), brass mills recovered 70%; copper smelters and refiners, 6%; ingot makers, 12%; and miscellaneous manufacturers, foundries, and chemical plants, 12%. Copper in all old and new, refined or remelted scrap contributed 31% of the U.S. copper supply.

Import Sources (1999-2002): Unmanufactured: Canada, 29%; Peru, 25%; Chile, 25%; Mexico, 13%; and other, 8%. Refined copper accounted for 72% of unwrought copper imports.

Tariff: **Item**	**Number**	**Normal Trade Relations[5] 12/31/03**
Copper ores and concentrates	2603.00.0000	1.7¢/kg 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 stockpile of about 20,000 tons of refined copper was liquidated in 1993. The stockpile of about 8,100 tons of brass was liquidated in 1994. 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: Following an interruption in 2002, world mine production resumed its upward trend. This happened despite production cutbacks at mines in the United States, Chile, and Peru that were intended to help reduce global oversupply. Chile accounted for most of the increase in global mine production and capacity (650,000 tons) principally owing to completion of the phase 4 expansion of the Escondida Mine. According to preliminary data compiled by the International Copper Study Group,[6] global production of refined copper for the first 7 months of 2003 declined by over 150,000 tons compared with the same period of 2002, while world use of refined copper, buoyed by a 16% rise in apparent use in China, increased by about 275,000 tons. As a result, the production surplus of the preceding years was reversed, and reported global inventories declined by about 300,000 tons. Copper prices rose accordingly; the COMEX spot price averaged $0.82 per pound in September, the highest level since February 2001.

Production cutbacks in the United States from prior years carried forward into 2003. ASARCO Incorporated reduced production at its Mission Mine in Arizona to about 22,000 tons per year, dropping its operating rate to just 15% of capacity. The cutback also affected downstream operations at the company's Hayden, AZ, smelter and its Amarillo, TX, refinery.[7] Asarco was granted permission by the U.S. Department of Justice to sell its interest in Southern Peru Copper Corp. A continued slump in domestic copper consumption of both wire and brass mill products was attributed by industry to weak commercial construction, telecommunications, and numismatic markets; industry destocking; and rising imports of manufactured items, especially from China, now the world's largest consumer of copper. (For details, see USGS Mineral Industry Surveys, Copper in June 2002). Except for the anticipated restart of one mine in Montana that closed in 2000 owing to high utility costs, little change in the domestic market is projected for 2004.

World Mine Production, Reserves, and Reserve Base: Official reserves data reported by Poland may include properties being considered for future development. Revisions to other countries were based on updated tabulations of resources reported by companies on individual properties.

	Mine production		Reserves[8]	Reserve base[8]
	2002	2003[e]		
United States	1,140	1,120	35,000	70,000
Australia	883	870	24,000	43,000
Canada	600	580	7,000	20,000
Chile	4,580	4,860	150,000	360,000
China	585	565	26,000	63,000
Indonesia	1,160	1,170	32,000	38,000
Kazakhstan	490	480	14,000	20,000
Mexico	330	330	27,000	40,000
Peru	843	850	30,000	60,000
Poland	503	500	30,000	48,000
Russia	695	700	20,000	30,000
Zambia	330	330	19,000	35,000
Other countries	1,500	1,500	60,000	110,000
World total (rounded)	13,600	13,900	470,000	940,000

World Resources: Land-based resources are estimated to be 1.6 billion tons of copper, and resources in deep-sea nodules are estimated to be 700 million tons. In the United States, discovered resources are estimated to contain 350 million tons of copper, and undiscovered deposits are estimated to contain 290 million tons of copper.

Substitutes: Aluminum substitutes for copper in various products, such as electrical power cables, electrical equipment, automobile radiators, and cooling/refrigeration tubing. In some applications, titanium and steel are used in heat exchangers, and steel is used for artillery shell casings. Optical fiber substitutes for copper in some telecommunications applications. Plastics also substitute for copper in water pipe, plumbing fixtures, and many structural applications.

[e]Estimated.
[1]Some electrical components are included in each end use. Distribution by Copper Development Association, 2002.
[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. In 1999, 2000, 2001, 2002, and 2003, general imports of 915,000 tons, 1,020,000 tons, 1,200,000 tons, 1,060,000 tons, and 680,000 tons, respectively, 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.
[6]International Copper Study Group, 2003, Copper Bulletin: Lisbon, Portugal, International Copper Study Group, v. 10, no. 10, October, 46 p.
[7]ASARCO Incorporated, 2002, Asarco to reduce Mission Unit copper production to 15 percent of total capacity: Phoenix, AZ, ASARCO Incorporated press release, December 20, 1 p.
[8] See Appendix C for definitions.

DIAMOND (INDUSTRIAL)

(Data in million carats, unless otherwise noted)

Domestic Production and Use: In 2003, domestic production was estimated at approximately 236 million carats, and the United States remained the world's largest market for industrial diamond. 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), stone cutting/polishing, and transportation systems (infrastructure and vehicles). Stone cutting and highway building and repair consumed most of the industrial stone. More than 90% of the 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:	1999	2000	2001	2002	2003[e]
Bort, grit, and dust and powder; natural and synthetic:					
Production:					
Manufactured diamond[e]	161	182	202	219	236
Secondary	10	10	10	5.7	5.1
Imports for consumption	208	291	281	185	223
Exports[1]	98	98	88	82	66
Sales from Government stockpile excesses	([2])	—	—	—	—
Consumption, apparent	281	385	405	328	398
Price, value of imports, dollars per carat	0.44	0.39	0.31	0.34	0.29
Net import reliance[3] as a percentage of apparent consumption	39	50	48	31	39
Stones, natural:					
Production:					
Mine	([2])	([2])	([2])	—	—
Secondary	([2])	([2])	([2])	([2])	([2])
Imports for consumption[4]	3.1	2.5	2.5	2.1	1.6
Exports[1]	0.7	1.6	1.0	1.1	0.8
Sales from Government stockpile excesses	0.6	1.0	0.5	0.4	0.3
Consumption, apparent	3.4	2.2	2.2	1.6	1.4
Price, value of imports, dollars per carat	4.61	5.31	3.54	5.43	2.46
Net import reliance[3] as a percentage of apparent consumption	88	86	91	88	80

Recycling: In 2003, the amount of diamond bort, grit, and dust and powder recycled was estimated to be 4.8 million carats. Lower prices and greater competition appear to be reducing the number and scale of diamond stone recycling operations. In 2003, it was estimated that 273 thousand carats of diamond stone were recycled.

Import Sources (1999-2002): Bort, grit, and dust and powder; natural and synthetic: Ireland, 42%; China, 19%; Ukraine, 16%; and other, 23%. Stones, primarily natural: Switzerland, 25%; Russia, 19%; United Kingdom, 17%; Ireland, 14%; and other, 25%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Miners' diamond, carbonados	7102.21.1010	Free.
Other	7102.21.1020	Free.
Industrial diamond, natural advanced	7102.21.3000	Free.
Industrial diamond, natural not advanced	7102.21.4000	Free.
Industrial diamond, other	7102.29.0000	Free.
Grit or dust and powder	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—9-30-03[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Industrial stones	0.513	0.388	0.513	0.600	0.284

Events, Trends, and Issues: The United States will continue to be the world's largest 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. 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 grit and powder are expected to be 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 increases.

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

	Mine production		Reserves[7]	Reserve base[7]
	2002	2003[e]		
United States	([2])	([2])	NA	NA
Australia	18.5	19.0	90	230
Botswana	7.1	9.0	130	225
China	1.0	1.0	10	20
Congo (Kinshasa)	9.1	15.0	150	350
Russia	11.5	11.8	40	65
South Africa	6.5	6.7	70	150
Other countries	1.4	3.0	85	210
World total (rounded)	55.2	65.5	580	1,250

World Resources: Natural diamond resources have been discovered in more than 35 countries. Natural diamond accounts for about 9% 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 more than 90% 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]Less than ½ unit.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[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 614 million carats in 2001; the largest producers included Ireland, Japan, Russia, and the United States.
[7]See Appendix C for definitions.

DIATOMITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: The estimated value of processed diatomite, f.o.b. plant, was $159 million in 2003. Production was from 7 companies with 13 processing facilities in 4 States. California and Nevada were the principal producing States and accounted for about 70% of U.S. production in 2003. Estimated end uses of diatomite were filter aids, 68%; absorbents, 14%; fillers, 12%; and other (mostly cement manufacture), 6%.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production[1]	747	677	644	624	625
Imports for consumption	2	([2])	([2])	([2])	2
Exports	123	131	148	128	39
Consumption, apparent	625	546	546	497	588
Price, average value, dollars per ton, f.o.b. plant	238	256	270	255	254
Stocks, producer, yearend	36	36	36	36	36
Employment, mine and plant, number[e]	1,000	1,000	1,000	1,000	1,000
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: None.

Import Sources (1999-2002): France, 61%; Italy, 21%; Mexico, 10%; and other, 8%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/03**
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: Filtration (including purification of beer, wine, liquors, oils, and greases) continued to be the largest end use for diatomite, also known as diatomaceous earth (D.E.). Other applications include the removal of microbial contaminants, such as bacteria, viruses, and protozoa, in public water systems, and the filtration of human blood plasma. D.E. filter aids have been successfully deployed in about 200 locations throughout the United States for the treatment of potable water. Emerging small-scale applications for diatomite include 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]
	2002	2003[e]		
United States[1]	624	625	250,000	500,000
China	370	370	110,000	410,000
Commonwealth of Independent States	80	80	NA	13,000
Czech Republic	35	35	4,500	4,800
Denmark[5] (processed)	28	30	NA	NA
France	75	75	NA	2,000
Japan	180	180	NA	NA
Korea, Republic of	30	21	NA	NA
Mexico	70	65	NA	2,000
Peru	35	35	2,000	5,000
Spain	36	36	NA	NA
Other countries	170	170	550,000	NA
World total (rounded)	1,730	1,720	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 for many applications. Expanded perlite and silica sand compete for filtration purposes. Other filtration technologies use ceramic, polymeric, or carbon membrane. Alternate filler materials include talc, ground silica sand, ground mica, clay, perlite, vermiculite, and ground limestone. For thermal insulation, materials such as various clays and special brick, mineral wool, expanded perlite, and exfoliated vermiculite 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 2003 had an estimated value of about $44 million. The three largest producers accounted for about 70% of the production, with six other companies supplying the remainder. Operations in North Carolina provided over 40% of the output; facilities in Virginia, California, Georgia, Oklahoma, Idaho, and South Dakota, in estimated descending order of 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 2003 end-use distribution of domestic feldspar was glass, 67%, and pottery and other, 33%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, marketable[e]	875	790	800	790	800
Imports for consumption	7	7	6	5	9
Exports	10	11	5	10	10
Consumption, apparent[e]	872	786	801	785	799
Price, average value, marketable production, dollars per ton[e]	49.00	56.00	55.00	54.00	55.00
Stocks, producer, yearend[1]	NA	NA	NA	NA	NA
Employment, mine and preparation plant, number[e]	400	400	400	400	400
Net import reliance[2] as a percentage of apparent consumption	E	E	([3])	E	E

Recycling: Insignificant.

Import Sources (1999-2002): Mexico, 96%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Feldspar	2529.10.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Glass, including containers and insulation for housing and building construction, continued to be the largest end use of feldspar in the United States. U.S. shipments of glass containers were about 5% less in the first 8 months of 2003 than in the comparable period of 2002, according to the U.S. Census Bureau.

Favorable activity in the U.S. housing construction market helped maintain feldspar usage in tile and vitreous plumbing fixtures at or above 2002 levels. U.S. housing starts for the first 8 months of 2003 were about 5% higher than in the comparable period of 2002, according to the U.S. Census Bureau.

Turkey, which began producing feldspar in the 1980s, became the world's second largest producer in 2003, after Italy (and excluding Asia). Some sources show Turkish exports of feldspar to be around 2.3 million tons in 2002. However, Turkish feldspar producers have faced some challenges in 2003, including increased costs for diesel fuel, electricity, materials, and labor. In response to increasing demand for higher quality feldspar, Turkish producers are turning to more sophisticated methods of production and ore dressing.[4]

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

FELDSPAR

World Mine Production, Reserves, and Reserve Base:

	Mine production 2002	Mine production 2003[e]	Reserves and reserve base[5]
United States[e]	790	800	Quantitative estimates of reserves and reserve base are not available.
Argentina	60	60	
Australia	50	50	
Brazil	100	75	
Colombia	55	55	
Czech Republic	300	400	
Egypt	350	350	
France	650	650	
Germany	450	450	
Greece	95	100	
India	110	150	
Iran	250	250	
Italy	2,500	2,500	
Japan	50	50	
Korea, Republic of	390	420	
Mexico	325	330	
Norway	75	75	
Poland	200	200	
Portugal	120	125	
South Africa	57	54	
Spain	450	450	
Thailand	540	700	
Turkey	1,200	1,700	
Venezuela	140	140	
Other countries	493	270	
World total (rounded)	9,800	10,400	

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]Less than ½ unit.
[4]Crossley, Penney, 2003, A feast of feldspar: Industrial Minerals, no. 432, September, p. 36-49.
[5]See Appendix C for definitions.

FLUORSPAR

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: There was no domestic mining of fluorspar in 2003. 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 80% 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 20% of the reported fluorspar consumption was as a flux in steelmaking, in iron and steel foundries, primary aluminum production, glass manufacture, enamels, welding rod coatings, cement production, and other uses or products. An estimated 52,000 tons of fluorosilicic acid (equivalent to 92,000 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:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production:					
Finished, all grades[1]	—	NA	NA	—	—
Fluorspar equivalent from phosphate rock	122	119	104	92	92
Imports for consumption:					
Acid grade	419	484	495	466	510
Metallurgical grade	59	39	27	28	35
Total fluorspar imports	478	523	522	494	545
Fluorspar equivalent from hydrofluoric acid plus cryolite	192	208	176	182	200
Exports[2]	55	40	21	24	30
Shipments from Government stockpile	131	106	65	23	75
Consumption:					
Apparent[3]	615	601	543	442	590
Reported	514	512	536	588	574
Stocks, yearend, consumer and dealer[4]	373	289	221	245	217
Employment, mine and mill, number	—	5	5	—	—
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: An estimated 8,000 to 10,000 tons per year of synthetic fluorspar is recovered primarily from uranium enrichment, but also from stainless steel pickling and petroleum alkylation. Primary aluminum producers recycled HF and fluorides from smelting operations. HF is recycled in the petroleum alkylation process.

Import Sources (1999-2002): China, 66%; South Africa, 22%; and Mexico, 12%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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 2003, there were no fluorspar sales from the Defense National Stockpile. Under the proposed fiscal year 2004 Annual Materials Plan, the Defense National Stockpile Center will be authorized to sell 54,400 metric tons (60,000 short dry tons) of metallurgical grade and 10,900 tons (12,000 short dry tons) of acid grade.

Stockpile Status—9-30-03[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Acid grade	7	80	11	11	—
Metallurgical grade	82	13	54	54	—

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

FLUORSPAR

Events, Trends, and Issues: China cut its fluorspar export quotas for 2003 to 850,000 tons. This is the second year in a row that China has cut exports, and during that period, exports have decreased by 300,000 tons. This has resulted in short supplies and rising prices. Other producers are likely to attempt to increase production, but short of new mine development, there is no way to make up for the entire Chinese shortfall. There are prospects for new mine development in Australia, Canada, Mexico, and Vietnam, but even if any of these projects are completed, it will still be several years before significant new production is seen.

The European Commission of the European Union (EU) has prepared draft legislation to reduce emissions of fluorinated gases in the EU by 25% by 2010. The Commission's regulations target combined emissions of hydrofluorocarbons (HFCs), perfluorocarbons, and sulfur hexafluoride and call for a phaseout of HFC-134a in air-conditioning systems in new vehicles between 2009 and 2013. The regulations will require approval by all 15 EU member nations and the European Parliament. If approved, the regulations will negatively affect future fluorspar and fluorochemical demand in Europe.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7, 8]	Reserve base[7, 8]
	2002	2003[e]		
United States	—	—	NA	6,000
China	2,450	2,450	21,000	110,000
France	105	110	10,000	14,000
Kenya	98	100	2,000	3,000
Mexico	650	630	32,000	40,000
Mongolia	200	190	12,000	16,000
Morocco	96	95	NA	NA
Namibia	[9]81	[9]85	3,000	5,000
Russia	200	200	Moderate	18,000
South Africa	227	240	41,000	80,000
Spain	130	125	6,000	8,000
Other countries	310	320	110,000	180,000
World total (rounded)	4,550	4,540	230,000	480,000

World Resources: Identified world fluorspar resources were approximately 500 million tons of contained fluorspar. Resources of equivalent fluorspar from domestic phosphate rock were approximately 32 million tons. World resources of fluorspar from phosphate rock were estimated at 330 million tons.

Substitutes: Olivine and/or dolomitic limestone were used as substitutes for fluorspar. Byproduct fluorosilicic acid from phosphoric acid production was used as a substitute in aluminum fluoride production, and the potential also exists to use it as a substitute in HF production.

[e]Estimated. NA Not available. — Zero.
[1]Shipments.
[2]Exports are all general imports reexported or National Defense Stockpile material exported.
[3]Excludes fluorspar equivalent of fluorosilicic acid, hydrofluoric acid, and cryolite.
[4]Industry stocks for three largest consumers, fluorspar distributors, and National Defense Stockpile material committed for sale pending shipment.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]See Appendix B for definitions.
[7]See Appendix C for definitions.
[8]Measured as 100% calcium fluoride.
[9]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 2003. One company in Oklahoma 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 $4 million, most of which was low-purity material. Gallium arsenide (GaAs) and gallium nitride (GaN) components represented about 98% of domestic gallium consumption. About 42% of the gallium consumed was used in optoelectronic devices, which include light-emitting diodes (LEDs), laser diodes, photodetectors, and solar cells. Integrated circuits represented 49% of gallium demand. The remaining 9% was used in research and development, specialty alloys, and other applications. Optoelectronic devices were used in areas such as aerospace, consumer goods, industrial components, medical equipment, and telecommunications. Integrated circuits were used in defense applications, high-performance computers, and telecommunications.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, primary	—	—	—	—	—
Imports for consumption	24,100	39,400	27,100	13,100	18,000
Exports	NA	NA	NA	NA	NA
Consumption:					
Reported	29,800	39,900	27,700	18,600	26,000
Apparent	NA	NA	NA	NA	NA
Price, yearend, dollars per kilogram, 99.99999%-pure	640	640	640	[1]530	[1]530
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 apparent consumption	NA	NA	NA	NA	NA

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

Import Sources (1999-2002): France, 43%; China, 19%; Kazakhstan, 12%; Russia, 8%; and other, 18%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Gallium metal	8112.92.1000	3.0% ad val.
Gallium arsenide wafers, undoped	2851.00.0010	2.8% ad val.
Gallium arsenide wafers, doped	3818.00.0010	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: A management group from the gallium recovery facility in Oklahoma that was closed in 2002 purchased the company's gallium assets in 2003 and formed a spinoff. The new company's product lines were expected to remain the same (gallium trichloride and 99.99999%-pure gallium metal), but it would not be recovering gallium from GaAs or other scrap material. The new firm also was based in Oklahoma.

Imports continued to supply almost all U.S. demand for gallium and increased from those in 2002 because of a rebound in the wireless communications industry. Using partial-year data, China, Ukraine, Russia, and Hungary were the principal U.S. gallium suppliers in 2003. Although U.S. consumption of GaAs is increasing because of a rebound in the demand for cellular telephones, the quantity of imports of gallium metal into the United States has not increased as significantly. This is because a significant portion of the GaAs wafer manufacturing industry moved to areas such as the Republic of Korea and Taiwan. To compensate for the decrease in the quantity of metal imports, imports of GaAs wafers are increasing. By July 2003, the quantity of undoped GaAs wafers imported into the United States was higher than that for 2002.

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

GALLIUM

Gallium prices began to rise slowly in the second half of 2003, reflecting an increase in demand. The price of low-purity gallium from China was estimated to be about $250 per kilogram at midyear, compared with about $200 per kilogram at the beginning of 2003. Prices for 99.9999%-pure gallium in the United States were estimated to be about $400 per kilogram.

Worldwide shipments of mobile phone handsets rose in the first half of 2003, compared with shipments in the same period of 2002. Global cellular telephone sales are split into two separate markets—mature markets like Western Europe and North America, where replacement growth is driving sales, and emerging markets like Africa, parts of Eastern Europe, and China, where new sales are fueling customer demand. As a result, the highest growth is in the emerging markets. In the mature markets, manufacturers are relying on customers to upgrade to more expensive, feature-rich, color phones with cameras and games to drive growth. Research and development work continued on GaN, primarily to commercialize blue and violet LEDs and laser diodes.

The company that purchased the 50-ton-per-year gallium extraction facility in Pinjarra, Western Australia, in 1999 chose to keep the facility dormant until there is improvement in the global market for gallium that would be sufficient to support the investment needed to operate the plant. The company also entered into a long-term contract with the owner of a nearby alumina extraction plant for the use of its Bayer liquor stream for the extraction of gallium.

World Production, Reserves, and Reserve Base: 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 2003, world primary production was estimated to be about 64 metric tons, about the same as that in 2002. China, Germany, Japan, and Russia were the largest producers; countries with smaller output were Hungary, Kazakhstan, Slovakia, and Ukraine. Refined gallium production was estimated to be about 83 metric tons; this figure includes some scrap refining. France was the largest producer of refined gallium, using as feed material crude gallium produced in Germany. Japan and the United States were the other large gallium-refining countries. Gallium was recycled from new scrap in Germany, Japan, the United Kingdom, and the United States.

Gallium occurs in very small concentrations in many rocks and 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:[3] 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 are also 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 integrated circuits 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]Producer published price series was discontinued. The prices shown for 2002-3 are the estimated 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 2003 by three firms, one in Idaho and two in New York. The estimated value of crude garnet production was about $3.9 million, while refined material sold or used had an estimated value of $10.8 million. Major end uses for garnet were abrasive blasting media, 35%; waterjet cutting, 30%; water filtration, 15%; abrasive powders, 10%; and other end uses, 10%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production (crude)	60,700	60,200	52,700	38,500	38,700
Sold by producers	43,900	51,900	46,200	37,500	34,100
Imports for consumption[e]	12,000	23,000	23,000	23,000	28,400
Exports[e]	10,000	10,000	10,000	10,400	10,900
Consumption, apparent[e]	33,700	66,300	59,300	51,400	58,900
Price, range of value, dollars per ton[2]	50-2,000	55-2,000	50-2,000	50-2,000	50-2,000
Stocks, producer[e]	52,100	50,100	50,000	48,700	16,700
Employment, mine and mill, number	220	220	220	200	180
Net import reliance[3] as a percentage of apparent consumption	E	23	22	27	56

Recycling: Small amounts of garnet reportedly are recycled.

Import Sources (1999-2002):[e] Australia, 47%; India, 35%; China, 17%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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 2003, U.S. garnet consumption increased 15%, while domestic production of crude garnet concentrates only increased slightly from that of 2002. In 2003, imports were estimated to have increased more than 23% compared with 2002, and exports were estimated to have increased about 5% from those of 2002. The 2003 domestic sales of garnet declined 9% from the 2002 level. Since 1999, the United States has moved from being a net exporter to being a net importer. Garnet imports have displaced U.S. production in the domestic market, with Australia, China, and India becoming major garnet suppliers.

In 2003, neither of Montana's garnet producers reported any production, and both operations may be sold. One of the New York garnet producers closed its quarry at the end of 2002 and has only processed stocks during 2003.

The garnet market is very competitive, and for that reason, there is a need to keep production costs to a minimum by developing deposits where garnet is produced in combination with other minerals. Demand is expected to rise owing to increased demand in blasting and other markets.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2002	2003[e]		
United States	38,500	38,700	5,000,000	25,000,000
Australia	127,000	130,000	1,000,000	7,000,000
China	27,000	27,000	Moderate to Large	Moderate to Large
India	63,000	63,000	90,000	5,400,000
Other countries	21,000	21,000	6,500,000	20,000,000
World total (rounded)	277,000	280,000	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, and other significant domestic resources of garnet occur in Idaho, Maine, Montana, New Hampshire, North Carolina, and Oregon. In addition to 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. E Net exporter.

[1]Excludes gem and synthetic garnet.

[2]Includes both crude and refined garnet; most crude concentrate is \$50 to \$150 per ton, and most refined material is \$150 to \$450 per ton.

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

[4]See Appendix C for definitions.

GEMSTONES[1]

(Data in million dollars, unless otherwise noted)

Domestic Production and Use: The combined U.S. natural and synthetic gemstone output increased by 46% in 2003 from that of 2002. Production of natural gemstones decreased by 13% during 2003, primarily owing to a decreased domestic production of pearls and opal. Domestic gemstone production included agates, amber, beryl, coral, garnet, jade, jasper, opal, pearl, quartz, sapphire, shell, topaz, tourmaline, turquoise, and many other gem materials. In decreasing order, Tennessee, Arizona, Oregon, California, Arkansas, Nevada, Idaho, and Montana produced 80% of U.S. natural gemstones. Production of synthetic gemstones increased by 88% during the year, owing to large increases in the production of moissanite. Reported output of synthetic gemstones was from five firms in North Carolina, New York, Florida, Michigan, and Arizona, in decreasing order of production. Major uses were jewelry, carvings, and gem and mineral collections.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:[2]					
Natural[3]	16.1	17.2	15.1	12.6	10.9
Synthetic	47.5	37.1	24.7	18.1	33.9
Imports for consumption	10,700	12,900	11,400	12,900	11,800
Exports, including reexports[4]	3,610	4,330	4,330	4,700	5,070
Consumption, apparent[5]	7,150	8,620	7,110	8,230	6,770
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 (1999-2002 by value): Israel, 42%; India, 21%; Belgium, 19%; and other, 18%. Diamond imports accounted for 94% of the total value of gem imports.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Diamonds, 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, cut but not set	7103.99.1000	Free.
Other precious stones	7103.99.5000	10.5% ad val.
Imitation precious stones	7018.10.2000	Free.
Synthetic cut, but not set	7104.90.1000	Free.
Pearls, natural	7101.10.0000	Free.
Pearls, cultured	7101.21.0000	Free.
Pearls, imitation, not strung	7018.10.1000	4.0% ad val.

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 materials 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 2003, the U.S. market for unset gem-quality diamonds was estimated to be more than $12.1 billion, accounting for more than one-third of world demand. The domestic market for natural, unset nondiamond gemstones was estimated at about $788 million. The United States is expected to dominate global gemstone consumption throughout this decade.

The United Nations mandated the Kimberley Process Certification Scheme for rough diamond shipments in 2001. This process was implemented during 2002. The U.S. Congress enacted the Clean Diamond Trade Act, and the President signed it into law on April 25, 2003. This law makes the United States a full participant in the Kimberley Process, and U.S. participation is critical to the scheme's success in excluding conflict diamonds from the legitimate supply chain.

Canada's Ekati Mine completed its fourth full year in 2002, with diamond production of 4.98 million carats. The Diavik Diamond Mine came onstream in January 2003 and will have production of 6 to 8 million carats per year. Canada's first entirely underground diamond mine, the Snap Lake project, is expected to come onstream in 2005. When Snap Lake begins production, Canada will be producing at least 15% to 20% of total world diamond output.

World Mine Production,[7] Reserves, and Reserve Base: Mine production in 2003 for Canada, Central African Republic, Guinea, Namibia, Sierra Leone, and Tanzania were revised upward, while production for Angola, Botswana, Brazil, and Congo (Kinshasa) were revised downward based on submissions from official country sources.

	Mine production		Reserves and reserve base[8]
	2002	2003[e]	
United States	([9])	([9])	World reserves and reserve base of diamond-bearing deposits are substantial. No reserves or reserve base data are available for other gemstones.
Angola	5,400	5,000	
Australia	15,100	17,000	
Botswana	21,300	20,000	
Brazil	700	500	
Canada	4,980	8,000	
Central African Republic	375	500	
China	235	240	
Congo (Kinshasa)	9,100	4,000	
Ghana	770	800	
Guinea	270	370	
Namibia	1,350	1,400	
Russia	11,500	11,800	
Sierra Leone	450	650	
South Africa	4,350	4,720	
Tanzania	182	440	
Other countries[10]	420	420	
World total (rounded)	76,500	75,800	

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

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

[e]Estimated.
[1]Excludes industrial diamond and garnet. See Diamond (Industrial) and Garnet (Industrial).
[2]Estimated minimum production.
[3]Includes production of freshwater shell.
[4]Reexports account for about 66% of the totals.
[5]If reexports were not considered, apparent consumption would be significantly greater.
[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]Less than ½ unit.
[10]In addition to countries listed, Cote d'Ivoire, Gabon, Guyana, 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 2003 producer price, was $6 million. Industry-generated scrap, imported concentrates, and processed residues from certain domestic base metal ores were the feed materials for the production of refined germanium in 2003. The domestic industry was based on two zinc mining operations, one in Tennessee and the other in Alaska. The Tennessee operation, which closed in mid-2003, prepared a germanium-rich residue for export to Europe. The Alaskan operation supplied a germanium-bearing concentrate, which was exported to Canada for processing.

A germanium refinery in Utica, NY, produced germanium tetrachloride for optical fiber production. Another refinery in Oklahoma produced refined germanium compounds for the production of fiber optics, infrared devices, and substrates for electronic devices. The major end uses for germanium, worldwide, were estimated to be lower in fiber optics than for 2002—polymerization catalysts, 35%; infrared optics, 25%; fiber-optic systems, 20%; electronics/solar electrical applications, 12%; and other (phosphors, metallurgy, and chemotherapy), 8%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, refinery[e]	20,000	23,000	20,000	15,000	12,000
Total imports[1]	12,400	8,220	8,240	13,100	12,000
Exports	NA	NA	NA	NA	NA
Consumption[e]	28,000	28,000	28,000	28,000	24,000
Price, producer, yearend, dollars per kilogram:					
Zone refined	1,400	1,250	890	620	470
Dioxide, electronic grade	900	800	575	400	300
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant,[2] number[e]	85	90	90	85	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 electronic and optical devices, more than half of the germanium metal used is routinely recycled as new scrap. Little domestic germanium returns as old scrap because there is a low unit use of germanium in most electronic and infrared devices.

Import Sources (1999-2002):[4] China, 33%; Belgium, 25%; Taiwan, 19%; Russia, 9%; and other, 14%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Germanium oxides	2825.60.0000	3.7% ad val.
Waste and scrap	8112.30.3000	Free.
Metal, unwrought	8112.30.6000	2.6% ad val.
Metal, wrought	8112.30.9000	4.4% ad val.

Depletion Allowance:[5] 14% (Domestic and foreign).

Government Stockpile:

Stockpile Status—9-30-03[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Germanium	40,263	166	40,263	8,000	1,923

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

GERMANIUM

Events, Trends, and Issues: The fiber optic and infrared divisions of the Oklahoma refiner were sold in July 2003, and several mine sources of germanium were scaled-back or closed. Domestic refinery production of germanium was reduced from 2002, and world output was reduced with the closure of a major smelter in France.

Recycling of new scrap continued to grow and remains a significant supply factor. Optical fiber manufacturing was lower owing to a prolonged downturn in the general economy and telecommunications in particular. Higher recycling rates helped to offset increasing polyethylene terephthalate (PET) plastics demand in Asia for germanium dioxide (a catalyst used in the production of PET).

Increases in demand for infrared applications in security, new uses as catalysts, and the potential replacement of gallium arsenide devices by silicon-germanium (SiGe) in wireless telecommunications portend a bright, long-term future for germanium. SiGe chips combine the high-speed properties of germanium with the low-cost, well-established production techniques of the silicon-chip industry. Research on germanium-on-insulator substrates as a replacement for silicon on miniaturized chips continued.

Germanium has little or no effect upon the environment because it usually occurs only as a trace element in ores and carbonaceous materials and is used in very small quantities in commercial applications.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production[e]		Reserves[6]	Reserve base[6]
	2002	2003		
United States	15,000	12,000	400,000	450,000
Other countries	35,000	32,000	NA	NA
World total	50,000	44,000	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. Production of germanium from coal ash is being pursued in Russia and China. Reserves and reserve base figures exclude germanium contained in coal ash.

Substitutes: Silicon is less expensive and can be substituted 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 competing materials in many high-frequency and high-power electronics applications and is more economical as a 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.

New catalysts are being investigated as substitutes for germanium in plastics. Most tend to discolor the plastic, but a new aluminum-base PET catalyst appears to overcome this coloration problem and is less expensive to produce.

[e]Estimated. NA Not available.
[1]Gross weight of wrought and unwrought germanium and waste and scrap. Does not include imports of germanium dioxide 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, unwrought, and waste and scrap. Total imports from republics of the Commonwealth of Independent States (Russia and Ukraine) accounted for 13% of the imports from 1999 to 2002.
[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 53 major 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 2002, the value of mine production was more than $2.9 billion. Commercial-grade refined gold came from about two 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%; dental, 8%; electrical and electronics, 7%; and other, 1%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:					
Mine	341	353	335	298	266
Refinery:					
Primary	265	197	191	194	185
Secondary (new and old scrap)	143	82	83	89	95
Imports[2]	221	223	194	217	220
Exports[2]	523	547	489	257	320
Consumption, reported	245	183	179	163	150
Stocks, yearend, Treasury[3]	8,170	8,140	8,140	8,140	8,140
Price, dollars per ounce[4]	280	280	272	311	350
Employment, mine and mill, number[5]	10,300	10,400	9,500	7,600	7,000
Net import reliance[6] as a percentage of apparent consumption	E	E	E	E	E

Recycling: 95 tons of new and old scrap, equal to 50% of reported consumption, was recycled in 2003.

Import Sources (1999-2002):[2] Canada, 54%; Brazil, 13%; Peru, 8%; United Kingdom, 5%; and other, 20%.

Tariff: Most imports of unwrought gold, including bullion and doré, enter 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 secondary precious metals recovery program.

Events, Trends, and Issues: Domestic gold mine production in 2003 was estimated at about 6% less than the level of 2002, but high enough to maintain the United States' position as the world's second largest gold-producing nation, after South Africa. Domestic output continued to be dominated by Nevada, where combined production accounted for more than 80% of the U.S. total. Between July 2002 and August 2003, two gold mines were closed in the United States. During this 12-month period, the average output per mine decreased, companies merged, and the size of gold-mining operations increased. Most of the larger companies were successfully replacing annual production with new reserves, but smaller companies were finding this more difficult. Estimates by an industry association indicate that worldwide gold exploration expenditures decreased for the fifth consecutive year, with 1997 marking the peak of exploration spending for the 1990s. The expenditures of U.S. gold producers continued to fall in 2002, but are expected to begin to increase in 2003 owing to the increase in the gold price.

Prepared by **Earle B. Amey [(703) 648-4969, eamey@usgs.gov, fax: (703) 648-7757]**

GOLD

During the first 8 months of 2003, the Englehard Corporation's daily price of gold ranged from a low of about $321 per troy ounce in April to a high of about $383 in February. During the year, this price range averaged $350. The Iraqi war in the Middle East and concerns about terrorism continued to prompt increases in gold prices; however, the main gold price driver was the up and down movements in the U.S. dollar. As the expiry of the Central Bank Gold Agreement I (CBGA) approaches September 2004, the Swiss National Bank continued selling 1,300 tons of gold (one-half of its reserves) joined by lesser selling from the Dutch and Portuguese Central Banks. German Bundesbank could be the next major gold seller, but is expected to wait until CBGA II. Concerns about central bank gold sales, prospects for more consolidations within the gold mining sector, and lack of renewed investor interest in gold will tend to keep gold prices depressed.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7]	Reserve base[7]
	2002	2003[e]		
United States	298	266	5,600	6,000
Australia	273	275	5,000	6,000
Canada	149	165	1,300	3,500
China	190	195	1,200	4,100
Indonesia	135	175	1,800	2,800
Peru	138	150	200	650
Russia	170	180	3,000	3,500
South Africa	399	450	8,000	36,000
Other countries	798	760	[8]17,000	[8]26,000
World total (rounded)	2,550	2,600	[8]43,000	[8]89,000

Of the estimated 145,200 tons of all gold ever mined, about 15% is thought to have been lost, used in dissipative industrial uses, or otherwise unrecoverable or unaccounted for. Of the remaining 123,000 tons, central banks hold an estimated 32,000 tons as official stocks, and about 91,000 tons is privately held as coin, bullion, and jewelry.

World Resources: Total world resources of gold are estimated at 100,000 tons, of which 15% to 20% is a byproduct resource. South Africa has about one-half of all world gold resources, and Brazil and the United States have about 9% each. Some of the 9,000-ton U.S. resource would be recovered as byproduct gold.

Substitutes: Base metals clad with gold alloys are widely used in electrical/electronic products and 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: 302.7 (1999), 355.8 (2000), 259.5 (2001), 39.6 (2002), and 59.8 (2003 estimated).

[3]Includes gold in Exchange Stabilization Fund. Stocks were valued at the official price of $42.22 per troy ounce.
[4]Englehard 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]Excludes countries for which reliable data were not available.

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 2003, approximately 200 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 2003 were refractory applications, 25%; brake linings, 13%; foundry operations, 9%; lubricants, 8%; and other uses (including steelmaking), 45%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, mine	—	—	—	—	—
Imports for consumption	56	61	52	45	53
Exports	29	22	24	22	21
Consumption, apparent[1]	26	39	28	24	32
Price, imports (average dollars per ton at foreign ports):					
Flake	547	615	520	565	560
Lump and chip (Sri Lankan)	1,270	1,250	1,360	1,220	1,200
Amorphous	148	130	131	115	120
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 (1999-2002): China, 33%; Mexico, 24%; Canada, 21%; Brazil, 6%; and other, 16%.

Tariff:

Item	Number	Normal Trade Relations 12/31/03
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:

Stockpile Status—9-30-03[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Sri Lanka, amorphous lump	—	0.68	—	3.41	0.02
Madagascar, crystalline flake	—	1.12	—	—	1.80

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

GRAPHITE (NATURAL)

Events, Trends, and Issues: Graphite was near supply-demand balance in 2003. Flake graphite imports were from Canada, China, Brazil, and Madagascar (in descending order of tonnage), imports of graphite lump and chip were from Sri Lanka; and amorphous graphite imports were from Mexico, China, and Japan (in descending order of tonnage). There has been a marked decrease in the consumption of graphite electrodes, owing to development of more efficient iron and steel production techniques. Use of natural graphite in lubrication applications is also decreasing because of changes in requirements for lubricants and in processing technologies. 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[4]	Reserve base[4]
	2002	2003[e]		
United States	—	—	—	1,000
Brazil	70	65	360	1,000
Canada	25	25	NA	NA
China	450	450	64,000	220,000
Czech Republic	25	15	11,400	13,000
India	130	110	800	3,800
Korea, North	25	25	NA	NA
Madagascar	1	10	940	960
Mexico	25	20	3,100	3,100
Other countries	62	62	5,100	44,000
World total (rounded)	810	780	85,000	280,000

World Resources: Domestic resources 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 B for definitions.
[4]See Appendix C for definitions.

GYPSUM

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: In 2003, domestic production of crude gypsum was estimated at 16.0 million tons with an estimated valued of $111 million. The top producing States were, in descending order, Oklahoma, Texas, Nevada, Iowa, California, Indiana, and Michigan, which together accounted for 73% of total output. Overall, 25 companies produced gypsum at 50 mines in 17 States, and 8 companies calcined gypsum at 61 plants in 29 States. Almost 90% of domestic consumption, which totaled approximately 33.0 million tons, was accounted for by manufacturers of wallboard and plaster products. Approximately 2.62 million tons for cement production, 1.0 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 uses. At the beginning of 2003, capacity of operating wallboard plants in the United States was 38.6 billion square feet[1] per year.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:					
Crude	22,400	19,500	16,300	15,700	16,000
Synthetic[2]	5,200	4,950	6,820	9,380	9,500
Calcined[3]	22,300	21,000	19,100	18,600	21,200
Wallboard products (million square feet[1])	28,700	26,100	29,500	29,900	31,500
Imports, crude, including anhydrite	9,340	9,210	8,270	7,970	7,640
Exports, crude, not ground or calcined	112	161	295	341	165
Consumption, apparent[4]	36,800	33,700	31,100	32,700	33,000
Price:					
Average crude, f.o.b. mine, dollars per ton	6.99	8.44	7.31	6.90	6.90
Average calcined, f.o.b. plant, dollars per ton	17.07	16.81	18.42	20.01	20.01
Stocks, producer, crude, yearend	1,500	1,500	1,500	1,500	1,500
Employment, mine and calcining plant, number[e]	6,000	6,000	5,900	5,900	5,900
Net import reliance[5] as a percentage of apparent consumption	25	27	26	23	23

Recycling: A portion of more than 4 million tons of gypsum waste generated every year by wallboard manufacturing, wallboard installation, and building demolition was recycled. The recycled gypsum was used chiefly for agricultural purposes and 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 (1999-2002): Canada, 68%; Mexico, 23%; Spain, 8%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Gypsum; anhydrite	2520.10.0000	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]**

GYPSUM

Events, Trends, and Issues: The U.S. gypsum industry continued experiencing acquisitions, mergers, bankruptcy reorganization filings, construction of new plants, and expansion of existing capacity as a result of increased efficiency of the manufacturing facilities.

Domestic housing starts in 2003 were slightly lower compared with 2002, while construction was slightly higher. The net result was a small overall gypsum production increase for the year. Demand for gypsum depends principally on the strength of the construction industry—particularly in the United States, where more than 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 more large wallboard plants designed to use synthetic gypsum will significantly accelerate substitution as they become operational.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	2002	2003[e]		
United States	15,700	16,000	700,000	Large
Australia	4,000	4,000		
Austria	1,000	1,000		
Brazil	1,510	1,650	1,300,000	Large
Canada	8,850	9,000	450,000	Large
China	6,850	6,900		
Egypt	2,000	2,000		
France	3,500	3,500		
India	2,300	2,300		
Iran	11,500	11,500		
Italy	1,300	1,200	Reserves and reserve base are large in major producing countries, but data are not available.	
Japan	5,900	5,700		
Mexico	6,500	6,800		
Poland	1,100	1,100		
Spain	7,500	7,500		
Thailand	6,330	6,500		
United Kingdom	1,500	1,500		
Uruguay	1,130	1,100		
Other countries	12,500	12,500		
World total (rounded)	101,000	102,000	Large	Large

World Resources: Domestic resources are adequate but unevenly distributed. Large imports from Canada augment domestic supplies for wallboard manufacturing on the eastern seaboard of the United States, where there are no significant gypsum deposits. Large imports from Mexico augment domestic supplies for wallboard manufacturing on the U.S. western seaboard. Large deposits occur in the Great Lakes region, midcontinental region, and California. Foreign resources are large and widely distributed; more than 90 countries produce gypsum.

Substitutes: Other construction materials may be substituted for gypsum, especially cement, lime, lumber, masonry, and steel. 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 becoming very important as a substitute for mined gypsum in wallboard manufacturing, cement production, and agricultural applications (in descending tonnage order). In 2003, synthetic gypsum accounted for 26% 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 + net import reliance.

[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: During 2003, the estimated value of Grade-A helium (99.995% or better) extracted domestically by private industry was about $285 million. Eleven industry plants (seven 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, one in Texas, and one each in Colorado, New Mexico, Oklahoma, 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 2003 domestic consumption of 80 million cubic meters (2.9 billion cubic feet) was used for cryogenic applications, 24%; for pressurizing and purging, 20%; for welding cover gas, 18%; for controlled atmospheres, 16%; leak detection, 6%; breathing mixtures, 3%; and other, 13%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Helium extracted from natural gas[2]	114	98	87	87	87
Withdrawn from storage[3]	3	29	45	40	37
Grade-A helium sales	117	127	132	127	124
Imports for consumption	—	—	—	—	—
Exports[4]	26.8	37.0	43.0	40.0	41.0
Consumption, apparent[4]	90.3	89.6	88.9	87.6	79.9
Employment, plant, number[e]	500	320	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 $1.893 per cubic meter ($52.50 per thousand cubic feet) in fiscal year (FY) 2003. 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 $2.16 to $2.34 per cubic meter ($60 to $65 per thousand cubic feet), with some producers posting surcharges to this price. This price includes price increases of 10% to18% that were implemented by the major helium producers in 2001 and 2002.

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

Import Sources (1999-2002): None.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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 the Public Law 104-273, the BLM manages the Federal Helium Program, which includes all operations of the Cliffside helium storage reservoir 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 crude helium (in-kind) from the BLM.

In FY 2003, privately owned companies purchased nearly 5.63 million cubic meters (203 million cubic feet) of in-kind crude helium. In addition to this, the privately owned companies also purchased 46.2 million cubic meters (1,666 million cubic feet) of open market sales helium. During FY 2003, BLM's Amarillo Field Office, Helium Operations (AMFO) accepted more than 18.1 million cubic meters (652 million cubic feet) of private helium for storage and redelivered nearly 55.1 million cubic meters (1,987 million cubic feet). As of September 30, 2003, 56.5 million cubic meters (2.0 billion cubic feet) of helium was owned by private firms.

Stockpile Status—9-30-03[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Helium	766.6	16.6	766.6	64.30	51.83

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

HELIUM

Events, Trends, and Issues: At the end of FY 2003, the major helium producers again announced helium price increases averaging 10% to 12%. Helium producers stated that the pricing initiatives are needed to address continued production, feedstock, and distribution cost increases. It is anticipated that the trend toward higher costs will continue as the potential for helium shortages increases with the continued depletion of U.S. helium reserves. It is anticipated that helium demand will grow at a rate of about 5% per year through 2004 and potentially into 2005; Helium demand has risen at this rate for the past 10 years. During 2003, there was a 4.3% increase in helium exports, which recovered part of the 8% decrease during 2002. AMFO continued the drafting of helium regulations to provide guidance for the Federal helium program. In early 2003, the AMFO conducted the first open market helium sale. During FY 2003, two overseas helium projects were initiated, one in Algeria and one in Qatar. Contracts were awarded for an expansion of the existing helium production facility in Algeria and for a new helium extraction facility in Qatar. The expansion of the Algerian facility will increase helium production capability by 16.6 million cubic meters (600 million cubic feet) per year, while the new facility at Qatar will have a production capacity of 8.3 million cubic meters (300 million cubic feet) per year. The Algerian facility expansion is scheduled to come onstream sometime during 2005, while the Qatar project is scheduled to be in operation by 2006.

World Production, Reserves, and Reserve Base:

	Production		Reserves[8]	Reserve base[8]
	2002	2003[e]		
United States	87	87	4,100	[9] 8,900
Algeria	17	17	2,000	3,000
Canada	NA	NA	NA	2,000
China	NA	NA	NA	1,100
Poland	1	1	40	280
Russia	4	4	1,700	6,700
Other countries	NA	NA	NA	2,800
World total (rounded)	109	109	NA	25,000

World Resources: The identified helium resources of the United States were estimated to be about 8.9 billion cubic meters (323 billion cubic feet) as of January 1, 2001. This includes 0.95 billion cubic meter (34.3 billion cubic feet) of helium stored in the Cliffside Field, 4.1 billion cubic meters (147 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 (111 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 4.0 billion cubic meters (143 billion cubic feet) of helium. Future supplies will probably come from known helium-rich natural gas with little fuel value and from helium-lean resources.

Helium resources of the world exclusive of the United States were estimated to be about 16 billion cubic meters (580 billion cubic feet). The locations and volumes of the principal deposits, in billion cubic meters, are Russia, 7; Algeria, 3; Canada, 2; China, 1; Poland, 0.3. As of December 31, 2003, AMFO had analyzed about 21,400 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 –429º 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 15º C, 27.737 cubic meters of helium = 1 Mcf of helium at 70º F and 14.7 psia.
[2]Helium from both Grade-A and crude helium.
[3]Extracted from natural gas in prior years (injected in parentheses).
[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.

INDIUM

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: Indium was not recovered from ores in the United States in 2003. 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.

Thin-film coatings, which are used in applications such as for electroluminescent lamps and for liquid crystal displays (LCDs) in flat panel video screens, continued to be the largest end use. Indium semiconductor compounds were used in infrared detectors, high-speed transistors, and high-efficiency photovoltaic devices. The estimated distribution of uses in 2003 indicated an increase in the application for coatings that was offset by the reduction in the uses for solder and alloys and for electrical components: Coatings, 65%; solders and alloys, 15%; electrical components and semiconductors, 10%; and research and other, 10%. The estimated value of primary indium metal consumed in 2003, based upon the annual average price, was about $14.8 million.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production, refinery	—	—	—	—	—
Imports for consumption[1]	77	69	79	112	115
Exports	NA	NA	[e]10	[e]10	NA
Consumption[e]	52	55	65	85	90
Price, annual average, dollars per kilogram (99.97% indium)	303	188	120	97	175
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, number	NA	NA	NA	NA	NA
Net import reliance[2] as a percentage of estimated consumption	100	100	100	100	100

Recycling: Recent trends in indium price combined with the curtailment of primary refining capacity have added an extra incentive to the recovery of secondary indium. Sustained prices in the $160 to $200 per kilogram range will encourage increased recycling.

In the United States, only small amounts of new indium scrap were recycled in 2003. This is because the infrastructure for collection of indium-containing products is not well established in the United States and because the recent low price of primary indium has not economically warranted its development. Recycling of indium could expand significantly in the United States if the price of indium continues to increase. About 60% of the indium-tin oxide scrap could be reused should the price of indium warrant increased recycling.

This can be compared with Japan where the decline in domestic zinc refining has stimulated an aggressive recycling program expected to make up for any shortfalls in domestic production. For example, in 2002, 155 tons of indium, or almost 45% of Japanese indium consumption, was derived from secondary sources, mostly of domestic origin. This compares with the 55 tons of primary indium that Japan produced.

Import Sources (1999-2002):[1] China, 46%; Canada, 27%; France, 8%; Russia, 7%; and other, 12%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Unwrought indium, including powder	8112.92.3000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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

INDIUM

Events, Trends, and Issues: Estimated domestic indium consumption increased by about 6% to 90 tons in 2003. After the annual average price of indium dropped in 2000 and 2001, it remained relatively stable in 2002 through the third quarter when it began to climb considerably. Although continued strong sales of flat panel displays and other LCD products increased demand for indium-tin oxide, the use of indium phosphide for semiconductors was negatively affected by the continued downturn in the world economy. The report of reduced production from mines that produce byproduct indium had a negative impact on the perceived availability of indium from China, which drove world prices up to the highest levels in 4 years. Although the short-range outlook for indium demand remains attractive, market supply remains questionable with its heavy dependence on the strength of the zinc market. Recycling efforts, especially in Japan, have done much to offset shortages in supply and to alleviate price pressures.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production[e]		Reserves[3]	Reserve base[3]
	2002	2003		
United States	—	—	300	600
Belgium	40	40	([4])	([4])
Canada	45	50	700	2,000
China	85	100	280	1,300
France	65	10	([4])	([4])
Japan	60	55	100	150
Peru	5	5	100	150
Russia	15	15	200	300
Other countries	20	20	800	1,500
World total (rounded)	335	295	2,500	6,000

World Resources: Indium is a rare element and ranks 61st in abundance in the Earth's crust at an estimated 240 parts per billion by weight. This makes it about three times more abundant than silver or mercury.

Indium occurs predominantly in 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 also tends to occur with the base metals—copper, lead, and tin—and to a lesser extent with bismuth, cadmium, and silver, most of these deposits 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. Indium phosphide can be substituted by gallium arsenide in solar cells and in many semiconductor applications. Hafnium can replace indium alloys for use in nuclear reactor control rods.

[e]Estimated. NA Not available. — Zero.
[1]Imports for consumption are based on U.S. Department of Commerce, U.S. Treasury, and U.S. International Trade Commission data for unwrought and waste and scrap (includes indium powder after 2002).
[2]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.
[3]Estimate based on the indium content of zinc ores. See Appendix C for definitions.
[4]Reserves and reserve base for this country and other European nations are included with "Other countries."

IODINE

(Data in thousand kilograms, elemental iodine, unless otherwise noted)

Domestic Production and Use: Iodine produced in 2003 from three companies operating in Oklahoma accounted for 100% of the elemental iodine value estimated at $19.7 million. 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, for domestic use and export to Germany. Of the consumers that participate in the annual survey, 16 plants reported consumption of iodine in 2002. Major consumers were located in the Eastern United States. The average value of iodine imports through September was $11.79 per kilogram. Establishing an accurate end-use pattern for iodine was difficult because intermediate iodine compounds were marketed before reaching their final end uses. Estimated world consumption of iodine was 19,600 metric tons.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production	1,620	1,470	1,290	1,420	1,750
Imports for consumption, crude content	5,430	4,790	5,030	6,200	5,800
Exports	1,130	886	1,460	1430	1,150
Shipments from Government stockpile excesses	221	949	83	25	251
Consumption:					
Apparent	6,140	6,320	3,650	4,780	6,650
Reported	1,860	2,170	1,820	2,320	NA
Price, average c.i.f. value, dollars per kilogram, crude	16.15	14.59	13.94	12.71	11.79
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, number	40	30	30	30	30
Net import reliance[1] as a percentage of apparent consumption	74	77	74	77	74

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

Import Sources (1999-2002): Chile, 66%; Japan, 30%; Russia, 2%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Iodine, crude	2801.20.0000	Free.
Iodide, calcium or of copper	2827.60.1000	Free.
Iodide, potassium	2827.60.2000	2.8% ad val.
Iodides and iodide oxides, other	2827.60.5000	4.2% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: In October, the Defense National Stockpile Center announced the fiscal year 2004 Annual Materials Plan would include sales of 454 tons (1,000,000 pounds) of crude iodine.

Stockpile Status—9-30-03[2]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Stockpile-grade	1,424	117	1,424	454	251

Prepared by **Phyllis A. Lyday [(703) 648-7713, plyday@usgs.gov, fax: (703) 648-7757]**

IODINE

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

The United States and Chile signed a free trade agreement on June 6, 2003, that when fully implemented was expected to eliminate bilateral tariffs, to lower trade barriers, to promote economic integration, and to expand opportunities for the peoples of both countries. The agreement would allow iodine derivatives in the future to enter duty free.

The Defense National Stockpile Center issued Amendment No. 001 to Solicitation of Offers for DLA-Iodine–004. The amendment solicits offers for the sale of 454 metric tons (1,000,000 pounds) of crude iodine in fiscal year 2004, with quarterly sales of approximately 113,400 kilograms (250,000 pounds).

The Nuclear Regulatory Commission (NRC) amended its emergency planning regulations to require that States consider including the prophylactic use of potassium iodide (KI) as a protective measure for the general public as a supplement to sheltering and evacuation. Subject to available funding, the NRC would provide an initial supply of KI for States that choose to incorporate it for the general public in their emergency plans. Iodine is necessary for the production of the hormone thyroxin, which regulates metabolism in animals. KI prevents radioactive iodine from entering the thyroid gland and causing cancer.

Test results announced by the U.S. Environmental Protection Agency (EPA) revealed that leafy vegetables grown with water irrigated by the Colorado River may be exposing consumers to a larger dose of perchlorate than is considered safe. Perchlorate impairs the thyroid's ability to absorb iodine. Iodine prevents goiters and produces hormones critical to proper fetal and infant brain development. EPA and the State of California were in the process of developing drinking water standards for perchlorate.

World Mine Production, Reserves, and Reserve Base: New information from China resulted in significant decreases in estimated reserves and reserve base for that country.

	Mine production		Reserves[3]	Reserve base[3]
	2002	2003[e]		
United States	1,420	1,750	250,000	550,000
Azerbaijan	300	300	170,000	340,000
Chile	11,400	11,650	9,000,000	18,000,000
China	500	500	4,000	120,000
Indonesia	75	75	100,000	200,000
Japan	6,500	6,500	4,900,000	7,000,000
Russia	300	300	120,000	240,000
Turkmenistan	200	300	170,000	350,000
Uzbekistan	2	2	NA	NA
World total (rounded)	20,700	21,400	15,000,000	27,000,000

World Resources: In addition to the fields listed in the reserve base, 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 is 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 also substitute 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.
[1]Defined as imports – exports + adjustments for Government and industry stock changes.
[2]See Appendix B for definitions.
[3]See Appendix C for definitions.

IRON ORE[1]

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

Domestic Production and Use: The value of usable ore shipped from mines in Michigan, Minnesota, and two other States in 2003 was estimated at $1.2 billion. Eleven iron ore production complexes with 11 mines, 8 concentration plants, and 8 pelletizing plants were in operation during the year. The mines included 11 open pits and no underground operations. Virtually all ore was concentrated before shipment. Eight mines operated by five companies accounted for 99% of production. The United States produced 5% of the world's iron ore output and consumed about 7%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, usable	57.7	63.1	46.2	51.6	50.0
Shipments	60.7	61.0	50.6	51.5	50.0
Imports for consumption	14.3	15.7	10.7	12.5	13.0
Exports	6.1	6.1	5.6	6.8	6.4
Consumption:					
Reported (ore and total agglomerate)[3]	75.1	76.5	67.3	59.0	56.0
Apparent	70.1	70.2	62.0	57.9	56.1
Price,[4] U.S. dollars per metric ton	25.52	25.57	23.87	26.04	25.00
Stocks, mine, dock, and consuming plant, yearend, excluding byproduct ore	26.4	28.8	18.0	17.5	18.0
Employment, mine, concentrating and pelletizing plant, quarterly average, number	6,820	6,814	5,017	4,742	4,500
Net import reliance[5] as a percentage of apparent consumption (iron in ore)	18	10	26	11	11

Recycling: None.

Import Sources (1999-2002): Canada, 47%; Brazil, 41%; Australia, 5%; Venezuela, 2%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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: Until 2003, conditions in China had little or no effect on conditions on the Mesabi iron Range in northeastern Minnesota. However, that situation has changed because of the tremendous increase in iron ore consumption in China. In 2003, one of the six iron ore producers in northeastern Minnesota closed. The operation had orders for pellets that sustained operations until May 2003. When those orders were filled, the producer filed for bankruptcy and ceased production. Late in the year, a U.S. company that owns and manages a number of North American iron ore mines joined forces with a Chinese steel producer and bought the mine. Pellet production was expected to resume in December.

China has become the dominant source of growth in demand for iron ore. About 98% of iron ore is used to produce pig iron and is the best indicator of iron ore consumption worldwide. In 1991, Japan, the world's leading pig-iron-producing country, produced 80 million tons. China was second with 68 million tons. In 1992, China became and remains the leading producing country; Japan is the second leading country. In 2002, China produced 170 million tons of pig iron, more than twice Japan's 81 million tons. China's share of world pig iron production in the first three quarters of 2002 was 28%; for the same period of 2003 its share rose to 31%. Japan's share of world pig iron production in the first three quarters of 2002 was 13%; for the same period in 2003, it remained at 13%.

Prepared by **William S. Kirk [(703) 648-4962, wkirk@usgs.gov, fax: (703) 648-7757]**

IRON ORE

This extraordinary growth affected the large global producers long before it had an impact on a U.S. producer. The three largest iron ore producing companies in the world were investing large sums of money to increase production to satisfy future Chinese demand. How long China can continue its extraordinary growth is the primary issue for the future of the iron ore industry worldwide. Even if growth in Chinese iron ore consumption were to level off in the next few years, it will have had a major effect on the global iron ore industry.

Research and development on a value-added product was started in Minnesota. The purpose of the project was to determine if iron ore pellets produced in Minnesota could be converted to a form of iron that is chemically similar to pig iron and, therefore, could be used in steelmaking furnaces in integrated steelworks and minimills. The successful completion of the project could make the Mesabi Range producers more competitive.

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

	Mine production		Crude ore		Iron content	
	2002	2003[e]	Reserves	Reserve base	Reserves	Reserve base
United States	52	50	6,900	15,000	2,100	4,600
Australia	183	190	18,000	40,000	11,000	25,000
Brazil	212	215	7,600	19,000	4,800	12,000
Canada	31	32	1,700	3,900	1,100	2,500
China	231	240	21,000	46,000	7,000	15,000
India	80	80	6,600	9,800	4,200	6,200
Iran	11	11	1,800	2,500	1,000	1,500
Kazakhstan	15	18	8,300	19,000	3,300	7,400
Mauritania	10	10	700	1,500	400	1,000
Russia	84	92	25,000	56,000	14,000	31,000
South Africa	36	38	1,000	2,300	650	1,500
Sweden	20	21	3,500	7,800	2,200	5,000
Ukraine	59	63	30,000	68,000	9,000	20,000
Venezuela	18	17	4,000	6,000	2,400	3,600
Other countries	38	40	11,000	30,000	6,600	18,000
World total (rounded)	1,080	1,120	150,000	330,000	70,000	150,000

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 is the only source of primary iron. In some operations, ferrous scrap constitutes as much as 7% of the blast furnace burden. Scrap is extensively used in steelmaking and in iron and steel foundries.

[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 used in producing sinter for blast furnaces. Consumption data are not entirely comparable to those of 1987 and earlier years owing to changes in data collection.
[4]Calculated from value of ore at mines.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]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 valued at about $63 billion. The steel industry consisted of about 83 companies that produced raw steel at about 214 locations, with combined raw steel production capability of about 103 million tons. Indiana accounted for about 20% of total raw steel production, followed by Ohio, 15%, Michigan, 7%, and Pennsylvania, 6%. Pig iron was produced by 11 companies operating integrated steel mills, with about 33 blast furnaces in continuous operation. The distribution of steel shipments was estimated as follows: warehouses and steel service centers, 23%; construction, 16%; transportation (predominantly for automotive production), 13%; cans and containers, 3%; and others, 45%. Ferrous foundries, numbering about 1,100, continued to be importers of pig iron into the United States, mainly from Brazil, Russia, and Ukraine.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Pig iron production[2]	46.3	47.9	42.1	40.2	39.4
Steel production:	97.4	102	90.1	91.6	91.5
Basic oxygen furnaces, percent	53.7	53.0	52.6	49.6	48.0
Electric arc furnaces, percent	46.3	47.0	47.4	50.4	52.0
Continuously cast steel, percent	95.9	96.4	97.2	97.2	97.1
Shipments:					
Steel mill products	96.3	99	89.7	90.7	94.7
Steel castings[3]	1.2	1.0	0.8	1.0	1.0
Iron castings[3]	9.8	9.4	8.3	83.3	7.8
Imports of steel mill products	32.4	34.4	27.3	29.6	21.7
Exports of steel mill products	4.9	5.9	5.6	5.4	8.2
Apparent steel consumption[4]	116	120	107	107	104
Producer price index for steel mill products (1982=100)[5]	105.3	108.4	101.3	102.3	108.9
Steel mill product stocks at service centers yearend[6]	7.7	7.8	7.1	7.3	7.5
Total employment, average, number[7]					
Blast furnaces and steel mills	153,000	151,000	141,000	140,000	140,000
Iron and steel foundries[e]	127,000	125,000	117,000	116,000	116,000
Net import reliance[8] as a percentage of apparent consumption	17	18	16	15	9

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

Import Sources (1999-2002): European Union, 18%; Canada, 15%; Mexico, 10%; Japan, 7%; and other, 50%.

Tariff: Item	Number	Normal Trade Relations[9] 12/31/03	Mexico 12/31/03
Pig iron	7201.10.0000	Free	Free.
Carbon steel:			
Semifinished	7207.12.0050	0.4% ad val.	Free.
Structural shapes	7216.33.0090	0.1% ad val.	Free.
Bars, hot-rolled	7213.20.0000	0.2% ad val.	Free.
Sheets, hot-rolled	7208.39.0030	0.5% ad val.	Free.
Hot-rolled, pickled	7208.27.0060	0.5% ad val.	Free.
Cold-rolled	7209.18.2550	0.3% ad val.	Free.
Galvanized	7210.49.0090	0.6% ad val.	Free.
Stainless steel:			
Semifinished	7218.91.0015	0.5% ad val.	Free.
	7218.99.0015	0.5% ad val.	Free.
Bars, cold-finished	7222.20.0075	1.1% ad val.	Free.
Pipe and tube	7304.41.3045	0.8% ad val.	Free.
Cold-rolled sheets	7219.33.0035	1.0% ad val.	Free.

Depletion Allowance: Not applicable.

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

IRON AND STEEL

Government Stockpile: None.

Events, Trends, and Issues: During the first 8 months of 2003, monthly pig iron production fluctuated near 3.3 million tons, and monthly raw steel production fluctuated near 7.6 million tons. Production totals during these periods were not significantly different for pig iron and steel from those of 2002. Shipments of steel mill products during the first 8 months of 2003 were unchanged compared with those of 2002. Pig iron and raw steel production were trending downward during the first half of 2003.

A lull in bankruptcy activity during the second half of 2002 followed the bankruptcies of three major steelmakers in early 2002. The first half of 2003 saw an additional four bankruptcies—Bayou Steel Corp; Kentucky Electric Steel, Inc; Slater Steel, Inc; and Weirton Steel Corp. U.S. integrated steelmakers and labor, represented by the United Steelworkers of America, finalized labor agreements that, in part, protect the current benefits held by retirees. Some domestic mills have not been cost competitive with foreign mills partly because the latter have lower healthcare costs as a result of nationalized or subsidized healthcare programs.

The International Trade Commission's section 201 investigation under the Trade Act of 1974 and subsequent recommendations in December 2001 led to a March 2002 imposition of 8% to 30% duties on a wide range of steel products. In mid-2003, the World Trade Organization (WTO) concluded that Section 201 violated global trading rules, and the European Union (EU), Brazil, China, among others, challenged the legality of Section 201. The EU threatened retaliatory trade sanctions against the United States. The United States was scheduled to review its policy in September 2003 prior to its appeal of the WTO decision.

Projections of U.S. economic growth by Boston Federal Research Bank and International Monetary Fund were no greater than 3.5% and 2.2%, respectively, for 2003. But by the end of October 2003, the U.S. Bureau of Economic Analysis reported an estimated increase in the annual rate of the real gross domestic product of 7.2% in the third quarter of 2003.

World Production:

	Pig iron		Raw steel	
	2002	2003[e]	2002	2003[e]
United States	40.2	39.4	91.6	91.5
Brazil	27.8	31.0	29.6	27.5
China	171	190	182	200
European Union	89.4	90.4	157	159
Japan	81.0	81.7	108	110
Korea, Republic of	26.5	26.6	45.4	46.0
Russia	46.1	48.0	59.8	61.2
Ukraine	27.6	29.0	34.5	38.0
Other countries	94.4	97.9	196	191
World total (rounded)	604	634	904	924

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 having 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 molten to steelmaking furnaces located at the same site.
[3]U.S. Department of Commerce, Census Bureau.
[4]Defined as steel shipments + imports – exports + adjustments for industry stock changes + adjustment for imports of semifinished steel products.
[5]Bureau of Labor Statistics.
[6]Metals Service Center Institute.
[7]Bureau of Labor Statistics. Blast furnaces and steel mills: SIC 3312; Iron and steel foundries: NAICS 331511.
[8]Defined as imports – exports + adjustments for Government and industry stock changes.
[9]No tariff for Canada, Israel, and certain Caribbean and Andean nations.

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 at $7.6 billion in 2003, up about 41% from that of 2002. Manufacturers of pig iron, raw steel, and steel castings accounted for 81% of scrap consumption by the domestic steel industry, using scrap together with pig iron and direct-reduced iron to produce steel products for the construction, transportation, oil and gas, machinery, container, appliance, and various other consumer industries. The ferrous castings industry consumed most of the remaining 19% 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 totaled less than 1 million tons.

Raw steel production in 2003 was an estimated 91.4 million tons, slightly less than that of 2002; capacity utilization was about the same as that of 2002. Net shipments of steelmill products were estimated at about 89.2 million tons compared with 90.7 million tons for 2002. The domestic ferrous castings industry shipped an estimated 8.6 million tons of all types of iron castings in 2003 and an estimated 0.7 million tons of steel castings, including investment castings.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:					
Home scrap	19	20	18	17	19
Purchased scrap[2]	53	56	55	56	57
Imports for consumption[3]	4	4	3	3	3
Exports[3]	6	6	7	9	11
Consumption, reported	71	74	71	69	69
Price, average, dollars per metric ton delivered, No. 1 Heavy Melting composite price, Iron Age Average, Pittsburgh, Philadelphia, Chicago	90.98	92.61	73.84	88.21	108.00
Stocks, consumer, yearend	4.8	5.3	4.9	5.1	4.2
Employment, dealers, brokers, processors, number[4]	37,000	37,000	37,000	37,000	37,000
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 over 200 years. The automotive recycling industry alone recycled about 14 million vehicles in 2001 through more than 200 car shredders to supply more than 14 million tons of shredded steel scrap to the steel industry for recycling. More than 12,000 vehicle dismantlers throughout North America resell parts. In the United States alone, an estimated 69 million tons of steel was recycled in steel mills and foundries in 2003. 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 28% home scrap (recirculating scrap from current operations), 23% prompt scrap (produced in steel-product manufacturing plants), and 49% post-consumer (old) scrap.

Import Sources (1999-2002): Canada, 58%; United Kingdom, 23%; Sweden, 7%; Netherlands, 3%; and other, 9%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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 Fenton [(703) 648-4972, mfenton@usgs.gov, fax: (703) 648-7757]**

IRON AND STEEL SCRAP

Events, Trends, and Issues: The recession that began in March 2001, following a 10-year economic expansion, ended in November 2001, according to the National Bureau of Economic Research. Growth in the U.S. gross domestic product during 2002 was only 2.4%. U.S. apparent steel consumption, an indicator of economic growth, remained at 107 million tons in 2001 and 2002, the lowest amount since 1995, from a peak of 120 million tons in 2000, and was expected to decline in 2003. Scrap prices increased steadily through 2002 and the first half of 2003. Hot-rolled steel prices and the producer price index for steelmill products rose during 2002 and declined during 2003. Steel mill capacity utilization also increased until late 2002 and then declined during 2003. This record of performance indicated economic recovery during 2003 would not be strong.

Ferrous scrap prices were higher, on average, during 2003 than in 2002. Composite prices published by Iron Age Scrap Price Bulletin for No. 1 Heavy Melting steel scrap delivered to purchasers in Chicago, Philadelphia, and Pittsburgh averaged about $111 per metric ton in 2003. As reported by Iron Age Scrap Price Bulletin, the average price for nickel-bearing stainless steel scrap delivered to purchasers in Pittsburgh was about $881 per ton in 2003, which was significantly higher than the 2002 average price of $695 per ton. Exports of ferrous scrap increased from 7.4 million tons during 2001 to about 9.2 million tons in 2002. Export scrap value increased from $0.5 billion in 2001 to an estimated $1.3 billion in 2002.

In the United States, the primary source of obsolete steel scrap is the automobile. The recycling rate for automobiles in 2002, the latest year for which statistics were available, was 101%. A recycling rate greater than 100% is a result of the steel industry recycling more steel from automobiles than was used in the production of new vehicles. The recycling rates for appliances and steel cans in 2002 were 87% and 59%, respectively. Recycling rates for construction materials in 2002 were about 95% for plates and beams and 58% for rebar and other materials. The recycling rates for appliance, can, and construction steel are expected to increase not only in the United States, but also in emerging industrial countries. As environmental regulations increase, recycling becomes more profitable and convenient, and public interest in recycling continues to grow.

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

World Resources: Not applicable.

Substitutes: About 2.2 million tons of direct-reduced iron was used in the United States in 2000 as a substitute for iron and steel scrap.

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

IRON AND STEEL SLAG

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Ferrous slags are valuable coproducts of ironmaking and steelmaking. In 2003, about 19 million tons of domestic iron and steel slag, valued at about $300 million[1] (f.o.b.), were consumed. Iron or blast furnace slag accounted for about 60% of the tonnage sold and was worth about $270 million. Steel slag, produced from basic oxygen, electric arc, and open hearth furnaces[2] accounted for the remainder. There were 23 slag-processing companies servicing iron and/or steel companies, or reprocessing old slag piles, at about 125 locations: iron slag at about 40 sites in about 15 States and steel slag at about 90 sites in about 32 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 slags. Actual prices per ton range from about $0.50 for steel slags in areas where natural aggregates are abundant to about $60 for GGBFS. The major uses of air-cooled iron slag and for steel slag were as aggregates for road bases, fill, and asphaltic paving. In contrast, because of its cementitious properties, GGBFS is mainly used as a partial substitute for portland cement in concrete mixes and in blended cements. Owing to the low unit value, most slag is shipped by truck and over short distances only (rail and waterborne transportation can be longer). Because it has a much higher unit value, GGBFS can be shipped over longer distances.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002[3]**	**2003[e, 3]**
Production, marketed[4]	17,000	16,300	16,900	19,000	19,000
Imports for consumption	900	1,200	2,600	1,000	1,000
Exports	12	20	([5])	400	400
Consumption, apparent[6]	18,000	20,200	19,500	18,600	18,600
Price average value, dollars per ton, f.o.b. plant	8.80	8.60	8.05	[7]15.50	[7]15.50
Stocks, yearend	NA	NA	NA	NA	NA
Employment, number[e]	2,750	2,750	2,700	2,700	2,700
Net import reliance[8] as a percentage of apparent consumption	5	10	8	6	6

Recycling: Ferrous slags are viewed as valuable byproducts of ironmaking and steelmaking. Apart from the large outside markets for slag in the construction sector, some iron and steel slags are used in the furnaces as iron 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 (1999-2002): Most imports are of unground granulated blast furnace slag. In recent years, some import data for ferrous slags have shown discrepancies related to both tonnages and unit values. Principal suppliers in recent years have been Brazil, Canada, France, Italy, Japan, and South Africa. Principal sources, for 2002 only, were Italy, 40%; France, 26%; Japan, 7%; Canada, 6%; and other, 21%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Granulated slag	2618.00.0000	Free.
Basic slag	3103.20.0000	Free.
Ferrous scale	2619.00.9000	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: Air-cooled blast furnace slag is in declining domestic supply owing to depletion of old slag piles and the closure of many blast furnaces over the years for economic and/or environmental reasons. No new blast furnaces are under construction or are planned. Steel slag from integrated works is likewise in decline; slag from electric arc furnaces (largely fed with steel scrap), in contrast, remains abundant. Both of these slag types compete with natural aggregates. Demand is growing for GGBFS in concrete; spurred by this demand and the much higher unit sales price for GGBFS, two new granulators have been added in recent years to existing blast furnaces, and a number of grinding facilities at independent sites or at cement plants have been constructed to process imported granulated slag. Sales in 2003 of GGBFS were almost 20% of the total slag market. Overall, most of the demand for slag is in large-scale (mostly public-sector) construction projects and fluctuates with levels of construction spending. Local environmental opposition to the use of slag in public sector construction stems from some material, especially if improperly cured, yielding non-neutral-pH, metal-rich, leachate under certain weathering conditions. But use in construction, or locally as feed to cement kilns, is the most economic way to remove otherwise unsightly slag piles and restore the land underneath to its original contours.

World Mine Production, Reserves, and Reserve Base: Slag is not a mined material. Production data for the world are unavailable, but it is estimated that annual world iron and steel slag output is on the order of 240 to 415 million tons, based on typical ratios of slag to crude iron and steel output.

World Resources: Not applicable.

Substitutes: Crushed stone and sand and gravel are common aggregate substitutes in the construction sector. Certain rock types, as well as silica fume and, especially, fly ash, are alternative cementitious additives in blended cements and concrete. As a cement kiln feed, slags (especially steel slag) compete with some of the traditional limestone and other rock raw materials.

[e]Estimated. NA Not available.

[1]The data (obtained from 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. Data for such recovered metal were unavailable.

[2]Sales of open hearth furnace steel slag were only from stockpiles; there was no domestic open hearth steel production in 2003.

[3]Owing to inclusion of new data (especially for granulated slag), data in 2002-3 are not strictly comparable to those of recent previous years.

[4]Data for actual production of marketable slag are unavailable, and the data shown are for sales, largely from stockpiles, and include sales (2002-3) of imported granulated blast furnace slag, either after domestic grinding or still unground. Overall, slag production may be estimated as equivalent to 25% to 30% of crude (pig) iron production and 10% to 15% of crude steel output.

[5]Less than ½ unit.

[6]Defined, for 1999-2001, as production (sales) + imports – exports and, for 2002-3, as total sales of slag (includes that from imported feed) – exports.

[7]The higher price in 2002-3 represents more complete data on sales of ground granulated blast furnace slag, which sold for almost $60 per ton, as opposed to air-cooled blast furnace and steel slags, which sold, on average, in the range of about $4 to $7 per ton.

[8]Defined as imports – exports for 1999-2001 and, for 2002-3, as total sales of import-based slag – exports of slag. Data are unavailable 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:	**1999**	**2000**	**2001**	**2002**	**2003**[e]
Production:					
Mine[e]	90	90	90	90	90
Synthetic mullite[e]	39	40	40	40	40
Imports for consumption (andalusite)	6	6	3	5	7
Exports[e]	35	35	35	35	35
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent[e]	100	101	100	100	102
Price, average, dollars per metric ton:					
U.S. kyanite, raw	158	165	165	165	165
U.S. kyanite, calcined	268	279	279	279	279
Andalusite, Transvaal, South Africa, 57%[1] Al_2O_3	200	161	162	176	203
Andalusite, Transvaal, South Africa, 58%[2] Al_2O_3	225	189	210	206	237
Stocks, producer	NA	NA	NA	NA	NA
Employment, kyanite mine and plant, number[e]	150	150	150	150	150
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1999-2002): South Africa, 100%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Andalusite, kyanite, and sillimanite	2508.50.0000	Free.
Mullite	2508.60.0000	Free.

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

Government Stockpile:

Stockpile Status—9-30-03[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Kyanite, lump	—	0.1	—	0.1	—

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

KYANITE AND RELATED MINERALS

Events, Trends, and Issues: Andalusite Resources (Pty) Ltd. began production at its Maroeleosfontein operation in Limpopo Province in South Africa. The company represents the only independent source of andalusite outside the Imerys group, which has andalusite operations at Glomel, France, and Annesley, South Africa.[5]

The global refractories industry is the largest market for kyanite and mullite. Vesuvius Group S.A., a major refractories company with its head office in Brussels, Belgium, had some plant closures and consolidations. However, the steel industry, which is the largest market for refractories, has shown signs of improved stability in Europe and the United States in 2003. Vesuvius reported significant business activity in the Asia-Pacific region, especially China. Growth in the Chinese market is highly competitive, with hundreds of indigenous refractory producers, some of which have very modern operations. The companies comprise a mixture of state and private ownership.[6]

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[7]
	2002	2003[e]	
United States	[e]90	90	Large in the United States. South Africa reports reserve base of about 51 million tons of aluminosilicates ore (andalusite and sillimanite).
France	65	65	
India	20	20	
South Africa	195	220	
Zimbabwe	10	5	
Other countries	8	5	
World total (rounded)	390	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]For 1999, 57.5% Al_2O_3.
[2]For 1999, 59.5% Al_2O_3.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]Industrial Minerals, 2003, Andalusite Resources on stream: Industrial Minerals, no. 427, April, p. 17.
[6]Moore, Paul, 2003, Let it flow: Industrial Minerals, no. 429, June, p. 14-15.
[7]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 2003, based on the average U.S. producer price, was $435 million. Six lead mines in Missouri plus lead-producing mines in Alaska, Idaho, and Montana yielded most of the total. Primary lead was processed at two smelter-refineries in Missouri. Of the 23 plants that produced secondary lead, 15 had annual capacities of 15,000 tons or more and accounted for more than 99% of secondary production. Lead was consumed at about 120 manufacturing plants. Transportation industries were the principal users of lead, consuming 76% of it for batteries, solder, seals, bearings, and wheel weights. Electrical, electronic, and communications devices (including batteries); ammunition; television glass; construction materials (including radiation shielding); and protective coatings accounted for approximately 22% of consumption. The balance was used in ballast and counterweights, ceramics and crystal glass, tubes and containers, type metal, foil, wire, and specialized chemicals, in order of consumption.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:					
Mine, lead in concentrates	520	465	466	451	450
Primary refinery	350	341	290	262	240
Secondary refinery, old scrap	1,060	1,080	1,050	1,070	1,060
Imports for consumption, lead in concentrates	12	31	2	([1])	([1])
Exports, lead in concentrates	94	117	181	241	160
Imports for consumption, refined metal, wrought and unwrought	323	366	284	218	210
Exports, refined metal, wrought and unwrought	37	49	35	43	95
Shipments from Government stockpile excesses, metal	61	32	41	6	60
Consumption:					
Reported	1,680	1,720	1,550	1,440	1,410
Apparent	1,760	1,740	1,640	1,510	1,460
Price, average, cents per pound:					
North American Producer	43.7	43.6	43.6	43.6	44
London Metal Exchange	22.8	20.6	21.6	20.5	21.5
Stocks, metal, producers, consumers, yearend	91	124	100	105	120
Employment:					
Mine and mill (peak), number	1,100	1,100	1,100	930	830
Primary smelter, refineries	450	450	400	320	320
Secondary smelters, refineries	1,700	1,700	1,600	1,600	1,600
Net import reliance[2] as a percentage of apparent consumption	20	18	19	12	11

Recycling: About 1.1 million tons of secondary lead was produced, an amount equivalent to 77% of domestic lead consumption. Nearly all of it was recovered from old (post-consumer) scrap. About 1 million tons (equivalent to 70% of domestic lead consumption) was recovered from used batteries alone.

Import Sources (1999-2002): Lead in concentrates: Brazil, 34%; Mexico, 31%; Poland, 15%; Peru, 4%; and other, 16%. Metal, wrought and unwrought: Canada, 64%; China, 18%; Australia, 7%; Mexico, 6%; Peru, 1%; Kazakhstan 1%; and other, 3%. Total lead content: Canada, 62%; China, 17%; Mexico, 7%; Australia, 7%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations[3] 12/31/03
Unwrought (refined)	7801.10.0000	2.5% ad val.

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

Government Stockpile:

Stockpile Status—9-30-03[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Lead	104	19	104	54	60

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

LEAD

Events, Trends, and Issues: During 2003, the price of refined lead increased in the United States and world markets. The average North American Producer and London Metal Exchange prices for the first 9 months of the year were 0.2% and 4.7%, respectively, above the averages for the previous year. Worldwide demand for lead rose by 1% in 2003, as vehicle fleet expansion, increased exports of automotive batteries, and further investment in the telecommunications and information technology sectors in China more than countered the decline in demand—particularly for batteries—in the U.S. and European markets. Global output of refined lead fell by about 1% in 2003 mainly because of closures and production cutbacks at smelters and refineries in Australia, Europe, and the United States—more than offsetting production increases in Asia. A close balance between supply and demand for refined lead was anticipated in the industrialized world in 2003, according to a report issued by the International Lead and Zinc Study Group at its 48th Session in Rome, Italy, during October.

U.S. mine production remained at about the same level as in 2002, continuing to be affected by small price increases and weak demand. Production of secondary refined lead, mostly derived from spent lead acid batteries, declined by about 1%. U.S. apparent consumption of lead decreased by about 2% compared with that of 2002. Declining demand for lead in all battery types—including original equipment and replacement automotive types as well as industrial types for the telecommunications industry—accounted for most of the consumption decrease.

The lead-acid battery industry recycled more than 97% of the available lead scrap from spent lead-acid batteries during the period 1997 through 2001, according to a report issued by Battery Council International (BCI) in July 2003. The lead recycling rate ranked higher than that of any other recyclable material. The BCI report tracks lead recycling from spent starting-lighting-ignition batteries—used in automobiles, trucks, motorcycles, boats, and garden tractors—as well as spent industrial batteries used in a variety of motive and stationary battery applications.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	2002	2003[e]		
United States	451	450	8,100	20,000
Australia	683	715	15,000	28,000
Canada	99	80	2,000	9,000
China	600	650	11,000	36,000
Kazakhstan	40	60	5,000	7,000
Mexico	140	140	1,500	2,000
Morocco	75	60	500	1,000
Peru	290	310	3,500	4,000
South Africa	49	40	400	700
Sweden	38	50	500	1,000
Other countries	445	285	19,000	30,000
World total (rounded)	2,910	2,840	67,000	140,000

World Resources: In recent years, significant lead resources have been demonstrated in association with zinc and/or silver or copper in the United States (Alaska), Australia, Canada, China, Ireland, Mexico, Peru, and Portugal. 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.

[e]Estimated.
[1]Less than ½ unit.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]No tariff for Mexico and Canada for item shown.
[4]See Appendix B for definitions.
[5]See Appendix C for definitions. Significant changes from previous reports are based on new information.

LIME[1]

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

Domestic Production and Use: In 2003, 18.2 million metric tons (20.1 million short tons) of quicklime and hydrate was produced (excluding commercial hydrators) in 34 States and Puerto Rico. Production was valued at about $1.17 billion, a slight increase from 2002 levels. Five companies accounted for more than 70% of the total output. Principal producing States, each with production over 1 million tons, were Alabama, Kentucky, Missouri, Nevada, Ohio, Pennsylvania, and Texas. These seven States produced about 11.9 million tons (13.1 million short tons), or 65% of the total output. Major markets for lime were steelmaking, flue gas desulfurization, mining, construction, pulp and paper, precipitated calcium carbonate, and water treatment.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production[3]	19,700	19,600	18,900	17,900	18,200
Imports for consumption	140	113	115	157	131
Exports	59	73	96	106	103
Consumption, apparent	19,800	19,600	19,000	17,900	18,200
Quicklime average value, dollars per ton at plant	57.30	57.50	58.10	59.20	61.40
Hydrate average value, dollars per ton at plant	80.20	85.00	80.70	88.50	91.50
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and plant, number	5,600	5,600	5,500	5,400	5,350
Net import reliance[4] as a percentage of apparent consumption	([5])	([5])	([5])	([5])	([5])

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 (1999-2002): Canada, 87%; and Mexico, 13%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/03**
Quicklime	2522.10.0000	Free.
Slaked lime	2522.20.0000	Free.
Hydraulic lime	2522.30.0000	Free.
Calcined dolomite	2518.20.0000	3% ad. val.

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

Government Stockpile: None.

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

LIME

Events, Trends, and Issues: The U.S. Environmental Protection Agency, as authorized by the Clean Air Act, issued a final rule to reduce toxic air pollutant emissions from lime plants. The rule applies to commercial or captive lime plants, excluding those at pulp and paper mills (regulated under another air toxics rule) and sugar mills (not considered major sources of toxic air pollutants). The final rule sets emissions limits for particulate matter (PM) from existing lime kilns and lime coolers at 0.12 pound of PM per short ton of feed to the kiln, from existing kilns and coolers with wet scrubbers at 0.60 pound per short ton of PM, and from new lime kilns and coolers at 0.10 pound per short ton of PM. The rule also sets limits on PM from certain types of materials handling operations, and it sets requirements for testing, monitoring, and recordkeeping. The rule will reportedly reduce nonvolatile and semivolatile metal hazardous air pollutants by approximately 6.5 short tons per year and PM emissions by 5,900 short tons per year.

Vulcan Materials Co. closed its McCook and Manteno lime plants in Illinois as a result of environmental compliance problems. The McCook plant produced high-calcium quicklime, and the Manteno plant produced dolomitic quicklime; the two plants had a combined capacity of about 380,000 tons per year.[6]

World Lime Production and Limestone Reserves and Reserve Base:

	Production		Reserves and reserve base[7]
	2002	2003[e]	
United States	17,900	18,200	Adequate for all countries listed.
Austria	2,000	2,000	
Brazil	6,300	6,500	
Canada	2,220	2,250	
China	22,500	23,500	
France	2,500	2,500	
Germany	7,000	6,800	
Iran	2,000	2,000	
Italy[8]	3,000	3,000	
Japan (quicklime only)	8,050	7,400	
Mexico	6,500	6,500	
Poland	2,000	2,000	
Russia	8,000	8,000	
South Africa (sales)	1,600	1,600	
United Kingdom	2,000	2,000	
Other countries	22,400	23,000	
World total (rounded)	116,000	117,000	

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 and 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. Excludes Puerto Rico, unless noted.
[2]To convert metric tons to short tons, multiply metric tons by 1.1023.
[3]Sold or used by producers.
[4]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.
[5]Less than ½ unit.
[6]Aggregate Research Institute, 2003, Vulcan to close lime plant near Manteno, accessed November 10, 2003, via URL http://www.aggregateresearch.com/press_archive.asp.
[7]See Appendix C for definitions.
[8]Includes hydraulic lime.

LITHIUM

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

Domestic Production and Use: Chile was the largest lithium chemical producer in the world; Argentina, China, Russia, and the United States were large producers also. 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.

The use of lithium compounds in ceramics, glass, and primary aluminum production represented more than 60% of estimated domestic consumption. Other major end uses for lithium were in the manufacture of lubricants and greases and in the production of synthetic rubber.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production	W	W	W	W	W
Imports for consumption	2,640	2,880	1,990	1,920	2,200
Exports	1,330	1,310	1,480	1,620	1,700
Consumption:					
Apparent	W	W	W	W	W
Estimated	2,800	2,800	1,400	1,100	1,300
Price, yearend, dollars per kilogram:					
Lithium carbonate	4.47	4.47	NA	NA	NA
Lithium hydroxide, monohydrate	5.74	5.74	NA	NA	NA
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 growing through the recycling of lithium batteries.

Import Sources (1999-2002): Chile, 88%; Argentina, 7%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Other alkali metals	2805.19.0000	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 remaining 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 costs for hard rock ores. Two brine operations in Chile dominate the world market; a facility at a brine deposit in Argentina produced lithium chloride and a limited quantity of lithium carbonate. Most of the lithium minerals mined in the world were consumed as ore concentrates 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.

Interest in lithium batteries for electric vehicles (EVs) continued; acceptance, however, of battery-powered EVs was not expanding significantly. Hybrid electric vehicles, vehicles with an internal combustion engine and a battery-powered electric motor, have been more popular than pure EVs. Commercially available hybrid vehicles do not use lithium batteries, although future models may. Other rechargeable lithium batteries were growing in popularity for powering video cameras, portable computers and telephones, and cordless tools. Nonrechargeable lithium batteries were used in calculators, cameras, computers, electronic games, and watches.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[2]	Reserve base[2]
	2002	2003[e]		
United States	W	W	38,000	410,000
Argentina[e]	946	940	NA	NA
Australia[e]	3,140	3,200	160,000	260,000
Bolivia	—	—	—	5,400,000
Brazil	224	240	190,000	910,000
Canada	707	700	180,000	360,000
Chile	5,920	5,900	3,000,000	3,000,000
China	2,400	2,400	540,000	1,100,000
Portugal	190	200	NA	NA
Zimbabwe	640	640	23,000	27,000
World total (rounded)	[3]14,200	[3]14,200	[4]4,100,000	[4]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.
[4]Excludes Argentina and Portugal.

MAGNESIUM COMPOUNDS[1]

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

Domestic Production and Use: Seawater and natural brines accounted for about 55% of U.S. magnesium compounds production. Magnesium oxide and other compounds were recovered from seawater by two companies in Delaware and Florida, from well brines by three 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 Nevada and one company in Texas, and olivine was mined by two companies in North Carolina and 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:	1999	2000	2001	2002	2003[e]
Production	395	370	388	312	285
Imports for consumption	321	395	307	337	350
Exports	52	56	62	66	50
Consumption, apparent	664	709	634	583	585
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant, number[e]	550	450	450	450	370
Net import reliance[2] as a percentage of apparent consumption	41	48	39	46	51

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

Import Sources (1999-2002): China, 66%; Australia, 10%; Canada, 9%; Austria, 3%; and other, 12%.

Tariff:[3] Item	Number	Normal Trade Relations 12/31/03
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: At the beginning of 2003, the Ludington, MI, brine producer announced that it would close its magnesium hydroxide production facility and instead would produce only calcium chloride from brine purchased from another brine producer in Manistee, MI. A 43-kilometer pipeline was installed to feed the brine from Manistee to Ludington. The change, however, had a significant impact on the nearby dead-burned magnesia plant that relies on the Ludington plant to supply its magnesium hydroxide slurry feed material. Because of a lack of feed material, the dead-burned magnesia producer was forced to close its plant in September. This closure leaves the United States with only one dead-burned magnesia producer.

During the first half of 2003, U.S. steel production had increased slightly from than in the corresponding period of 2002, but because of consolidation in the steel industry, there were fewer furnace relinings than would have been expected. As a result, consumption of dead-burned magnesia fell slightly; this was offset by an increase in consumption of caustic-calcined magnesia. Most of the dead-burned magnesia used in the United States was supplied by imports, mainly from China; this country continued to be the largest import source of magnesia.

World Mine Production, Reserves, and Reserve Base:

	Magnesite production		Magnesite reserves and reserve base[4]	
	2002	2003[e]	Reserves	Reserve base
United States	W	W	10,000	15,000
Australia	140	140	100,000	120,000
Austria	202	200	15,000	20,000
Brazil	78	80	45,000	65,000
China	[e]1,070	1,100	380,000	860,000
Greece	[e]144	140	30,000	30,000
India	110	110	14,000	55,000
Korea, North	[e]288	290	450,000	750,000
Russia	[e]288	300	650,000	730,000
Slovakia	144	140	41,000	319,000
Spain	151	150	10,000	30,000
Turkey	576	580	65,000	160,000
Other countries	126	130	390,000	440,000
World total (rounded)	[5]3,320	[5]3,360	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, and magnesium-bearing evaporite minerals are enormous, and magnesia-bearing brines are estimated to constitute a resource in billions of tons. Magnesium hydroxide can be recovered from seawater.

Substitutes: Alumina, silica, and chromite 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 2003, magnesium was produced by one company in Utah by an electrolytic process that recovered magnesium from brines from the Great Salt Lake. The largest use for magnesium, which accounted for 47% of apparent consumption, was as a constituent of aluminum-base alloys that were used for packaging, transportation, and other applications. Structural uses of magnesium (castings and wrought products) accounted for 30% of domestic metal use. Desulfurization of iron and steel accounted for 13% of U.S. consumption of primary metal, and other uses were 10%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:					
Primary	W	W	W	W	W
Secondary (new and old scrap)	86	82	66	74	75
Imports for consumption	91	91	69	88	80
Exports	29	24	20	25	22
Consumption:					
Reported, primary	131	104	96	96	100
Apparent	179	[2]160	[2]120	[2]110	[2]120
Price, yearend:					
Metals Week, U.S. spot Western, dollars per pound, average	1.48	1.27	1.25	1.16	1.10
Metal Bulletin, European free market, dollars per metric ton, average	2,500	2,000	1,825	1,930	1,900
Stocks, producer and consumer, yearend	W	W	W	W	W
Employment, number[e]	700	700	375	375	375
Net import reliance[3] as a percentage of apparent consumption	38	43	44	55	47

Recycling: In 2003, about 26,000 tons of the secondary production was recovered from old scrap.

Import Sources (1999-2002): Canada, 43%; China, 18%; Russia, 17%; Israel, 11%; and other, 11%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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: A magnesium producer in Canada indefinitely closed its 58,000-ton-per-year primary magnesium plant in Quebec in April. Competition from imports from China and technical problems at the plant were cited as the principal reasons for the closure. The sole U.S. magnesium producer continued to install new electrolytic cells at its plant in Utah. These cells are larger, more energy efficient, and generate fewer emissions. Installation of these cells would increase the plant's capacity to 60,000 tons per year from its current level of 45,000 tons per year; no timetable was set for completion.

Construction of a 97,000-ton-per-year magnesium plant in Queensland, Australia, was stopped in June when its owner could not secure additional funding necessary to complete the plant. The company wrote off $525 million for the project. When completed, this plant had been expected to supply a U.S. auto manufacturer with 45,000 tons per year of magnesium for 10 years, worth an estimated $1.3 billion; the supply agreement between the two firms was dissolved. Another company that was planning to construct an 84,000-ton-per-year magnesium plant in South Australia did not raise enough through a stock offering to fund the initial phase of construction of 41,000 tons per year.

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

MAGNESIUM METAL

Despite the difficulties faced by some proposed magnesium projects, other firms continued to plan new magnesium plants. One firm raised enough equity to fund a feasibility study for a 100,000-ton-per-year plant in La Trobe Valley, Victoria, Australia, that would recover magnesium from coal fly ash. The study was scheduled to be completed by 2005. In Canada, a company that plans to construct a 120,000-ton-per-year magnesium extraction plant completed its feasibility study and raised additional capital though a stock offering. The $1.24 billion project near Hope, British Columbia, would recover magnesium from a body of ultramafic rocks containing about 25% magnesium. Also, development of a 60,000-ton-per-year magnesium plant in Congo (Brazzaville) continued with the company raising capital through a stock offering and signing an offtake agreement with a German metals firm. Initial production at the plant is scheduled for 2007, and magnesium would be recovered from a deposit of magnesium salts.

Several magnesium producers in China planned production capacity increases within the next 2 years for metal and/or alloy. In addition to the country's role as a magnesium supplier to the United States, China is becoming a significant supplier to Europe. With the closure of nearly all of Europe's primary magnesium production facilities by the end of 2002 and the removal of the European Commission's antidumping duty on magnesium from China in April 2003, Europe has become an attractive market for magnesium from China. By midyear, increasing coal prices in China led to an increase in magnesium production costs and a subsequent increase in China free market prices. Prices increased from about $1,400 per metric ton at the beginning of 2003 to about $1,650 per metric ton near the end of the year.

Some U.S. magnesium consumers had financial difficulties in 2003. A large desulfurization reagent producer filed for Chapter 11 bankruptcy in June. Much of the company's production is sold to steel producers, and the recent bankruptcy filings of many U.S. steel producers cost the company more than $5.5 million over the past 3 years. One of the largest U.S. producers of magnesium wrought products filed for Chapter 11 bankruptcy protection in January; this company's Madison, IL, plant was purchased by a United Kingdom-based magnesium scrap processor.

For the 2004 model year, the average North American-produced family vehicle contained about 4.5 kilograms (10 pounds) of magnesium castings. This quantity has been increasing each year and has doubled in 10 years. Auto manufacturers continued to broaden the use of existing magnesium diecastings by installing them in new models. In addition, magnesium producers are investigating new magnesium-base alloys with enhanced properties that could increase magnesium's use in automotive applications.

World Primary Production, Reserves, and Reserve Base:

	Primary production	
	2002	**2003**[e]
United States	W	W
Brazil	6	6
Canada	80	50
China	[e]230	300
Israel	34	30
Kazakhstan	18	14
Norway	10	—
Russia	[e]50	45
Serbia and Montenegro	1	2
World total[5]	429	447

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. — Zero.
[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 2003. Manganese ore was consumed mainly by about eight firms with plants principally in the Eastern United States and the Midwestern United States. Most ore consumption was related to steel production, directly in pig iron manufacture and indirectly through upgrading ore to ferroalloys and metal. Additional quantities of ore were used for such nonmetallurgical purposes as production of dry cell batteries, as an ingredient in plant fertilizers and animal feed, and as a colorant for brick. Manganese ferroalloys were produced at two smelters. Leading identifiable end uses of manganese were in products for construction, machinery, and transportation, which were estimated to be 27%, 11%, and 11%, respectively, of total 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 $205 million.

Salient Statistics—United States:[1]	1999	2000	2001	2002	2003[e]
Production, mine[2]	—	—	—	—	—
Imports for consumption:					
Manganese ore	460	430	358	427	390
Ferromanganese	312	312	249	275	240
Silicomanganese[3]	301	378	269	247	200
Exports:					
Manganese ore	4	10	9	15	9
Ferromanganese	12	8	9	9	9
Shipments from Government stockpile excesses:[4]					
Manganese ore	76	63	37	56	44
Ferromanganese	35	33	2	38	28
Consumption, reported:[5]					
Manganese ore[6]	479	486	425	360	410
Ferromanganese	281	300	266	253	266
Consumption, apparent, manganese[7]	719	768	692	689	610
Price, average value, 46% to 48% Mn metallurgical ore, dollars per mtu cont. Mn, c.i.f. U.S. ports	2.26	2.39	2.44	2.30	2.35
Stocks, producer and consumer, yearend:					
Manganese ore[6]	172	226	138	148	127
Ferromanganese	40	31	25	21	14
Net import reliance[8] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Scrap recovery specifically for manganese was negligible, but a significant amount was recycled through processing operations as a minor component of ferrous and nonferrous scrap and steel slag.

Import Sources (1999-2002): Manganese ore: Gabon, 71%; South Africa, 13%; Australia, 9%; Brazil, 3%; and other, 4%. Ferromanganese: South Africa, 49%; France, 20%; Mexico, 7%; Australia, 6%; and other, 18%. Manganese contained in all manganese imports: South Africa, 34%; Gabon, 20%; Australia, 12%; Mexico, 7%; and other, 27%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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: In addition to the quantities shown below, the stockpile contained 331,000 metric tons of nonstockpile-grade metallurgical ore, all of which was authorized for disposal.

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

MANGANESE

Stockpile Status—9-30-03[9]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Battery:					
Natural ore	48	7	48	27	27
Synthetic dioxide	3	—	3	3	—
Chemical ore	84	28	84	36	—
Metallurgical ore	336	231	336	227	23
Ferromanganese, high-carbon	720	15	720	23	23
Electrolytic metal	0.5	0.03	0.5	2	2

Events, Trends, and Issues: The annual growth rate for manganese ferroalloy demand usually falls in the range of 1% to 2% and is tied to steel production. Through the first 8 months of 2003, however, domestic steel production was the same as that for the same period in 2002. Ferromanganese prices in the United States trended downward from those at the end of 2002, while silicomanganese prices increased owing to slight supply deficits. Manganese ore prices increased as a result of an increase in the international benchmark price for metallurgical-grade ore set between Japan and major suppliers in mid-2003. Manganese is an essential nutritional element for people, animals, and plants, but it can be harmful in excessive amounts. In July 2003, the U.S. Environmental Protection Agency determined that no regulatory action under the Safe Drinking Water Act was necessary for regulating manganese in drinking water because available data suggest it is generally not toxic when ingested with the diet, and drinking water accounts for a relatively small proportion of manganese intake.

World Mine Production, Reserves, and Reserve Base (metal content): Data for reserves and reserve base have been revised downward from those previously published for Brazil and upward for South Africa reserves based on information reported by the Government of Brazil and the major manganese producers of South Africa. Reserves for South Africa are based on reported company estimates of proven and probable reserves.

	Mine production 2002	Mine production 2003[e]	Reserves[10]	Reserve base[10]
United States	—	—	—	—
Australia	983	990	32,000	82,000
Brazil	[e]1,300	950	23,000	51,000
China	[e]900	900	40,000	100,000
Gabon	[e]810	1,000	20,000	160,000
India	[e]630	630	15,000	33,000
Mexico	88	85	4,000	9,000
South Africa	1,504	1,630	32,000	[11]4,000,000
Ukraine	940	830	140,000	520,000
Other countries	955	985	Small	Small
World total (rounded)	[e]8,100	8,000	300,000	5,000,000

World Resources: Land-based 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 more than 80 % of the world's identified resources, and Ukraine account for more about 10%.

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

[e]Estimated. — Zero.
[1]Manganese content typically ranges from 35% to 54% for manganese ore and from 74% to 95% for ferromanganese.
[2]Excludes insignificant quantities of low-grade manganiferous ore.
[3]Imports more nearly represent amount consumed than does reported consumption; internal evaluation indicates that reported consumption of silicomanganese is considerably understated.
[4]Net quantity.
[5]Total manganese consumption cannot be approximated from consumption of manganese ore and ferromanganese because the ore is used to produce manganese ferroalloys and metal.
[6]Exclusive of ore consumed at iron and steel plants.
[7]Thousand 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 has not been mined as a primary mineral commodity in the United States since 1992. A small quantity of byproduct mercury was recovered from gold ore, but production was not reported. Recovery of mercury from obsolete or wornout items remains the principal source of domestic mercury production. The chlorine-caustic soda industry is the largest end user of mercury as an electrolyte, and that mercury is recycled in-plant. Mercury in varying amounts is used in, and may be recycled from, automobile convenience switches, barometers, computers, dental amalgam, manometers, mercury-vapor and fluorescent lamps, thermometers, and thermostats. It is also used in cleansers, pesticides, folk medicine, and skin lighteners; however, its use in batteries and paints has been discontinued.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production:					
Mine	NA	NA	NA	NA	NA
Secondary, industrial	NA	NA	NA	NA	NA
Imports for consumption (gross weight)	62	103	100	209	200
Exports (gross weight)	181	182	108	201	200
Price, average value, dollars per flask, free market	140.00	155.00	155.00	155.00	170.00
Net import reliance[2] as a percentage of apparent consumption[e]	>95%	>95%	>95%	>95%	>95%

Recycling: Recycling of old scrap, chiefly from in-plant processing of amalgam from the chlorine-caustic soda production process, accounted for most of the domestic mercury production in 2003.

Import Sources (1999-2002): Australia, 30%; Chile, 30%; Germany, 15%; Peru, 12%; and other, 13%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/03**
Mercury	2805.40.0000	1.7% ad val.

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

Government Stockpile: In addition to the quantities shown below, 146 tons of secondary mercury was held by the U.S. Department of Energy at Oak Ridge, TN. The Defense National Stockpile Center has prepared a Mercury Management Environmental Impact Statement to determine how to manage its elemental mercury inventory. A Record of Decision will be published that discusses which storage option will be implemented. Sales from the National Defense Stockpile remained suspended.

Stockpile Status—9-30-03[3]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2003**	**Disposals FY 2003**
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: Federal, State, and local governments are concerned about the toxic effects of mercury, and therefore regulations are being implemented that address mercury releases, recycling, and the final disposition of mercury-bearing products. As a result, environmental standards and regulations are likely to continue as the major determinants of domestic mercury supply and demand. The major component of supply will remain the secondary industry owing to the recycling of many products and various wastes to avoid deposition in landfills. Domestic primary production is expected to remain limited to byproduct production where the mercury is recovered to avoid releases to the environment. Domestic mercury consumption will continue to decline as mercury-containing products such as dental amalgam or thermometers are replaced by ceramic fillings and digital thermometers, respectively.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2002	2003[e]		
United States	NA	NA	—	7,000
Algeria	800	400	2,000	3,000
Italy	—	—	—	69,000
Kyrgyzstan	250	250	7,500	13,000
Spain	300	500	76,000	90,000
Other countries	405	400	38,000	61,000
World total (rounded)	1,760	1,600	120,000	240,000

World Resources: In the United States, there are mercury occurrences in Alaska, California, Nevada, and Texas. World mercury resources are estimated at nearly 600,000 tons, principally in Kyrgyzstan, Russia, Slovenia, Spain, and Ukraine. These are sufficient for another century or more, especially with declining consumption rates. Byproduct mercury may be produced at copper, gold, and lead mines worldwide; however, there are no data on the amount of mercury produced.

Substitutes: Diaphragm and membrane cells replace mercury cells in the electrolytic production of chlorine and caustic soda. Lithium, nickel-cadmium, and zinc-air batteries are substitutes for mercury-zinc batteries. Indium compounds substitute for mercury in alkaline batteries. Ceramic composites can replace dental amalgams. Organic compounds have replaced mercury fungicides in latex paint, and digital instruments have replaced mercury instruments in many applications.

[e]Estimated. 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 0.034 ton.

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

[3]See Appendix B for definitions.

[4]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 97,000 tons in 2003. North Carolina accounted for about 40% of U.S. production. The remaining output came from Georgia, New Mexico, 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 2003 scrap mica production was estimated at $20.2 million. Ground mica sales in 2002 were valued at $29.6 million. There were nine domestic producers of scrap and flake mica.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:[2, 3]					
Mine	95	101	98	81	98
Ground	111	112	89	98	107
Imports, mica powder and mica waste	21	29	32	38	14
Exports, mica powder and mica waste	11	10	9	10	7
Consumption, apparent[4]	125	119	121	106	105
Price, average, dollars per ton, reported:					
Scrap and flake	148	136	82	90	120
Ground:					
Wet	849	751	771	960	1,000
Dry	192	169	147	180	200
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine, number[5]	367	NA	NA	NA	NA
Net import reliance[6] as a percentage of apparent consumption	10	15	19	24	7

Recycling: None.

Import Sources (1999-2002): Canada, 55%; India, 24%; China, 12%; Argentina, 2%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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 increased in 2003. The increase primarily resulted from higher production in Georgia, New Mexico, and South Dakota. Production in North Carolina in 2003 was estimated to be essentially unchanged from 2002. Development continued at a newly opened mica operation in Arizona, and the associated processing plant produced several wet ground mica products. The United States remained a major world producer of scrap and flake mica. 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]
	2002	2003[e]		
United States[2]	81	98	Large	Large
Brazil	4	4	Large	Large
Canada	17	17	Large	Large
India	2	2	Large	Large
Korea, Republic of	40	40	Large	Large
Russia	100	100	Large	Large
Other countries	35	35	Large	Large
World total (rounded)	280	300	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, vermiculite, and perlite, 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: A minor amount of sheet mica was produced in 2003, 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 2003, an estimated 130 tons of unworked mica split block and mica splittings valued at $348 thousand was consumed by five companies in four States, mainly in the East and Midwest. Most was fabricated into parts for electronic and electrical equipment. An additional estimated 1,010 tons of imported worked mica valued at $11.1 million also was consumed.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, mine[e]	([2])	([2])	([2])	([2])	([2])
Imports, plates, sheets, strips; worked mica; split block; splittings; other > $1.00/kg	4,550	5,430	4,290	1,580	1,140
Exports, plates, sheets, strips; worked mica; crude and rifted into sheet or splittings > $1.00/kg	1,290	1,150	1,160	723	1,030
Shipments from Government stockpile excesses	708	1,230	1,860	894	1,280
Consumption, apparent	3,980	5,500	4,990	1,750	1,390
Price, average value, dollars per kilogram, muscovite and phlogopite mica, reported:					
Block	20	23	55	50	60
Splittings	1.67	1.81	1.67	1.82	2.00
Stocks, fabricator and trader, yearend	NA	NA	NA	NA	NA
Net import reliance[3] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1999-2002): India, 67%; Belgium, 13%; China, 4%; Germany, 3%; and other, 13%.

Tariff:

Item	Number	Normal Trade Relations 12/31/03
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—9-30-03[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Block:					
Muscovite (stained and better)	7.24	12.0	7.11	([5])	2.89
Phlogopite	—	([2])	—	—	([2])
Film, muscovite	0.506	—	0.506	([5])	([2])
Splittings:					
Muscovite	—	1,290	—	([5])	—
Phlogopite	12.2	—	12.2	([5])	119

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 decreased in 2003. The decrease in apparent consumption was primarily the result of decreased imports. Although U.S. imports of worked mica increased, unworked mica imports of split block and splittings decreased substantially, partly because of increased shipments from the National Defense Stockpile (NDS). Imports, however, remained a principal source of the domestic supply of sheet mica. Stocks of mica remaining in the NDS have declined and future supplies are expected to come increasingly from imports, primarily from India. Prices for imported sheet mica also are expected to increase. The availability of good quality 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		Reserves[6]	Reserve base[6]
	2002[e]	2003[e]		
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	Large	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 the sheet mica.

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]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]The total disposal plan for all categories of mica in the National Defense Stockpile is undifferentiated at 3,856 metric tons (8,500,000 pounds).
[6]See Appendix C for definitions.

MOLYBDENUM

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

Domestic Production and Use: In 2003, molybdenum, valued at about $342 million (based on average oxide price), was produced by six mines. Molybdenum ore was produced at three primary molybdenum mines, one each in Colorado, Idaho, and New Mexico; whereas three copper mines in Arizona and Utah recovered molybdenum as a byproduct. Two roasting plants converted molybdenite (MoS_2) concentrate to molybdic oxide, from which intermediate products, such as ferromolybdenum, metal powder, and various chemicals, were produced. Iron and steel, cast and wrought alloy, and superalloy producers accounted for about 75% of the molybdenum consumed.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, mine	42,400	40,900	37,600	32,600	34,100
Imports for consumption	14,000	15,000	13,400	11,500	11,800
Exports	32,700	27,900	31,500	23,600	32,300
Consumption:					
Reported	18,700	18,300	15,800	14,400	14,900
Apparent	28,000	28,600	20,100	21,200	13,900
Price, average value, dollars per kilogram[1]	5.90	5.64	5.20	8.27	11.57
Stocks, mine and plant concentrates, product, and consumer materials	12,000	11,400	10,700	10,000	9,800
Employment, mine and plant, number	610	618	518	489	510
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Secondary 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. Quantities of molybdenum recycled from new and old scrap are estimated to be 30% of the apparent supply of molybdenum.

Import Sources (1999-2002): Ferromolybdenum: China, 78%; United Kingdom, 19%; and other, 3%. Molybdenum ores and concentrates: Mexico, 58%; Canada, 38%; Chile, 2%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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 2003 increased about 5% from that of 2002. U.S. imports for consumption increased an estimated 3% from those of 2002, while the U.S. exports increased 37% from those of 2002. The increase in exports reflects the return to full year production levels in 2003 after reduced byproduct molybdenum production by the copper companies in the first half of 2002. U.S. reported consumption increased 3% from that of 2002. Mine capacity utilization was about 40%.

China continued its high level of steel production and consumption, thus providing a stable demand for molybdenum. In addition, copper production cutbacks of prior years stabilized copper prices and allowed some production capacity to come back online in 2003, thus increasing byproduct molybdenum production. The Continental Pit operation in Butte, MT, reopened and resumed mining activities in December. The operation is expected to produce about 3,200 tons (7 million pounds) of molybdenum in 2004. With the continuing high price of nickel-bearing stainless steel in 2003, consumers increasingly considered use of duplex stainless steel. If this trend holds, molybdenum consumption could be increased in the near future.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	2002	2003[e]	(thousand metric tons)	
United States	32,600	34,100	2,700	5,400
Armenia	3,500	4,000	200	400
Canada	7,500	7,500	450	910
Chile	29,500	31,400	1,100	2,500
China	29,300	30,000	3,300	8,300
Iran	1,700	1,700	50	140
Kazakhstan	230	225	130	200
Kyrgyzstan	250	250	100	180
Mexico	3,400	3,500	90	230
Mongolia	1,590	1,500	30	50
Peru	9,500	9,500	140	230
Russia[e]	2,900	2,900	240	360
Uzbekistan[e]	500	500	60	150
World total (rounded)	123,000	127,000	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 the metal, industry has sought to develop new materials that benefit from the alloying properties of molybdenum. Potential substitutes for molybdenum include chromium, vanadium, columbium (niobium), 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]Major producer price per kilogram of molybdenum contained in technical-grade molybdic oxide.

[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 2003. Limited amounts of byproduct nickel, though, were recovered from copper and palladium-platinum ores mined in the Western United States. On a monthly or annual basis, 143 facilities reported nickel consumption. The principal consuming State was Pennsylvania, followed by West Virginia, Kentucky, and Indiana. Approximately 41% of the primary nickel consumed went into nonferrous alloy and superalloy production, 39% into stainless and alloy steels, 18% into electroplating, and 2% into other uses. Ultimate end uses were as follows: transportation, 32%; chemical industry, 14%; electrical equipment, 11%; construction, 9%; fabricated metal products, 8%; machinery, 7%; household appliances, 6%; petroleum industry, 6%; and other, 7%. Estimated value of apparent primary consumption was $1.19 billion.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production, mine	—	—	—	—	—
Shipments of purchased scrap[1]	93,000	123,000	141,000	130,000	131,000
Imports: Primary	139,000	156,000	136,000	121,000	133,000
Imports: Secondary	9,480	10,700	8,760	9,110	10,500
Exports: Primary	7,440	8,150	8,450	6,520	5,930
Exports: Secondary	31,400	49,900	48,600	39,400	48,800
Consumption: Reported, primary	116,000	115,000	98,800	87,300	71,200
Consumption: Reported, secondary	71,000	84,000	101,000	99,800	92,900
Consumption: Apparent, primary	140,000	147,000	129,000	121,000	126,000
Consumption: Total[2]	211,000	231,000	230,000	221,000	218,000
Price, average annual, London Metal Exchange:					
Cash, dollars per metric ton	6,011	8,638	5,945	6,772	9,446
Cash, dollars per pound	2.727	3.918	2.696	3.072	4.285
Stocks: Government, yearend	—	—	—	—	—
Stocks: Consumer, yearend	10,000	14,300	13,900	12,700	13,200
Stocks: Producer, yearend[3]	12,700	12,300	12,600	6,150	7,140
Employment, yearend, number: Mine	1	1	—	—	—
Employment, yearend, number: Smelter and port	1	—	—	—	—
Net import reliance[4] as a percentage of apparent consumption	63	56	46	48	48

Recycling: About 92,900 tons of nickel was recovered from purchased scrap in 2003. This represented about 57% of total reported consumption for the year.

Import Sources (1999-2002): Canada, 42%; Norway, 12%; Russia, 12%; Australia, 10%; and other, 24%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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 9,700 tons of nickel ingot contaminated by low-level radioactivity plus 3,600 tons of contaminated shredded nickel scrap. Planned decommissioning activities at former nuclear defense sites are expected to generate an additional 23,000 tons of shredded scrap.

Events, Trends, and Issues: Stainless steel accounts for two-thirds of the primary nickel used in the world. U.S. production of austenitic (nickel-bearing) stainless steel reached an all-time high of 1.49 million tons in 2003—6% more than the previous record of 1.41 million tons set in 2002. U.S. stainless producers continued to struggle against significant import penetration and were hurt by lackluster demand and a flat economy in the first half of 2003. Imported steels accounted for 25% of the 1.96 million tons of total stainless steel used in the United States in 2002.

World mine production was at an all-time high in 2003 despite a 3-month-long strike at a major operation in Canada's Sudbury Basin. Since 1950, stainless steel production in the Western World has been growing at an average rate of

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

NICKEL

6.0% per year. Demand for stainless steel in China has been particularly robust since 2000 and is now on par with that of Japan. Prices moved upward for most of the year, reaching levels not seen in the market since 1989. For the week ending November 28, 2003, the London Metal Exchange cash price for 99.8% pure nickel averaged $12,096 per metric ton ($5.49 per pound). Twelve months earlier, the cash price was only $7,390 per ton ($3.35 per pound). High prices could encourage substitution of duplex or ferritic stainless for applications where austenitic is now used. Some nickel consumers were concerned that global demand for the metal would outstrip supply before several new mining projects could be completed. In mid-2002, a major Canadian-based producer began developing the huge Voisey's Bay sulfide deposit in northeastern Labrador. The same company also was developing the Goro laterite deposit at the southeastern tip of New Caledonia. The New Caledonian nickel was to be recovered onsite using advanced pressure acid leach (PAL) technology. In Australia, three greenfield PAL projects built in 1998-9 continued to ramp up production. A second generation of Australian PAL projects was in varying stages of development. Competitors were considering employing some form of acid leach technology to recover nickel at greenfield sites in Cuba, Indonesia, and the Philippines. Several automobile manufacturers were using nickel-metal hydride (NiMH) batteries to power their gasoline-electric hybrid vehicles for the 2005 and 2006 model years. Demand for gasoline-electric hybrid vehicles has been gradually building up in the United States since their introduction in late 1999. Three commercial models were being offered in North America—all of Japanese design. In mid-2003, about 31,100 hybrid passenger cars were operating on U.S. highways. In November 2003, a leading NiMH battery manufacturer commissioned a major production facility at Springboro, OH, near Dayton. The new plant will enable the manufacturer to produce up to 1.2 million battery modules per year for transportation and stationary applications.

World Mine Production, Reserves, and Reserve Base: Estimates of reserves for Brazil, China, Colombia, and the Dominican Republic were revised based on new information from the mining industry.

	Mine production		Reserves[5]	Reserve base[5]
	2002	2003[e]		
United States	—	—	—	—
Australia	211,000	220,000	22,000,000	27,000,000
Botswana	20,005	18,000	490,000	920,000
Brazil	45,029	46,000	4,500,000	8,300,000
Canada	178,338	180,000	5,200,000	15,000,000
China	54,500	56,000	1,100,000	7,600,000
Colombia	58,196	65,000	830,000	1,000,000
Cuba	73,000	75,000	5,600,000	23,000,000
Dominican Republic	38,859	39,000	740,000	1,000,000
Greece	22,670	23,000	490,000	900,000
Indonesia	122,000	120,000	3,200,000	13,000,000
New Caledonia	99,650	120,000	4,400,000	12,000,000
Philippines	26,532	27,000	940,000	5,200,000
Russia	310,000	330,000	6,600,000	9,200,000
South Africa	38,546	40,000	3,700,000	12,000,000
Venezuela	18,200	21,000	610,000	610,000
Zimbabwe	8,092	8,000	15,000	260,000
Other countries	14,000	12,000	1,300,000	5,100,000
World total (rounded)	1,340,000	1,400,000	62,000,000	140,000,000

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: With few exceptions, substitutes for nickel would result in increased cost or tradeoff in the economy or performance of the product. Aluminum, coated steels, and plastics can replace stainless steel to a limited extent in many construction and transportation applications. Nickel-free specialty steels are sometimes used in place of stainless steel within the power generating, petrochemical, and petroleum industries. Titanium alloys or specialty plastics can substitute for nickel metal or nickel-base superalloys in highly corrosive chemical environments.

[e]Estimated. — Zero.

[1]Scrap receipts – shipments by consumers + exports – imports + adjustments for consumer stock changes.

[2]Apparent primary consumption + reported secondary consumption.

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

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

[5]See Appendix C for definitions.

NITROGEN (FIXED)—AMMONIA

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

Domestic Production and Use: Ammonia was produced by 17 companies at 34 plants in the United States during 2003. Fifty-three 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 2003, U.S. producers operated at about 59% of their rated capacity. The United States remained the world's second largest ammonia producer and consumer following China. 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]	1999	2000	2001	2002	2003[e]
Production[2]	12,900	11,800	9,350	10,800	9,300
Imports for consumption	3,890	3,880	4,550	4,670	7,200
Exports	562	662	647	437	500
Consumption, apparent	16,300	14,900	13,500	15,200	16,000
Stocks, producer, yearend[3]	996	1,120	916	771	800
Price, dollars per ton, average, f.o.b. Gulf Coast[3]	109	169	183	137	240
Employment, plant, number[e]	2,200	2,000	1,800	1,700	1,550
Net import reliance[4] as a percentage of apparent consumption	21	21	31	29	42

Recycling: None.

Import Sources (1999-2002): Trinidad and Tobago, 57%; Canada, 22%; Russia, 9%; and other, 12%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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: A precipitous increase in natural gas prices in the beginning of 2003 resulted in the temporary closure of a significant portion of U.S. nitrogen production capacity. By the end of February, when the Henry Hub spot natural gas price had risen briefly to more than $18 per million British thermal units (Btu), about two-thirds of the U.S. ammonia production capacity was idled. By mid-March, the natural gas price had fallen to less than $6 per million Btu, and by the end of the month, some of the idled capacity had come back onstream. In June and July, more than 20% of the U.S. ammonia production capacity was idled again, responding to a seasonal drop in demand or increasing natural gas prices; natural gas prices were more than $6 per million Btu. Much of this capacity was brought back onstream in October as natural gas prices approached $4 per million Btu. With the drop in domestic production in 2003, imports of ammonia grew, replacing an even larger share of production.

The International Trade Administration, U.S. Department of Commerce, announced preliminary antidumping duties on urea ammonium nitrate (UAN) solutions imported into the United States from Belarus, Russia, and Ukraine in 2002. In 2003, the U.S. International Trade Commission reversed the decision and determined that U.S. producers did not suffer material injury from UAN imports from these three countries. Rather, the UAN was shipped during a period of high U.S natural gas prices, and the high natural gas prices were the main cause of the U.S. industry's declining profitability, not low-cost imports.

Responding to Congressional concerns about the effects of high natural gas prices on U.S. nitrogen fertilizer producers and farmers, the U.S. Government Accounting Office (GAO) undertook a study to determine the effects of natural gas prices on production and availability of nitrogen fertilizer and the role of the Federal Government in mitigating the impact of natural gas prices on the U.S. fertilizer market. GAO concluded that although higher natural gas prices have contributed to higher nitrogen fertilizer prices, supplies have generally been adequate during periods

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

NITROGEN (FIXED)—AMMONIA

of high natural gas prices because of increased imports and that the Federal Government had a limited role in managing the effects of natural gas prices on the fertilizer market. Ammonia production in the United States generally consumes about 3% of the natural gas produced each year.

After the third-largest U.S. ammonia producer filed for bankruptcy in 2002, the company that had been the seventh largest producer (6% of U.S. capacity) purchased the bankrupt producer's plants in Beatrice, NE, Dodge City, KS, Enid, OK, and Fort Dodge, IA, in May 2003 as well as the company's share of a joint-venture plant in Trinidad and Tobago. As a result of this purchase, it became the largest U.S. ammonia producer, with 18% of the total U.S. production capacity. The company's Coffeyville, KS, petroleum coke-to-ammonia plant was sold to a separate company. The sixth largest domestic ammonia producer (10% of total U.S. capacity) filed for Chapter 11 bankruptcy protection in May citing financial losses resulting from the volatility of U.S. natural gas prices as the principal cause for the filing. This company and its subsidiaries operate ammonia plants in Donaldsonville, LA, and Yazoo City, MS, with a total capacity of 1.52 million tons of ammonia per year.

No significant ammonia production capacity additions are planned for 2004. Many of the planned large-scale projects are expected to come onstream from 2005 to 2007; much of this capacity is being built in the Middle East.

According to long-term projections from the U.S. Department of Agriculture, U.S. plantings for eight major field crops rose by about 1.6% from 2002 to 2003. Corn, wheat, and soybeans represent about 85% of the crop total. Corn and wheat acreage each rose in 2003 in response to reduced supplies and high market prices. Plantings were projected to decline during the next 2 years as supplies rebound and prices fall. Because corn is the most nitrogen-intensive of the major field crops, a drop in corn plantings should translate to a decline in ammonia demand in the United States.

Nitrogen compounds are also 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]
	2002	2003[e]	
United States	10,800	9,300	Available atmospheric nitrogen and sources of natural gas for production of ammonia are considered adequate for all listed countries.
Canada	3,600	3,800	
China	30,100	31,000	
Egypt	1,840	1,800	
Germany	2,560	2,850	
India	9,830	9,000	
Indonesia	4,200	4,300	
Netherlands	1,970	1,600	
Pakistan	1,960	2,000	
Poland	1,310	1,400	
Russia	8,600	9,100	
Saudi Arabia	1,740	1,650	
Trinidad and Tobago	3,300	3,400	
Ukraine	3,700	4,100	
Other countries	23,000	23,000	
World total (rounded)	109,000	108,000	

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 MA325B and 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 $15.9 million in 2003. Peat was harvested and processed by about 55 companies in 15 of the conterminous States; several other producers in Alaska were canvassed independently by the Alaska Department of Natural Resources. Florida, Michigan, and Minnesota were the largest producing States, in order of quantity harvested. Reed-sedge peat accounted for 88% of the total volume produced, followed by hypnum moss, 4%, humus, 4%, and sphagnum moss, 4%. More than 85% of domestic peat was sold for horticultural use, including general soil improvement, potting soils, earthworm culture, nurseries, and golf course construction. Other applications included seed inoculants, vegetable cultivation, mushroom culture, mixed fertilizers, and packing for flowers and plants. 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:	1999	2000	2001	2002	2003[e]
Production	731	792	870	642	618
Commercial sales	834	847	998	933	728
Imports for consumption	752	786	776	763	790
Exports	40	37	31	32	30
Consumption, apparent[2]	1,580	1,530	1,640	1,420	1,390
Price, average value, f.o.b. mine, dollars per ton	26.48	26.85	24.82	26.70	25.75
Stocks, producer, yearend	272	279	257	207	200
Employment, mine and plant, number[e]	800	800	800	800	800
Net import reliance[3] as a percentage of apparent consumption	54	48	47	55	55

Recycling: None.

Import Sources (1999-2002): Canada, 99%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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 production in the conterminous United States has fallen from a high of 870,000 tons in 2001 to 618,000 tons in 2003 mainly because a major processor ceased harvesting peat. Additionally, several companies in the Midwest were affected by wet weather conditions that reduced amount of peat harvested. Sphagnum moss peat is preferred for potting soils, seed propagation, garden mulches, and other home gardening applications because of its fibrous composition and superior ability to retain moisture. Sphagnum peat was imported both in packaged and bulk form for custom soil blending.

Because peat is the primary constituent of growing media, the demand for peat generally follows that for horticultural applications. Over the past decade, golf course construction and maintenance, residential and commercial landscaping, and rising interest in home gardening have all contributed to increased peat usage. According to recent studies, four out of five U.S. households undertook some form of lawn and garden activity, and the average family spent $466 per year on their yards. Overall, gardening is a $40 billion per year industry in the United States. Although demand for peat in the United States will likely continue to grow, the amount obtained from domestic producers may be supplanted by imports from Canada. Several other important factors, including Federal and State wetlands protection regulations, restrictions on permitting new bogs, and competition from composted yard waste and other organic materials also will have an influence the domestic peat industry.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2002	2003[e]		
United States	642	618	15,000	6,400,000
Belarus	2,100	2,000	([5])	([5])
Canada	1,300	1,300	22,000	30,000,000
Estonia	850	800	([5])	([5])
Finland	5,500	6,500	64,000	3,000,000
Germany	4,100	4,000	42,000	450,000
Ireland	2,750	5,000	160,000	820,000
Latvia	560	600	([5])	([5])
Lithuania	270	550	([5])	([5])
Moldova	475	475	([5])	([5])
Russia	2,100	2,100	([5])	([5])
Sweden	1,150	1,200	([5])	([5])
Ukraine	1,000	1,000	([5])	([5])
United Kingdom	500	250	([5])	([5])
Other countries	862	912	4,900,000	160,000,000
World total (rounded)	24,200	27,300	5,200,000	200,000,000

World Resources: U.S. resources of peat were estimated at more than 110 billion tons, with more than 50% located in undisturbed areas of Alaska. World resources of peat were estimated to be 2 trillion tons, of which Belarus, Russia, Ukraine, and other countries of the Commonwealth of Independent States have about 770 billion tons and Canada about 510 billion tons.

Substitutes: Natural organic materials may be composted and compete with peat in certain applications. Shredded paper is 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]Defined as production + imports – exports + adjustments for industry stocks.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions.
[5]Included with "Other countries."

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 2003 was $19.2 million. Crude ore production came from 10 mines operated by 8 companies in 7 Western States. New Mexico continued to be the major producing State. Processed ore was expanded at 63 plants in 30 States. The principal end uses were building construction products, 64%; horticultural aggregate, 13%; fillers, 9%; filter aid, 9%; and other, 5%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production[1]	711	672	588	521	512
Imports for consumption[e]	144	180	175	224	240
Exports[e]	47	43	43	42	40
Consumption, apparent	808	809	720	703	712
Price, average value, dollars per ton, f.o.b. mine	33.40	33.78	36.31	36.45	37.36
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill	150	150	145	145	140
Net import reliance[2] as a percentage of apparent consumption	12	17	18	26	28

Recycling: Not available.

Import Sources (1999-2002): Greece, 100%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Mineral substances, not specifically provided for	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: Production[1] of domestic perlite decreased about 2% compared with that of 2002. Domestic production decreased for the fourth year in a row and has dropped nearly 28% since 1999. Imports increased about 7% compared with 2002, setting a record for a second consecutive year.

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 with strong cost disadvantages compared with Greek imports. 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 overburden, reject ore, and mineral fines 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, Crude Ore Reserves, and Reserve Base:

	Production		Reserves[3]	Reserve base[3]
	2002	2003[e]		
United States	521	512	50,000	200,000
Greece	360	360	50,000	300,000
Hungary	150	175	3,000	([4])
Japan	250	250	([4])	([4])
Turkey	150	150	([4])	5,700,000
Other countries	150	160	600,000	1,500,000
World total (rounded)	1,600	1,600	700,000	7,700,000

World Resources: Insufficient information is available to estimate resources in perlite-producing countries with any reliability.

Substitutes: Alternative materials can be substituted for all uses of perlite, if necessary. Long-established competitive commodities include diatomite, expanded clay and shale, pumice, slag, and vermiculite.

[e]Estimated. NA Not available.
[1]Processed perlite sold and used by producers.
[2]Defined as imports – exports + adjustments for Government and industry stock changes; changes in stocks not available and assumed to be zero for apparent consumption and net import reliance calculations.
[3]See Appendix C for definitions.
[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 nine firms in four States, and upgraded to an estimated 33.3 million tons of marketable product valued at $895 million, f.o.b. mine. Florida and North Carolina accounted for 85% of total domestic output, with the remainder produced in Idaho and Utah. More than 95% of the U.S. phosphate rock ore mined was used to manufacture wet-process phosphoric acid and superphosphoric acid, which were used as intermediates in the manufacture of granular and liquid ammonium phosphate fertilizers and animal feed supplements. More than 50% of the wet-process phosphoric acid produced was exported in the form of upgraded granular diammonium and monoammonium phosphate (DAP and MAP, respectively) fertilizer, triple superphosphate fertilizer, and merchant-grade phosphoric acid. The balance of the phosphate rock mined was used to manufacture elemental phosphorus, which was used to produce high-purity phosphoric acid and phosphorus compounds for use in a variety of industrial and food-additive applications.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, marketable	40,600	38,600	31,900	36,100	33,300
Sold or used by producers	41,600	37,400	32,800	34,700	34,800
Imports for consumption	2,170	1,930	2,500	2,700	2,500
Exports	272	299	9	39	5
Consumption[1]	43,500	39,000	35,300	37,400	37,300
Price, average value, dollars per ton, f.o.b. mine[2]	30.56	24.14	26.82	27.47	26.93
Stocks, producer, yearend	6,920	8,170	7,510	8,860	7,500
Employment, mine and beneficiation plant, number[e]	7,200	6,300	6,000	5,800	5,500
Net import reliance[3] as a percentage of apparent consumption	7	1	9	3	10

Recycling: None.

Import Sources (1999-2002): Morocco, 99%; and other, 1%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/03**
Natural calcium phosphates:		
Unground	2510.10.0000	Free.
Ground	2510.20.0000	Free.

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

Government Stockpile: None.

Events, Trends, and Issues: After a slight recovery in 2002, phosphate rock production dropped in 2003 owing to the closure of one mine in Idaho for the entire year and a 5-month closure of a mine in Florida combined with an effort to reduce stocks of phosphate rock by several other producers. Consumption, sales, and usage of phosphate rock were about the same as in 2002. Phosphoric acid and elemental phosphorus production also were about the same. Production and exports of DAP, the primary phosphate fertilizer, were down substantially because of lower sales to China.

The operator of the closed mine in Idaho also closed its associated purified phosphoric acid (PPA) plant that had opened in 2001 to replace its elemental phosphorus facility. The closure was necessitated by a restructuring program that included closing its sodium tripolyphosphate plant, which was supplied exclusively by the PPA facility. Its joint-venture partner purchased the PPA facility for manufacturing merchant-grade phosphoric acid for fertilizer use.

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

PHOSPHATE ROCK

Domestic fertilizer consumption is projected to remain flat in 2004 based on projected planted acreage for major crops and average weather conditions. Phosphate rock production is likely to remain below capacity in the Florida, as companies reduce stocks and adjust production to meet demand and to extend the lifespan of existing mines.

The several new mines that are planned to open in the next 5 years would be replacements for existing mines and probably would not have a significant impact on annual production capacity. However, the permitting procedures for new mines in Florida have became increasingly difficult because of opposition from local governments and the public concerning the potential affect on the environment. Phosphate rock and fertilizer production is expected to remain steady in Idaho and Utah because output in the region only is used domestically.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2002	2003[e]		
United States	36,100	33,300	1,000,000	4,000,000
Australia	2,025	2,200	77,000	1,200,000
Brazil	4,850	4,960	260,000	370,000
Canada	1,000	1,200	25,000	200,000
China	23,000	24,000	6,600,000	13,000,000
Egypt	1,500	1,500	100,000	760,000
India	1,250	1,250	90,000	160,000
Israel	3,500	4,000	180,000	800,000
Jordan	7,180	7,200	900,000	1,700,000
Morocco and Western Sahara	23,000	24,000	5,700,000	21,000,000
Russia	10,700	11,000	200,000	1,000,000
Senegal	1,500	1,500	50,000	160,000
South Africa	2,910	2,500	1,500,000	2,500,000
Syria	2,400	2,400	100,000	800,000
Togo	1,280	2,100	30,000	60,000
Tunisia	7,750	7,700	100,000	600,000
Other countries	4,830	7,000	800,000	2,000,000
World total (rounded)	135,000	138,000	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 are based on official government data and include deposits of low-grade ore. 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 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.
[1]Defined as 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 (PGM) production sites in the United States. These mines produced about 820,000 metric tons of ore and recovered more than 18,000 kilograms of palladium and platinum in 2003. Small quantities of PGM were also recovered as byproducts of copper refining by companies in Texas and Utah. Catalysts for air pollution abatement continued to be the largest demand sector for PGM. In the United States, more than 100,000 kilograms of PGM was used by the automotive industry in the manufacture of catalytic converters. 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:	1999	2000	2001	2002	2003[e]
Mine production:[1]					
Platinum	2,920	3,110	3,610	4,390	4,100
Palladium	9,800	10,300	12,100	14,800	14,600
Imports for consumption:					
Platinum	125,000	93,700	84,200	160,000	111,000
Palladium	189,000	181,000	160,000	117,000	73,000
Rhodium	10,300	18,200	12,400	9,890	8,630
Ruthenium	11,400	20,900	8,170	10,800	9,940
Iridium	2,270	2,700	3,110	2,100	1,800
Osmium	23	133	77	36	25
Exports:					
Platinum	19,400	25,000	31,300	27,800	15,900
Palladium	43,800	57,900	37,000	42,700	17,000
Rhodium	114	797	982	348	290
Price,[2] dollars per troy ounce:					
Platinum	378.94	549.30	533.29	542.56	590.00
Palladium	363.20	691.84	610.71	339.68	290.50
Rhodium	904.35	1,990.00	1,598.67	838.88	750.25
Ruthenium	40.70	129.76	130.67	66.33	55.60
Employment, mine, number	954	1,290	1,320	1,420	1,400
Net import reliance as a percentage of apparent consumption:[e]					
Platinum	96	78	90	93	96
Palladium	92	84	87	69	74

Recycling: An estimated 6,000 kilograms of PGM was recovered from new and old scrap in 2003.

Import Sources (1999-2002): Platinum: South Africa, 30%; United Kingdom, 19%; Germany, 16%; Canada, 13%; Russia, 8%; and other, 14%. Palladium: Russia, 50%; South Africa, 15%; United Kingdom, 11%; Belgium, 5%; Germany, 5%; and other, 14%.

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

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

Government Stockpile:

Stockpile Status—9-30-03[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003[4]	Disposals FY 2003
Platinum	650	—	650	1,560	—
Palladium	1,823	—	1,823	10,900	5,213
Iridium	631	—	631	187	153

Prepared by **Henry E. Hilliard [(703) 648-4970, hhilliar@usgs.gov, fax: (703) 648-7757]**

PLATINUM-GROUP METALS

Events, Trends, and Issues: South Africa's PGM producers were in the process of reevaluating their ambitious expansion plans announced in 1999 and raised the prospect that their production targets will not be met within the allocated timeframe. The expansions were deemed necessary to meet anticipated growth in demand for PGM from the automobile catalyst and jewelry sectors. However, the volatility of the South Africa rand against the U.S. dollar has forced producers to put some of the expansion plans on hold.

Domestic imports for consumption of PGM declined sharply as end users worked off stocks and reduced their requirements for the metals through thrifting and substitution. Russia and South Africa accounted for most of the imports. U.S. exports decreased sharply. Switzerland received most of the exports, followed by Germany and Canada.

Palladium and platinum prices were at near record highs in the first quarter of 2002, but began to diverge in the fourth quarter when palladium prices sank to near record lows. The price of platinum however, continued to climb, trading between $590 and $600 per ounce in 2003 compared with $543 in 2002. Market conditions carried the price of platinum to an 12-month high of $605 per ounce in mid-November, 2002, subsequently falling back and stabilizing at around $590 in the first half of 2003. Palladium prices firmed in the second quarter of 2003, trading in the $200 to $230 per ounce range.

World Mine Production, Reserves, and Reserve Base:

	Mine production				PGM	
	Platinum		Palladium		Reserves[5]	Reserve base[5]
	2002	2003[e]	2002	2003[e]		
United States	4,390	4,100	14,800	14,600	900,000	2,000,000
Canada	7,000	7,000	11,500	11,000	310,000	390,000
Russia	35,000	36,000	84,000	74,000	6,200,000	6,600,000
South Africa	134,000	135,000	64,000	64,800	63,000,000	70,000,000
Other countries	3,400	5,000	6,900	7,000	800,000	850,000
World total (rounded)	184,000	187,000	181,000	171,000	71,000,000	80,000,000

World Resources: World resources of PGM 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. In 2003, there were 10 producing mines in the Bushveld Complex; of these, 9 produced from the Merensky Reef and the UG2 Chromite Layer and 1 produced from the Platreef, on the northern limb of the Complex.

Substitutes: Some motor vehicle manufacturers have substituted platinum for the more expensive palladium in catalytic converters. 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. — Zero.
[1]Estimates from published sources.
[2]Handy & Harman quotations.
[3]See Appendix B for definitions.
[4]Actual quantity will be limited to remaining sales authority or inventory.
[5]See Appendix C for definitions.

POTASH

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

Domestic Production and Use: In 2003, the production value of marketable potash, f.o.b. mine, was about $260 million; sales decreased relative to 2002. 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 separation, or combinations of these processes, and provided more than 70% 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 recovered the 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 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 potash was produced as MOP. Potassium sulfate (sulfate of potash) and potassium magnesium sulfate (sulfate of potash-magnesia), required by certain crops and soils, were also sold.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production, marketable[1]	1,200	1,300	1,200	1,200	1,100
Imports for consumption	4,470	4,600	4,540	5,300	4,500
Exports	459	367	366	367	370
Consumption, apparent[2]	5,600	5,100	5,600	5,400	5,300
Price, dollars per metric ton of K_2O, average, muriate, f.o.b. mine[3]	145	145	155	155	155
Employment, number:					
Mine	660	610	585	540	520
Mill	725	665	670	645	620
Net import reliance[4, 5] as a percentage of apparent consumption	80	80	80	80	80

Recycling: None.

Import Sources (1999-2002): Canada, 93%; Russia, 3%; Belarus, 2%; Germany, 1%; and other, 1%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/03**
Crude salts, sylvinite, etc.	3104.10.0000	Free.
Potassium chloride	3104.20.0000	Free.
Potassium sulfate	3104.30.0000	Free.
Potassium nitrate	2834.21.0000	Free.
Potassium-sodium nitrate mixtures	3105.90.0010	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: The world's largest potash producers operated below capacity for another year owing to potential oversupply. At the end of 2002, North American producer stocks were slightly less than 25% of annual production (8 million tons) resulting in a slight decline in potash prices. There were extended summer vacations and turnarounds (nonproducing periods of maintenance and upgrades) at the mines and mills in United States, Canada, and the Commonwealth of Independent States, which allowed a slight price rise in the traditionally low priced Asian Pacific Basin. By the end of August 2003, North American potash stocks were down to about 1 million tons. Domestic producers supplied more than 10% of domestic consumption with MOP sales going mostly to the southwestern United States. Through June, exports of domestic potash declined by about 32,000 tons, K_2O, to 200,000 tons. Total MOP exports declined by about 20%, while exports to Latin America fell by about 30% for the first half of the year. Total SOP exports of increased by about 7%, and shipments to the Asia-Pacific area increased by about 10%. Total exports of sulfate of potash-magnesia declined by about 14%. Sulfate of potash-magnesia exports to Latin America were essentially unchanged, while exports to the Asia-Pacific area fell by about 40%.

Prepared by **James P. Searls [(703) 648-7724, jsearls@usgs.gov, fax: (703) 648-7975]**

POTASH

In June 2003, the parent corporation of a Carlsbad, NM, MOP producer filed for Chapter 11 bankruptcy protection. The horizontally integrated fertilizer firm was having trouble with profitability in nitrogen and phosphorus sales.

Based on data from the first half of 2003, estimated annual 2003 potash consumption in Asian Pacific is expected to decline by about 9% compared to 2002 and to account for approximately 33% of the world total. Potash consumption in Eastern Europe, and Central Asia is forecast to decline by about 15% from that of 2002 and to account for about 7% of the world consumption in 2003. Latin America potash consumption is forecast to increase by about 38% and to account for about 20% of the world total in 2003. North America is forecast to remain unchanged and account for about 20% of the world total consumption. Potash consumption in Western Europe and Central Europe is predicted to decline by about 5% and to account for about 18% of the world consumption in 2003.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	2002	2003[e]		
United States	[1]1,200	[1]1,100	90,000	300,000
Belarus	3,800	4,000	750,000	1,000,000
Brazil	352	380	300,000	600,000
Canada	8,200	8,500	4,400,000	9,700,000
Chile	350	420	10,000	50,000
China	450	450	8,000	450,000
Germany	3,450	3,600	710,000	850,000
Israel	1,930	2,050	[7]40,000	[7]580,000
Jordan	1,200	1,200	[7]40,000	[7]580,000
Russia	4,400	4,600	1,800,000	2,200,000
Spain	407	470	20,000	35,000
Ukraine	60	10	25,000	30,000
United Kingdom	540	610	22,000	30,000
Other countries	—	—	50,000	140,000
World total (rounded)	26,300	27,400	8,300,000	17,000,000

World Resources: Estimated domestic potash resources total about 6 billion tons. Most of this lies 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 of reserves in central Michigan. Estimated world resources total about 250 billion tons. The potash deposits in the Russia and Thailand contain large amounts of carnallite; it is not clear if this can be profitably mined 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 the nearest 0.1 million ton to avoid disclosing company proprietary data.
[2]Rounded to the nearest 0.2 million ton 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]Rounded to one significant digit to avoid disclosing company proprietary data.
[6]See Appendix C for definitions.
[7]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 2003 was about $22 million. Domestic output came from 16 producers in 6 States. Pumice and pumicite was mined in Arizona, California, Idaho, Kansas, New Mexico, and Oregon. About 63% of production came from Arizona and Oregon. About 76% of the pumice was consumed for building blocks, and the remaining 24% was used in abrasives, concrete, horticulture, landscaping, stone-washing laundries, and other applications.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production, mine[1]	1,000	1,050	920	956	914
Imports for consumption	354	385	379	360	400
Exports[e]	23	27	27	30	30
Consumption, apparent	1,330	1,410	1,270	1,320	1,280
Price, average value, dollars per ton, f.o.b. mine or mill	27.69	24.27	21.42	20.69	23.56
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number	105	105	100	100	100
Net import reliance[2] as a percentage of apparent consumption	25	25	28	25	29

Recycling: Not available.

Import Sources (1999-2002): Greece, 77%; Italy, 18%; Turkey, 4%; and other, 1%.

Tariff:

Item	**Number**	**Normal Trade Relations 12/31/03**
Crude or in irregular pieces, including crushed pumice	2513.11.0000	Free.
Other	2513.19.0000	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 2003 decreased 4% compared with that of 2002. Imports increased about 11% compared with those of 2002 as more Greek and Italian pumice was brought into the eastern half of the United States. Total apparent consumption in 2003 fell about 2% compared with that of 2002.

In 2004, domestic mine production of pumice and pumicite is expected to be about 1 million tons, with U.S. apparent consumption at approximately 1.35 million tons. Imports, mainly from Greece, will continue to supply markets primarily in the U.S. East Coast and Gulf Coast States.

Although pumice and pumicite are plentiful in the Western United States, changes in laws and public land designations could decrease access to many deposits. Pumice and pumicite are sensitive to mining costs, and, if domestic production costs were to increase, imports and competing materials might replace pumice in many domestic markets.

All domestic mining of pumice in 2003 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]
	2002	2003[e]		
United States[1]	956	914	Large	Large
Algeria	400	450	NA	NA
Chile	750	850	NA	NA
Ecuador	280	100	NA	NA
France	450	450	NA	NA
Germany	500	500	NA	NA
Greece	1,600	1,600	NA	NA
Guadeloupe	210	210	NA	NA
Guatemala	260	270	NA	NA
Iran	700	700	NA	NA
Italy	4,600	4,600	NA	NA
Spain	600	600	NA	NA
Turkey	700	800	NA	NA
Other countries	1,000	1,000	NA	NA
World total (rounded)	13,000	13,000	NA	NA

World Resources: The identified U.S. domestic resources of pumice and pumicite in the West are estimated to be at least 25 million tons. The estimated total resources (identified and undiscovered) in the Western and Great Plains States are 250 million to 450 million tons.

Substitutes: Transportation cost determines the maximum distance that pumice and pumicite can be shipped and remain competitive with alternate materials. Competitive materials that can be substituted for pumice and pumicite for several end uses include crushed aggregates, diatomite, and expanded shale and clay.

[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 was stopped at the end of 1997, but three U.S. firms continued to produce cultured quartz crystals by using imported and stockpiled lascas as feed material. 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 television receivers and electronic games.

Salient Statistics—United States: Production statistics for cultured quartz crystals were withheld to avoid disclosing company proprietary data. Trade data for cultured quartz crystal and devices with mounted quartz crystal are available, but lascas import data are not available. Exports of cultured quartz crystals totaled about 53 tons, and imports were about 10 tons in 2003. The average value of exports and imports was $208,000 per ton and $210,000 per ton, respectively. Other salient statistics were not available.

Recycling: None.

Import Sources (1999-2002): The United States is 100% import reliant. Brazil, Germany, and Madagascar are reportedly the major sources for lascas with Canada becoming an increasingly important supplier. Other possible sources of lascas include China, South Africa, and Venezuela.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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—9-30-03[2]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Quartz crystal	7	97	([3])	98	98

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), particularly in the United States, will continue to promote domestic production. The growing global electronics market may require additional production capacity worldwide.

World Mine Production, Reserves, and Reserve Base: 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 (e.g., 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]Less than ½ unit.

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 2003. Bastnäsite, a rare-earth fluocarbonate mineral, was previously mined as a primary product at Mountain Pass, CA. The United States was a processor of rare earths and continued to be a major exporter and consumer of rare-earth products in 2003. The estimated value of refined rare earths consumed in the United States was more than $1 billion. The approximate distribution in 2002 by end use was as follows: petroleum refining catalysts, 27%; glass polishing and ceramics, 23%; automotive catalytic converters, 21%; metallurgical additives and alloys, 15%; permanent magnets, 5%; rare-earth phosphors for lighting, televisions, computer monitors, radar, and X-ray intensifying film, 4%; and other, 5%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, bastnäsite concentrates[e]	5,000	5,000	5,000	5,000	—
Imports:[2]					
Thorium ore (monazite)	—	—	—	—	—
Rare-earth metals, alloy	1,780	2,470	1,420	1,450	1,130
Cerium compounds	3,990	4,310	3,850	2,540	2,630
Mixed REOs	5,980	2,190	2,040	1,040	2,150
Rare-earth chlorides	1,530	1,330	2,590	1,800	1,890
Rare-earth oxides, compounds	7,760	11,200	9,150	7,260	10,900
Ferrocerium, alloys	120	118	118	89	111
Exports:[2]					
Rare-earth metals, alloys	1,600	1,650	884	1,300	1,190
Cerium compounds	3,960	4,050	4,110	2,740	1,940
Other rare-earth compounds	1,690	1,650	1,600	1,340	1,450
Ferrocerium, alloys	2,360	2,250	2,500	2,830	2,800
Consumption, apparent	11,500	12,100	15,100	11,000	11,500
Price, dollars per kilogram, yearend:					
Bastnäsite concentrate, REO basis[e]	4.85	4.08	4.08	4.08	4.08
Monazite concentrate, REO basis	0.73	0.73	0.73	0.73	0.73
Mischmetal, metal basis, metric ton quantity[3]	5-7	5-7	5-7	5-6	5-6
Stocks, producer and processor, yearend	W	W	W	W	W
Employment, mine and mill, number	78	78	90	95	90
Net import reliance[4] as a percentage of apparent consumption	70	71	67	54	100

Recycling: Small quantities, mostly permanent magnet scrap.

Import Sources (1999-2002): Rare-earth metals, compounds, etc.: China, 66%; France, 25%; Japan, 4%; Estonia, 3%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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

<u>Events, Trends, and Issues</u>: Domestic demand for rare earths in 2003 was essentially the same as that of 2002. U.S. imports of rare earths decreased in most trade categories as a result of decreased demand in the United States in 2002. Although the rare-earth separation plant at Mountain Pass, CA, is still closed, it is expected to resume operations, possibly in 2004. The mine at Mountain Pass continued to produce bastnäsite concentrates and cerium concentrates. The trend is for continued increased use of the rare earths in many applications, especially automotive catalytic converters, permanent magnets, and rechargeable batteries.

The international conference *Rare Earths '04* is planned for November 7-12, in Nara, Japan. The *Fifth International Conference of f-Elements (ICFE-5)* was held in Geneva, Switzerland, August 24-29, 2003. The first *Scandium Symposium* was held August 17-23, 2003, in Oslo, Norway. *The International Conference on Magnetism (ICM 2003)* convened in Rome, Italy, July 27-August 1, 2003.

<u>World Mine Production, Reserves, and Reserve Base</u>: Brazil's reserve base was lowered based on marginal reserves becoming subeconomic.

	Mine production[e]		Reserves[5]	Reserve base[5]
	2002	2003		
United States	5,000	—	13,000,000	14,000,000
Australia	—	—	5,200,000	5,800,000
Brazil	—	—	110,000	200,000
Canada	—	—	940,000	1,000,000
China	88,000	90,000	27,000,000	89,000,000
Commonwealth of Independent States	2,000	2,000	19,000,000	21,000,000
India	2,700	2,700	1,100,000	1,300,000
Malaysia	450	450	30,000	35,000
South Africa	—	—	390,000	400,000
Sri Lanka	120	120	12,000	13,000
Other countries	—	—	21,000,000	21,000,000
World total (rounded)	98,300	95,000	88,000,000	150,000,000

<u>World Resources</u>: 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. Xenotime, rare-earth-bearing (ion adsorption) clays, loparite, phosphorites, apatite, eudialyte, secondary monazite, cheralite, and spent uranium solutions make up most of the remaining resources. Undiscovered resources are thought to be very large relative to expected demand.

<u>Substitutes</u>: Substitutes are available for many applications, but generally are less effective.

[e]Estimated. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Data includes lanthanides and yttrium, but excludes most scandium. See also Scandium and Yttrium.
[2]REO equivalent or contents of various materials were estimated. Data from U.S. Census Bureau.
[3]Price range from Elements—Rare Earths, Specialty Metals and Applied Technology, Trade Tech, Denver, CO, and web-based High Tech Materials, Longmont, CO.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.

RHENIUM

(Data in kilograms of rhenium content, unless otherwise noted)

Domestic Production and Use: During 2003, ores containing rhenium were mined by three operations. Rhenium compounds are included in molybdenum concentrates derived from porphyry copper deposits in the Southwestern United States, 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 high-temperature superalloys used in turbine engine components, representing about 40% and 50%, respectively, of the total demand. Rhenium was used in petroleum-reforming catalysts for the production of high-octane hydrocarbons, which are used in the production of lead-free gasoline. Bimetallic platinum-rhenium catalysts have replaced many of the monometallic catalysts. Rhenium improves the high-temperature (1,000° C) strength properties of some nickel-base superalloys. Some of the uses for rhenium alloys were in crucibles, electrical contacts, electromagnets, electron tubes and targets, heating elements, ionization gauges, mass spectrographs, metallic coatings, semiconductors, temperature controls, thermocouples, and vacuum tubes. The estimated value of rhenium consumed in 2003 was $20 million.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production[1]	6,600	7,500	6,300	4,400	4,600
Imports for consumption	14,700	15,900	23,400	16,600	14,500
Exports	NA	NA	NA	NA	NA
Consumption, apparent	21,300	23,400	29,600	21,000	19,100
Price, average value, dollars per kilogram, gross weight:					
Metal powder, 99.99% pure	1,100	1,010	910	1,030	1,110
Ammonium perrhenate	610	510	790	810	840
Stocks, yearend, consumer, producer, dealer	NA	NA	NA	NA	NA
Employment, number	Small	Small	Small	Small	Small
Net import reliance[2] as a percentage of apparent consumption	69	68	79	79	76

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 (1999-2002): Rhenium metal: Chile, 87%; and other, 13%. Ammonium perrhenate: Kazakhstan, 28%; Estonia, 6%; United Kingdom, 6%; and other, 10%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Other inorganic acids, other—rhenium, etc.	2811.19.6050	4.2% ad val.
Salts of peroxometallic acids, other—ammonium perrhenate	2841.90.2000	3.1% ad val.
Rhenium, etc., (metals) waste and scrap	8112.92.0500	Free.
Rhenium, (metals) unwrought; powders	8112.92.5000	3% ad val.
Rhenium, etc., (metals) wrought; etc.	8112.99.0100	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 2003, the average rhenium prices were $1,110 per kilogram for metal and $840 per kilogram for ammonium perrhenate in the United States. Production increased by 5%, and imports of rhenium decreased by about 16%. Increased rhenium recovery in the United States was due to resumed production of byproduct molybdenum concentrates from porphyry copper deposits. Copper production from these deposits had been reduced in 2002 to stabilize copper prices. The United States relied on imports for much of its supply of rhenium. Chile and Germany supplied the majority of the rhenium imported.

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: Production data for the United States were revised to reflect rhenium recovered from byproduct molybdenum concentrates. Production data for Chile were revised based on new information.

	Mine production[3]		Reserves[4]	Reserve base[4]
	2002	2003		
United States	4,400	4,600	390,000	4,500,000
Armenia	800	800	95,000	120,000
Canada	1,700	1,700	—	1,500,000
Chile	14,100	15,000	1,300,000	2,500,000
Kazakhstan	2,600	2,900	190,000	250,000
Peru	5,000	5,000	45,000	550,000
Russia	1,400	1,500	310,000	400,000
Other countries	1,000	1,000	91,000	360,000
World total (rounded)	31,000	33,000	2,400,000	10,000,000

World Resources: Most rhenium occurs with molybdenum in porphyry copper deposits. Identified U.S. resources are estimated to be about 4.5 million kilograms, and the identified resources of the rest of the world are approximately 5.5 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 may decrease rhenium's share of the catalyst market. Materials that can substitute for rhenium in various end uses are as follows: cobalt and tungsten for coatings on copper X-ray targets, rhodium and rhodium-iridium for high-temperature thermocouples, tungsten and platinum-ruthenium for coatings on electrical contacts, and tungsten and tantalum for electron emitters.

[e]Estimated. NA Not available. — Zero.
[1]Based on estimated rhenium contained in MoS_2 concentrates assuming 90% recovery of rhenium content.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]Estimated amount of rhenium extracted in association with copper and molybdenum production.
[4]See Appendix C for definitions.

RUBIDIUM

(Data in kilograms of rubidium content, unless otherwise noted)

Domestic Production and Use: Rubidium is not mined in the United States, and only a small number of U.S. companies process imported rubidium ore. Small amounts of rubidium and its compounds are used for inorganic chemicals, as standards for atomic absorption analytical techniques, in gas-type vapor cells, DNA separation, fiber optics, night vision devices, and lamps. Both rubidium and cesium are used in atomic clocks. Rubidium is important in geochronology, and rubidium-82 (a decay product of strontium-82) is used in imaging technology in the diagnosis of heart conditions.

Salient Statistics—United States: Data on production of rubidium from Canada, the major source of U.S. supplies, are proprietary; consumption, import, and export data are not available. The U.S. rubidium market is small, and annual consumption amounts to only a few thousand kilograms. The metal is not traded and, therefore, no market price is available. Prices for rubidium and rubidium compounds have remained stable. In 2003, 1-gram ampoules of 99.75%-grade rubidium metal were offered at $54.10, and the price for 100 grams of the same material was $1,038.00.

Recycling: None.

Import Sources (1999-2002): The United States is 100% import reliant. Canada is the chief source of rubidium ore imported by the United States.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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: Use and consumption of rubidium and rubidium compounds are not commercially significant nor are environmental or human health issues associated with use or processing of the metal. Present technology does not indicate a potentially new rubidium market nor is a change in use patterns predicted.

World Mine Production, Reserves, and Reserve Base: Canada is the world's leading producer of rubidium, which is found in trace amounts in some potassium-bearing minerals such as micas and feldspars that form during the crystallization of pegmatites. These exceptionally coarse-grained rocks formed late in the crystallization of granitic magma and may have concentrations of unusual and rare elements. Lepidolite is a potassium-lithium mica that may contain up to 3.15% rubidium and is the principal ore of rubidium. Rubidium may also be obtained as a byproduct from pollucite, a cesium aluminosilicate mineral that may contain up to 1.35% rubidium. There are, however, no minerals in which rubidium is the predominant metallic element. Rubidium has also been reported in brines in northern Chile and in China and also in salt beds in Germany, France, and New Mexico.

World Resources: There are pegmatite occurrences in Maine and South Dakota in which rubidium may be present in minor amounts in lepidolite. Lepidolite, which is also an important source of lithium, may occur with pollucite, the ore mineral of cesium, in zoned pegmatites. These minerals are mined chiefly in Canada; however, there are pegmatite occurrences in Afghanistan, Namibia, Zambia and other countries. World resources of rubidium are unknown, but supplies of lepidolite are adequate for current use patterns.

Substitutes: The properties of rubidium and its compounds are similar to those of cesium and its compounds. Therefore, rubidium and cesium may be used interchangeably in atomic clocks and other applications; however, cesium is less expensive.

SALT

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Domestic production of salt increased slightly in 2003 based on only 35% of the salt operations responding to the production estimate canvass. The total value was estimated at $1 billion. Twenty nine companies operated 69 plants in 15 States. The estimated percentage of salt sold or used, by type, was salt in brine, 51%; rock salt, 30%; vacuum pan, 11%; and solar salt, 8%.

The chemical industry consumed about 45% of total salt sales, with salt in brine representing about 89% of the type of salt used for feedstock. Chlorine and caustic soda manufacture was the main consuming sector within the chemical industry. Salt for highway deicing accounted for 31% of U.S. demand. The remaining markets for salt, in declining order, were distributors, 8%; industrial, 6%; agricultural, 4%; food, 4%; water treatment, 2%; and other combined with exports, less than 1%.

Salient Statistics—United States:[1]	1999	2000	2001	2002	2003[e]
Production	44,900	45,600	44,800	40,300	41,200
Sold or used by producers	44,400	43,300	42,200	37,700	38,600
Imports for consumption	8,870	8,960	12,900	8,160	12,000
Exports	892	642	1,120	689	500
Consumption:					
Reported	50,000	54,000	48,700	43,600	50,100
Apparent	52,400	51,600	54,000	45,100	50,100
Price, average value of bulk, pellets and packaged salt, dollars per ton, f.o.b. mine and plant:					
Vacuum and open pan salt	112.49	113.95	120.02	120.02	122.00
Solar salt	52.08	50.46	52.33	53.93	59.00
Rock salt	22.55	20.67	21.84	21.62	20.00
Salt in brine	6.65	5.70	6.26	5.89	6.00
Stocks, producer, yearend[e, 2]	500	2,300	NA	NA	NA
Employment, mine and plant, number	4,100	4,100	4,100	4,100	4,100
Net import reliance[3] as a percentage of apparent consumption	15	16	22	17	23

Recycling: None.

Import Sources (1999-2002): Canada, 42%; Chile, 20%; Mexico, 12%; The Bahamas, 9%; and other, 17%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Iodized salt	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: Severe winter weather during the first quarter of 2003 increased sales of rock salt for highway deicing. In addition to an increase in domestic rock salt production, imports rose to add to the supply availability of deicing salt. During the fourth quarter, sufficient supplies of rock salt were made available should there be further adverse winter weather.

The Washington State Department of Transportation extended its pilot project to evaluate the performance of rock salt and alternative deicing chemicals along several State roads. The State stopped using rock salt several years ago because of concerns about corrosion and the effect of salt on the environment. Although more expensive deicing chemicals had been used, corrosion still happened on vehicles. This project will address how much corrosion reduction is actually happening using the more expensive deicing agents when compared with the less expensive rock salt.

A State commission is evaluating a project that would increase the availability of fresh water in California by constructing numerous coastal desalination plants. Opponents to the proposal claim that the desalination plants could harm marine life, alter sensitive habitats, trap plants and small sea creatures in water intake pipes, and discharge large quantities of salt to the ocean.

Domestic consumption of salt in 2003 is expected to be higher than that of 2002. With the proposed closure of some solar salt capacity in California, domestic production may decline, but overall supplies, especially those from imports, should meet any unanticipated increase in demand.

World Production, Reserves, and Reserve Base:

	Production		Reserves and reserve base[4]
	2002	2003[e]	
United States[1]	40,300	41,200	Large. Economic and subeconomic deposits of salt are substantial in principal salt-producing countries. The oceans contain an inexhaustible supply of salt.
Australia	9,890	10,000	
Brazil	5,600	6,100	
Canada	12,300	12,300	
China	32,800	34,000	
France	7,000	7,000	
Germany	15,700	14,000	
India	14,500	15,000	
Italy	3,600	3,600	
Mexico	8,500	8,000	
Poland	4,200	3,500	
Russia	2,800	3,000	
Spain	3,200	3,200	
Ukraine	2,300	2,500	
United Kingdom	5,800	5,800	
Other countries	41,500	41,000	
World total (rounded)	210,000	210,000	

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 applicable.
[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 $5.8 billion was produced by an estimated 4,000 companies from 6,400 operations in 50 States. Leading States, in order of decreasing tonnage, were California, Texas, Michigan, Arizona, Ohio, Minnesota, Washington, Wisconsin, Nevada, and Colorado, which together accounted for about 54% of the total output. It is estimated that about 53% of the 1.13 billion tons of construction sand and gravel produced in 2003 was for unspecified uses. Of the remaining total, about 42% was used as concrete aggregates; 23% for road base and coverings and road stabilization; 15% as construction fill; 12% as asphaltic concrete aggregates and other bituminous mixtures; 3% for concrete products, such as blocks, bricks, pipes, etc.; 1% for plaster and gunite sands; and the remaining 4% for snow and ice control, railroad ballast, roofing granules, filtration, 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 2003 was about 851 million tons, a slight increase from the revised total for the same period of 2002. 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:	1999	2000	2001	2002	2003[e]
Production	1,110	1,120	1,130	1,130	1,130
Imports for consumption	2	3	4	4	4
Exports	2	2	3	3	3
Consumption, apparent	1,110	1,120	1,130	1,130	1,130
Price, average value, dollars per ton	4.73	4.81	5.02	5.07	5.14
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e]	37,800	37,800	37,500	35,300	35,300
Net import reliance[3] as a percentage of apparent consumption	—	([4])	([4])	([4])	([4])

Recycling: Asphalt road surfaces and cement concrete surfaces and structures were recycled on an increasing basis.

Import Sources (1998-2001): Canada, 72%; Mexico, 18%; The Bahamas, 2%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Sand, construction	2505.90.0000	Free.
Gravel, construction	2517.10.0000	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: Construction sand and gravel output remained at approximately 1.13 billion tons, about equal to that of 2002. It is estimated that 2004 domestic production and U.S. apparent consumption will be about 1.2 billion tons each, a slight increase. Aggregate consumption is expected to continue to grow slowly in response to the slowly growing economy and outlays for road and other construction. Although some areas of the country could experience increased sales and consumption of sand and gravel and other areas may have decreases, overall growth should be slightly positive.

The construction sand and gravel industry continues to be concerned with safety and health and environmental regulations. Movement of sand and gravel operations away from highly populated centers is expected to continue where local zoning, environmental, and land development regulations discourage sand and gravel operations. Consequently, shortages of construction sand and gravel in urban and industrialized areas also are expected to increase.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	2002	2003[e]	
United States	1,130	1,130	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 their geographic distribution, environmental restrictions, 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 river flood plains, river channels, and glacial deposits. Offshore deposits are being used presently in the United States, mostly for 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.

[e]Estimated. NA Not available. — Zero.
[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 not available and assumed to be zero.
[4]Less than ½ unit.
[5]See Appendix C for definitions.
[6]No reliable production information for other countries is available, owing to a wide variation 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)

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Industrial sand and gravel valued at about $566 million was produced by 67 companies from 157 operations in 34 States. Leading States, in order of tonnage, were Illinois, Michigan, California, North Carolina, Texas, Wisconsin, New Jersey, and Oklahoma. Combined production from these States represented 59% of the domestic total. About 38% of the U.S. tonnage was used as glassmaking sand, 20% as foundry sand, 5% as hydraulic fracturing sand, 5% as abrasive sand, and 32% was for other uses.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production	28,900	28,400	27,900	27,300	28,300
Imports for consumption	211	247	172	250	250
Exports	1,670	1,660	1,540	1,410	1,400
Consumption, apparent	27,400	27,400	26,500	26,100	27,200
Price, average value, dollars per ton	18.64	19.58	20.64	20.98	20.01
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e]	1,400	1,400	1,400	1,400	1,400
Net import reliance[1] 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 (1999-2002): Canada, 48%; Mexico, 47%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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.

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

SAND AND GRAVEL (INDUSTRIAL)

Events, Trends, and Issues: Domestic sales of industrial sand and gravel in 2003 increased by almost 4% compared with those of 2002. U.S. apparent consumption was 27.2 million tons in 2003, an increase over the previous year. Imports of industrial sand and gravel in 2003 remained at about the same level as 2002. Mexico's share of imports increased dramatically, and Canada's share increased as well. Imports of silica are generally of two types: small-quantity shipments of very-high-purity silica or a few large shipments of lower grade silica that were shipped only under special circumstances (e.g., very low freight rates).

The United States was the world's largest producer and consumer of industrial sand and gravel based on estimated world production figures. It was difficult to collect definitive numbers 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. This was attributed to the high quality and advanced processing techniques for a large variety of grades of silica sand and gravel, meeting virtually every specification.

Domestic production and apparent consumption is estimated to be about 28.3 million tons and 27.2 million tons, respectively, in 2003.

The industrial sand and gravel industry continued to be concerned with safety and health regulations and environmental restrictions in 2003. 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[2]
	2002	2003	
United States	27,300	28,300	
Australia	4,500	4,500	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	5,500	
Germany	8,500	8,500	
India	1,400	1,450	
Iran	1,700	1,700	
Italy	3,000	3,000	
Japan	2,200	1,900	
Mexico	1,700	1,800	
Norway	1,400	1,400	
South Africa	2,300	2,300	
Spain	6,500	6,500	
Turkey	1,400	1,300	
United Kingdom	4,500	4,000	
Other countries	10,300	10,300	
World total (rounded)	95,000	94,000	

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 source of industrial silica sand, occur throughout the world.

Substitutes: Silica sand continues to be the major material used for glassmaking and for foundry and molding sands; alternatives are chromite, olivine, staurolite, and zircon sands.

[e]Estimated. E Net exporter. NA Not available.
[1]Defined as imports – exports + adjustments for Government and industry stock changes.
[2]See Appendix C for definitions.

SCANDIUM[1]

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

Domestic Production and Use: Demand for scandium increased slightly in 2003. Although scandium was not mined domestically in 2003, 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; Urbana, IL; and Knoxville, TN. 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 2003 were aluminum alloys for sporting equipment, metallurgical research, high-intensity metal halide lamps, analytical standards, electronics, and laser research.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Price, yearend, dollars:					
Per kilogram, oxide, 99.0% purity	900	700	700	700	500
Per kilogram, oxide, 99.9% purity	2,000	2,000	2,300	2,000	1,300
Per kilogram, oxide, 99.99% purity	3,000	3,000	2,700	2,500	2,500
Per kilogram, oxide, 99.999% purity	4,000	6,000	4,100	3,200	3,200
Per gram, dendritic, metal[2]	270.00	270.00	279.00	178.00	185.00
Per gram, metal, ingot[3]	175.00	175.00	198.00	198.00	119.00
Per gram, scandium bromide, 99.99% purity[4]	91.80	91.80	94.60	94.60	98.40
Per gram, scandium chloride, 99.9% purity[4]	39.60	39.60	40.80	40.80	42.40
Per gram, scandium fluoride, 99.9% purity[4]	80.10	80.10	173.00	173.00	180.00
Per gram, scandium iodide, 99.999% purity[4]	151.00	151.00	156.00	156.00	162.00
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1999-2002): Not available.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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 decreased from the previous year. The supply of domestic and foreign scandium remained strong despite increased demand. Although demand increased in 2003, 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 in 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 additions, as the metal or the iodide, mixed with other elements, were added to halide light bulbs to adjust the color to simulate natural sunlight. Demand also continued to increase for scandium-aluminum alloys. Future development of alloys for aerospace and specialty markets, including sports equipment, is expected. Scandium's availability from the Kazakhstan, Russia, and Ukraine increased substantially in 1992, after export controls were relaxed, and sales to the Western World have been increasing. China also continued to supply goods to the U.S. market.

World Mine Production, Reserves, and Reserve Base:[6] 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 2003. 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 due to its lack of affinity to combine with the common ore forming anions. It is widely dispersed in the lithosphere and forms solid solutions in over 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 are also 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 varisite 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 may substitute in sporting goods, especially bicycle frames.

[e]Estimated.
[1]See also Rare Earths.
[2]Scandium pieces, 99.9% purity, distilled dendritic, 1999-2003 prices converted from 0.5-gram price, from Alfa Aesar, a Johnson Matthey company.
[3]Scandium, metal lump, sublimed dendritic 99.99% purity, from Alfa Aesar, a Johnson Matthey company, 1999 and 2000. Metal ingot pieces 99.9% purity 2001-3.
[4]Bromide, chloride, and fluoride in crystalline or crystalline aggregate form and scandium iodide as ultradry powder from Alfa Aesar, a Johnson Matthey company.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]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 domestic production of primary selenium. One producer exported semirefined selenium for toll-refining in Asia and three other companies generated selenium-containing slimes, which were exported for processing.

The estimated consumption of selenium by end use was as follows: glass manufacturing, 35%; chemicals and pigments, 20%; electronics, 12%; and other, including agriculture and metallurgy, 33%. In glass manufacturing, selenium is used to decolorize the green tint caused by iron impurities in glass containers and other soda-lime silica glass and is used in architectural plate glass to reduce solar heat transmission. It is also used, as cadmium sulfoselenide, 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; and to increase yields in the electrolytic production of manganese.

Selenium is used as a human dietary supplement and in antidandruff shampoos. The largest 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. Its primary electronic use was as a photoreceptor on the drums of copiers, but now it is only used for replacement parts for older copiers, which are gradually being replaced by newer models that do not use selenium in the reproduction process.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, refinery	W	W	W	W	W
Imports for consumption, metal and dioxide	326	476	483	422	431
Exports, metal, waste and scrap	233	82	41	85	226
Consumption, apparent[1]	W	W	W	W	W
Price, dealers, average, dollars per pound, 100-pound lots, refined	2.50	3.84	3.80	4.27	5.00
Stocks, producer, refined, yearend	W	W	W	W	W
Employment, number	NA	NA	NA	NA	NA
Net import reliance[2] as a percentage of apparent consumption	W	W	W	W	W

Recycling: There was no domestic production of secondary selenium. Scrap xerographic materials were exported for recovery of the contained selenium. An estimated 25 tons of selenium metal was recovered from imported scrap in 2003.

Import Sources (1999-2002): Canada, 50%; Philippines, 23%; Belgium, 8%; Germany, 5%; and other, 14%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Selenium metal	2804.90.0000	Free.
Selenium dioxide	2811.29.2000	Free.

Depletion Allowance:[3] 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **John D. Jorgenson [(703) 648-4912, jjorgenson@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, nickel, and cobalt. In 2003, domestic consumption of selenium increased slightly when compared with that of 2002. The average annual global consumption of selenium over the past 4 years is estimated to have been about 2,000 tons per year. Production of selenium did not decrease in 2003 in spite of the idling of high-cost copper capacity and the use of solvent extraction instead of older slime-producing technology. Continued concern over selenium supply saw the price increase from $3.75-$4.25 per pound in the last quarter of 2002 to $5.80-$6.40 by late in the third quarter of 2003. Owing to higher prices, the production drop was more than offset by the increase of selenium-bearing anode slimes and other selenium scrap sent to refineries.

The use of selenium in China rose significantly with continued interest in selenium as a fertilizer supplement, as an ingredient in glassmaking, and as selenium dioxide to increase the yield in the manganese smelting process, where selenium is substituting for nickel in a portion of the Chinese stainless steel market.

The use of selenium in glass remained strong, while 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 supplements in the plant-animal-human food chain increased as its health benefits were confirmed. Increased selenium supplementation in fertilizer has been used to achieve this public health benefit—both as improved feed for livestock and as produce for human consumption.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[4]	Reserve base[4]
	2002	2003[e]		
United States	W	W	10,000	19,000
Belgium	200	200	—	—
Canada	226	230	6,400	10,000
Chile	40	40	16,000	37,000
Finland	39	39	—	—
Germany	100	100	—	—
India	12	12	—	—
Japan	740	760	—	—
Peru	16	20	5,000	8,000
Philippines	40	118	2,000	3,000
Serbia and Montenegro	20	30	1,000	2,000
Sweden	20	20	—	—
Other countries[5]	60	90	42,000	90,000
World total (rounded)	[6]1,510	[6]1,660	82,000	170,000

World Resources: The reserve base for selenium is based on identified economic copper deposits. An additional 2.5 times this reserve base is estimated to exist in copper and other metal deposits that have not yet been developed. 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 does not appear likely in the foreseeable future.

Substitutes: High-purity silicon has replaced selenium in high-voltage rectifiers. Silicon is also the major substitute for selenium in low- and medium-voltage rectifiers and solar photovoltaic cells. Amorphous silicon and organic photoreceptors are substitutes in xerographic document copiers. 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.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Defined as reported shipments + imports of selenium metal – estimated exports of selenium metal, excluding scrap.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.
[4]See Appendix C for definitions.
[5]In addition to the countries listed, Australia, China, Kazakhstan, Russia, and the United Kingdom are known to produce refined selenium.
[6]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 2003 was about $307 million. Ferrosilicon was produced by four companies in four plants, and silicon metal was produced by four companies in four plants. Two of the six companies in the industry produced both products. 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 one-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 few percent of silicon demand.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production	423	367	282	261	250
Imports for consumption	286	361	231	285	300
Exports	61	41	23	22	23
Consumption, apparent	643	689	502	540	530
Price,[1] average, cents per pound Si:					
Ferrosilicon, 50% Si	49.1	45.0	42.8	41.1	49
Ferrosilicon, 75% Si	40.2	35.4	31.9	32.8	45
Silicon metal	58.1	54.8	50.5	53.2	61
Stocks, producer, yearend	54	52	40	25	23
Net import reliance[2] as a percentage of apparent consumption	34	47	44	52	54

Recycling: Insignificant.

Import Sources (1999-2002): Norway, 18%; South Africa, 16%; Russia, 10%; Canada, 10%; and other, 46%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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.

Events, Trends, and Issues: Domestic apparent consumption of silicon for 2003 is projected to be slightly less than that of 2002. Of the 2003 total, the share accounted for by ferrosilicon is estimated to have decreased to 52% from 56% in 2002, while that for silicon metal increased to 48% from 44%. 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. Through the first 9 months of 2003, however, domestic steel production was the same as that for the same period in 2002. Domestic shipments of silicon metal through the first 8 months in 2003 were about 19% higher than those of the same period in 2002. Demand for silicon metal comes primarily from the aluminum and chemical industries. In 2003, the demand growth rate in domestic specialty chemicals, which include silicones, was expected to be about that of total global chemical sector, 2%. While domestic primary production rose by about 2% through the first 9 months in 2003 compared year-on-year with 2002, production was projected to level off by yearend 2003. Global primary aluminum production in 2003 was 5% higher than that of 2002. Through the first 6 months in 2003, domestic secondary aluminum production was about 2% lower than that during the same period in 2002, while world secondary aluminum production rose slightly.

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

SILICON

Domestic production in 2003, expressed in terms of contained silicon, was projected to decline. For all silicon materials combined, the overall decline was 6% to the lowest level since 1982. Production was curtailed or stopped at some plants because of slackening demand.

Through the first 9 months of 2003, prices trended upward in the U.S. market for silicon materials, except for 50% ferrosilicon. Compared with those at the beginning of the year, weekly average prices as of the end of September were higher for 75% ferrosilicon (12%) and silicon metal (2%), and flat for 50% ferrosilicon. Year-average prices were projected to be higher for 50% ferrosilicon, 75% ferrosilicon, and silicon metal than those for 2002. At the end of September, the range in dealer import price, in cents per pound of contained silicon, was 46 to 48 for 50% ferrosilicon, 42.5 to 45 for 75% ferrosilicon, and 60 to 61 for silicon metal.

U.S. imports and exports of silicon materials in 2003, projected on the basis of data for the first 7 months of the year, were 7% more than those in 2002. The smallest overall percentage rise was for imports of silicon metal. Net import reliance rose in comparison with that for recent years owing to increases in silicon material imports.

World Production, Reserves, and Reserve Base:

	Production[e]		Reserves and reserve base[3]
	2002	2003	
United States	261	250	The reserves and reserve base in most major producing countries are ample in relation to demand. Quantitative estimates are not available.
Brazil	217	230	
Canada	66	70	
China	1,270	1,600	
France	140	100	
Iceland	73	73	
India	34	34	
Kazakhstan	83	83	
Norway	390	350	
Poland	39	31	
Russia	490	480	
Slovakia	33	30	
South Africa	110	110	
Spain	55	60	
Ukraine	210	230	
Venezuela	38	58	
Other countries	214	210	
World total (rounded)	3,720	4,000	

Production quantities given above are combined totals of estimated content for ferrosilicon and silicon metal, as applicable. For the world, ferrosilicon accounts for about four-fifths of the total. The leading countries for ferrosilicon production were China, Russia, Ukraine, and Brazil, and for silicon metal China, Brazil, France, the United States, and Norway. China was by far the largest producer of both ferrosilicon and silicon metal. An estimated 300,000 tons of silicon metal is included in China's total silicon production for 2003.

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.
[1]Based on U.S. dealer import price.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions.

SILVER

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

Domestic Production and Use: In 2003, U.S. mine production of silver was about 1,230 tons, with an estimated value of $184 million. Alaska replaced Nevada as the leading producer. Precious-metal ores accounted for approximately one-half of domestic silver production; the remainder was recovered as a byproduct from the processing of copper, lead, and zinc ores. There were 21 principal refiners of commercial-grade silver, with an estimated total output of 3,800 tons. About 30 fabricators accounted for more than 90% of the silver consumed in arts and industry. The remainder was consumed mostly by small companies and artisans. Aesthetic uses of silver for decorative articles, jewelry, tableware, and coinage were overshadowed by industrial and technical uses. Industrial and technical uses include photographic materials, electrical and electronic products, catalysts, brazing alloys, dental amalgam, and bearings.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:					
Mine	1,950	1,860	1,740	1,420	1,300
Refinery:					
Primary	2,000	2,780	2,640	2,580	2,700
Secondary	1,500	1,680	1,060	1,030	1,100
Imports for consumption[2]	2,660	3,810	3,310	4,600	3,300
Exports[2]	481	279	963	624	320
Consumption, apparent[e]	5,500	6,300	5,800	7,700	5,430
Price, dollars per troy ounce[3]	5.25	5.00	4.39	4.62	4.66
Stocks, yearend:					
Treasury Department[4]	617	220	220	220	220
COMEX, CBT[5]	2,360	2,920	3,340	3,290	3,260
National Defense Stockpile	778	458	200	—	—
Employment, mine and mill,[6] number	1,500	1,500	1,100	1,000	980
Net import reliance[7] as a percentage of apparent consumption[e]	39	43	44	68	56

Recycling: About 1,100 tons of silver was recovered from old and new scrap in 2003.

Import Sources[2] (1999-2002): Mexico, 45%; Canada, 42%; Peru, 5%; United Kingdom, 4%; and other, 4%.

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

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

Government Stockpile: The Defense Logistics Agency (DLA) has transferred all of the remaining silver in the National Defense Stockpile to the U.S. Mint for use in the manufacture of numismatic and bullion coins. Under an agreement with the U.S. Department of the Treasury, the metal was carried as DLA stocks until the metal was consumed by the Mint. The transfer marked the end of silver requirements for the National Defense Stockpile.

Stockpile Status—9-30-03[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Silver	—	—	—	21	21

Prepared by **Henry E. Hilliard [(703) 648-4970, hhilliar@usgs.gov, fax: (703) 648-7757]**

SILVER

Events, Trends, and Issues: Silver use in photography fell for the fourth successive year. The decline exceeded that of the two previous years combined by more than 4%. In 2003, estimated sales of digital cameras could increase 10% to reach 26 million units, compared with a modest fall in sales of conventional cameras. The switch to digital cameras by the consumer and the professional sectors is expected to gradually reduce the share of cameras using film. As new technology is introduced and the costs of digital cameras become more competitive with conventional cameras, this trend can be expected to accelerate.

The deficit between world silver fabrication demand and world silver supply (mine production and scrap) remained very large in 2003 at about 2,000 tons. Industrial demand for silver increased while world silver mine production declined and is likely to decline further. Overall world silver demand fell by about 4%, primarily due to lower demand in India.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[9]	Reserve base[9]
	2002	2003[e]		
United States	1,420	1,300	25,000	80,000
Australia	2,077	2,100	31,000	37,000
Canada	1,344	1,270	16,000	35,000
Chile	1,350	1,300	NA	NA
China	2,500	2,300	26,000	120,000
Mexico	2,748	2,800	37,000	40,000
Peru	2,687	2,750	36,000	37,000
Poland	1,200	1,200	51,000	140,000
Other countries	4,600	4,000	50,000	80,000
World total (rounded)	20,000	19,000	270,000	570,000

World Resources: More than two-thirds of world silver resources is associated with copper, lead, and zinc deposits, often at great depths. The remainder is in vein deposits in which gold is the most valuable metallic component. Although most recent discoveries have been primarily gold and silver deposits, significant future reserves and resources are expected from major base-metal discoveries that contain silver. While the price of silver and improved technology may appear to increase the reserves and reserve base, the extraction of silver from these resources will be driven by demand for the base metals.

Substitutes: Aluminum and rhodium can be substituted for silver in mirrors and other reflecting surfaces. Tantalum can be used in place of silver for surgical plates, pins, and sutures. Stainless steel is an alternate material used widely in the manufacture of table flatware. Nonsilver batteries being developed may replace silver batteries in some applications. Silverless black and white film, xerography, and film with reduced silver content are alternatives to some uses of silver in photography.

[e]Estimated. NA Not available. — Zero.
[1]One metric ton (1,000 kilograms) = 32,150.7 troy ounces.
[2]Refined bullion, plus silver content of ores, concentrates, precipitates, and doré; 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: Mine Safety and Health Administration.
[7]Defined as imports – exports + adjustments for Government and industry stock changes.
[8]See Appendix B for definitions.
[9]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 U.S. soda ash (sodium carbonate) industry, which is the largest in the world, comprised four companies in Wyoming operating four plants (a fifth plant is mothballed), one company in California with one plant, and one company with one plant in Colorado. The six producers have a combined annual nameplate capacity of 14.5 million tons. Sodium bicarbonate, sodium sulfate, potassium chloride, potassium sulfate, borax, and other minerals were produced as coproducts from sodium carbonate production in California. Sodium bicarbonate, sodium sulfite, sodium tripolyphosphate, and chemical caustic soda were manufactured as coproducts at several of the Wyoming soda ash plants. Sodium bicarbonate was produced as a coproduct at the Colorado operation. The total estimated value of domestic soda ash produced in 2003 was $800 million.[1]

Based on final 2002 reported data, the estimated 2003 distribution of soda ash by end use was glass, 49%; chemicals, 26%; soap and detergents, 11%; distributors, 5%; miscellaneous uses, 4%; flue gas desulfurization, 2%; pulp and paper, 2%; and water treatment, 1%.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production[2]	10,200	10,200	10,300	10,500	10,600
Imports for consumption	92	75	33	9	5
Exports	3,620	3,900	4,090	4,250	4,400
Consumption:					
Reported	6,430	6,390	6,380	6,430	6,200
Apparent	6,740	6,430	6,310	6,250	6,200
Price:					
Quoted, yearend, soda ash, dense, bulk,					
f.o.b. Green River, WY, dollars per short ton	105.00	105.00	105.00	105.00	105.00
f.o.b. Searles Valley, CA, same basis	130.00	130.00	130.00	130.00	130.00
Average sales value (natural source),					
f.o.b. mine or plant, same basis	69.11	66.23	67.79	68.00	69.00
Stocks, producer, yearend	248	245	226	222	200
Employment, mine and plant, number	2,600	2,600	2,700	2,600	2,600
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 (1999-2002): Canada, 99%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Disodium carbonate	2836.20.0000	1.2% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: The newest natural soda ash facility in the United States, which came onstream in Colorado in late 2000 was sold in September 2003 to the world's largest soda ash producer based in Belgium. This plant will be the 10th soda ash plant the company operates worldwide and the second plant that it owns that produces soda ash from natural sources; the other plant refines soda ash from Wyoming trona ore. The company's total worldwide capacity now exceeds 9 million tons, or about 20% of the world total. The Colorado facility solution mines underground nahcolite ore and transports the brine to a processing plant where soda ash and sodium bicarbonate are produced.

The largest soda ash company in the United States announced that it planned to close its Green River, WY, phosphate plant, which is associated with its soda ash operation in early 2004. About 50 employees will be affected by the closure. The company indicated that the closure was required in order to reduce fixed costs and strengthen the company and its joint-venture partner's market position in food phosphates and technical phosphates.

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

SODA ASH

Surplus nameplate capacity continued to adversely affect the U.S. soda ash industry's efforts to increase prices in the past couple of years. Although the industry announced a $7-per-short-ton price increase in the third quarter 2003, it was uncertain by yearend how much of the increase was realized. Domestic soda ash consumption remained stagnant during the year despite a small increase in glass container production during the year.

China is a major world producer of synthetic soda ash, and remains the largest competitor of the United States in the Asian soda ash markets. China announced it planned to increase capacity at its Weifang soda ash plant by 600,000 tons by 2004 and to construct a new synthetic soda ash facility at Zhejiang that will have an annual capacity of 900,000 tons when it is commissioned in late 2004. Reports indicate that China will surpass the United States in 2003 as the world's largest soda-ash-producing nation.

Notwithstanding 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. Domestic demand should be slightly higher in 2004.

World Production, Reserves, and Reserve Base:

	Production		Reserves[4 5]	Reserve base[5]
Natural:	2002	2003[e]		
United States	10,500	10,600	[6]23,000,000	[6]39,000,000
Botswana	270	280	400,000	NA
Kenya	308	310	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)	11,100	11,200	24,000,000	40,000,000
World total, synthetic (rounded)	26,000	26,800	XX	XX
World total (rounded)	37,000	38,000	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 a combination of conventional, continuous, and shortwall mining equipment is the primary method of mining Wyoming trona ore. The method has an average 45% mining recovery, which is higher than the 30% average mining recovery from solution mining. 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. 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. Fifteen companies operating 16 plants in 13 States recovered byproduct sodium sulfate from various manufacturing processes or products, including ascorbic acid, battery reclamation, cellulose, rayon, and silica pigments. More than one-half of the total output in 2003 was a byproduct of these plants. The total value of natural and synthetic sodium sulfate sold was an estimated $55 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:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production, total (natural and synthetic)[1]	599	462	512	500	500
Imports for consumption	87	73	34	51	45
Exports	137	165	191	139	140
Consumption, apparent (natural and synthetic)	549	370	355	412	405
Price, quoted, sodium sulfate (100% Na_2SO_4), bulk, f.o.b. works, East, dollars per short ton	114.00	114.00	114.00	114.00	114.00
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 (1999-2002): Canada, 95%; Mexico, 4%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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: A new anhydrous natural sodium sulfate operation with an annual capacity of 200,000 tons came onstream in midyear. The plant is located at Xishunhe in Hongze County, Jiangsu Province, in China. The company, which is a joint venture between a Chinese company and an Indonesian firm, mines mirabilite from the only large sodium sulfate deposit in east China. Along with a second facility with an annual capacity of 600,000 tons that is owned by a Chinese chemical company and a Spanish sodium sulfate producer, the region is the world's largest natural sodium sulfate production base with a combined capacity of 800,000 tons per year.

Domestic sodium sulfate demand has fluctuated for the past several years. 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 grow. Sodium sulfate consumption in the textile industry also has been declining because imports of less expensive textile products have won a greater share of the domestic market. Declining domestic demand in the past several years resulted in a decrease of sodium sulfate imports, especially from Canada. However, growth in powdered home laundry detergents abroad (approximately 80% of world sodium sulfate consumption is for detergents) and the expanding textile sectors in Central America and South America may result in increased U.S. sodium sulfate export sales.

The outlook for sodium sulfate in 2004 is expected to be comparable with that of 2003, with detergents remaining the largest sodium sulfate-consuming sector. If the winter of 2003-4 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 grow 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 million 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 listed above with reserves, the following countries also contain 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 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 $8.6 billion was produced by 1,260 companies operating 3,300 active quarries and distribution yards in 49 States. Leading States, in order of production, were Texas, Florida, Pennsylvania, Missouri, Illinois, Georgia, Ohio, North Carolina, Virginia, and California, together accounting for 51.8% of the total output. Of the total crushed stone produced in 2003, about 71% was limestone and dolomite; 15%, granite; 7%, traprock; and the remaining 7% was shared, in descending order of quantity, by sandstone and quartzite, miscellaneous stone, marble, calcareous marl, slate, volcanic cinder and scoria, and shell. It is estimated that of the 1.49 billion tons of crushed stone consumed in 2003, 35% was for unspecified uses, and 19% was estimated for nonrespondents to the U.S. Geological Survey (USGS) canvasses. Of the remaining 686 million tons reported by uses, 82% was used as construction aggregates mostly for highway and road construction and maintenance; 14% for chemical and metallurgical uses, including cement and lime manufacture; 2% for agricultural uses; and 2% for special and miscellaneous uses and products. To provide a more accurate estimate of the consumption patterns for crushed stone, the "unspecified uses – reported and estimated" as defined in the USGS Minerals Yearbook, are not included in the above percentages.

The estimated output of crushed stone in the 48 conterminous States shipped for consumption in the first 9 months of 2003 was 1.11 billion tons, a 5.4% decrease compared with the same period of 2002. It should be noted that the third quarter shipments for consumption increased by 0.8% compared with the same period of 2002. 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:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production	1,530	1,550	1,590	1,520	1,490
Imports for consumption	12	13	14	14	14
Exports	4	4	4	3	3
Consumption, apparent[3]	1,550	1,560	1,600	1,530	1,500
Price, average value, dollars per metric ton	5.35	5.39	5.57	5.71	5.78
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e, 4]	79,000	78,800	79,200	79,000	78,000
Net import reliance[5] as a percentage of apparent consumption	1	1	([6])	([6])	([6])

Recycling: Road surfaces made of asphalt and crushed stone and, to a lesser extent, cement concrete surfaces and structures were recycled on a limited but increasing basis in most States.

Import Sources (1999-2002): Canada, 53%; Mexico, 33%; The Bahamas, 7%; and other, 7%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/03**
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 **Valentin V. Tepordei, [(703) 648-7728, vtepordei@usgs.gov, fax: (703) 648-7975]**

STONE (CRUSHED)

Events, Trends, and Issues: Crushed stone output decreased 2% in 2003 to 1.49 billion tons. It is estimated that in 2004, domestic production and apparent consumption will be about 1.54 billion tons each, a 3.2% increase. Gradual increases in demand for construction aggregates are anticipated after 2003 based on the expected volume of work on the infrastructure that will be financed by the new Safe, Accountable, Flexible, and Efficient Transportation Equity Act of 2003, the new Flight 100-Century of Aviation Reauthorization Act, and the expanding U.S. economy in general. 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. Crushed stone f.o.b. prices are not expected to increase significantly, but the delivered prices of crushed stone are expected to increase, especially in and near metropolitan areas, mainly because more aggregates are being transported longer distances.

The crushed stone industry continued to be concerned with safety and environmental regulations. Shortages in some urban and industrialized areas were expected to continue to increase, owing to local zoning regulations and land-development alternatives. These issues are expected to continue and to cause crushed stone quarries to relocate away from large-population centers.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[7]
	2002	2003[e]	
United States	1,520	1,490	Adequate except where special
Other countries[8]	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]Data rounded to no more than three significant digits.
[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]Less than ½ unit.
[7]See Appendix C for definitions.
[8]No reliable production information for other countries is available, owing to a wide variation 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 1.35 million tons of dimension stone, valued at $236 million, was sold or used in 2003. Dimension stone was produced by 132 companies, operating 176 quarries, in 34 States. Leading producer States, in descending order by tonnage, were Indiana, Wisconsin, Georgia, Vermont, and Massachusetts. These five States accounted for 53% of the tonnage output. Leading producer States, in descending order by value, were Indiana, Vermont, Georgia, South Dakota, and North Carolina. These States contributed 50% of the value of domestic production. Approximately 34%, by tonnage, of dimension stone sold or used was granite, followed by limestone (28%), sandstone (16%), marble (5%), slate (1%), and miscellaneous stone (16%). By value, the largest sales or uses were for granite (43%), followed by limestone (27%), miscellaneous stone (10%), sandstone (9%), marble (7%), and slate (4%). Rough block represented 52% of the tonnage and 41% of the value of all the dimension stone sold or used by domestic producers, including exports. The largest uses of rough block, by tonnage, were in construction (44%) and irregular-shaped stone (23%) applications. Dressed stone mainly was sold for flagging (26%), curbing (21%), and ashlars and partially squared pieces (15%), by tonnage.

Salient Statistics—United States[2]:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production:					
Tonnage	1,250	1,320	1,220	1,260	1,350
Value, million dollars	254	235	263	254	236
Imports for consumption, value, million dollars	808	986	1,070	1,190	1,460
Exports, value, million dollars	55	60	74	64	60
Consumption, apparent, value, million dollars	1,010	1,160	1,260	1,380	1,630
Price	Variable, depending on type of product				
Stocks, yearend	NA	NA	NA	NA	NA
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)	75	78	79	82	86
Granite only:					
Production	437	415	408	431	430
Imports for consumption	NA	NA	NA	NA	NA
Exports (rough and finished)	166	116	141	140	140
Consumption, apparent	NA	NA	NA	NA	NA
Price	Variable, depending on type of product				
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[3]	1,500	1,500	1,500	1,500	1,500
Net import reliance[4] as a percentage of apparent consumption (based on tonnage)	NA	NA	NA	NA	NA

Recycling: Small amounts of dimension stone were recycled principally by restorers of old stone work.

Import Sources (1999-2002 by value): Dimension stone: Italy, 40%; Canada, 13%; India, 11%; Spain, 9%; and other, 27%. Granite only: Italy, 41%; Brazil, 17%; India, 13%; Canada, 11%; and other, 18%.

Tariff: Dimension stone tariffs ranged from free to 6.5% ad valorem for countries with normal trade relations in 2003, according to type, degree of preparation, shape, and size. Most crude or rough trimmed stone was imported for 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: Domestic production tonnage increased to about 1.35 million tons, with value decreasing to $236 million in 2003. Imports of dimension stone continued to increase. Imports increased by 23% in value to $1.46 billion. Dimension stone exports decreased by 6% to $60 million. Apparent consumption, by value, was $1.6 billion in 2003—a $254 million increase over 2002. Dimension stone is being used more commonly in residential markets. Additionally, improved quarrying, finishing, and handling technology, as well as a greater variety of stone and the rising costs of alternative construction materials, are among the factors that suggest a continuing increase in demand for dimension stone during the next 5 to 10 years.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	2002	2003[e]	
United States	1,260	1,350	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 some 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. Primary strontium compounds were used in the faceplate glass of color television picture tubes, 75%; ferrite ceramic magnets, 9%; pyrotechnics and signals, 9%; and other applications, 7%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production	—	—	—	—	—
Imports for consumption:					
Strontium minerals	13,700	7,460	5,640	1,150	1,100
Strontium compounds	26,800	29,900	26,500	25,400	22,000
Exports, compounds	2,890	4,520	929	340	950
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent, celestite and compounds	37,600	32,800	31,200	26,200	22,200
Price, average value of mineral imports at port of exportation, dollars per ton	73	62	62	60	57
Net import reliance[2] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1999-2002): Strontium minerals: Mexico, 100%. Strontium compounds: Mexico, 91%; Germany, 5%; and other, 4%. Total imports: Mexico, 93%; Germany, 4%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Celestite	2530.90.8010	Free.
Strontium metal	2805.19.1000	3.7% ad val.
Compounds:		
Strontium carbonate	2836.92.0000	4.2% ad val.
Strontium nitrate	2834.29.2000	4.2% ad val.
Strontium oxide, hydroxide, peroxide	2816.40.1000	4.2% ad val.

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

Government Stockpile: Although 11,600 tons of celestite containing about 5,100 tons of strontium is in the National Defense Stockpile, none of it is stockpile grade; its total value is listed as zero. The stockpile goal for celestite was reduced to zero in 1969, and at that time, the stockpile contained stockpile- and nonstockpile-grade material. Since then, all the stockpile-grade celestite has been sold. Although the nonstockpile-grade celestite has been offered for sale, none has been sold since 1979. The fiscal year 2004 Annual Materials Plan, announced in October 2003 by the Defense National Stockpile Center, listed all the stockpiled celestite to be offered for disposal. Because the remaining material does not meet the quality specifications of celestite purchasers, the material will be difficult to dispose of in the traditional markets. It might be attractive as a low-cost replacement for barite in drilling mud applications.

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

STRONTIUM

Events, Trends, and Issues: With the plant capacity to produce 95,000 and 103,000 tons per year, respectively, Germany and Mexico have been the largest producers of strontium carbonate for many years. The German producer uses imported celestite, and Mexican producers use domestic ore to supply their plants. In recent years, Chinese strontium carbonate capacity has expanded tremendously to about 140,000 tons per year, although actual plant production is believed to be much less than that. The Chinese strontium carbonate is marketed in Asia and Europe, causing decreases in celestite and strontium carbonate prices in those regions. Chinese celestite reserves are smaller and of lower quality than the ores in major producing countries including Mexico, Spain, and Turkey, raising the question of whether Chinese producers will be able to maintain high production levels to meet the demand at strontium carbonate plants for an extended period of time.

The demand for strontium carbonate for television faceplate glass continues and increases as the popularity of larger screen sizes increases worldwide. Domestic consumption of strontium carbonate has decreased in the past 3 years, probably as a result of a shift in production facilities for color televisions to other countries and a slow economy. China, Europe, and North America are the most important markets for televisions. Southeast Asia and Latin America have higher growth rates, representing potentially huge markets for television manufacturers and thus the strontium carbonate industry. Flat screen technology, which does not require strontium carbonate, likely will diminish the demand for strontium carbonate for television displays as the technology becomes more affordable and commonplace.

World Mine Production, Reserves, and Reserve Base:[3]

	Mine production		Reserves[4]	Reserve base[4]
	2002	2003[e]		
United States	—	—	—	1,400,000
Argentina	1,474	1,500	All other:	All other:
China	[e]50,000	60,000	6,800,000	11,000,000
Iran	2,000	2,000		
Mexico	140,000	100,000		
Morocco	4,000	4,000		
Pakistan	2,000	900		
Spain	125,000	130,000		
Tajikistan	NA	NA		
Turkey	70,000	70,000		
World total (rounded)	[5]390,000	[5]370,000	6,800,000	12,000,000

World Resources: Resources in the United States are several times the reserve base. Although not thoroughly evaluated, 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 color television 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 amount 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.
[5]Excludes Tajikistan.

SULFUR

(Data in thousand metric tons of sulfur, unless otherwise noted)

Domestic Production and Use: In 2003, elemental sulfur and byproduct sulfuric acid were produced at 120 operations in 30 States and the U.S. Virgin Islands. Total shipments were valued at about $235 million. Elemental sulfur production was 8.8 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 39 companies at 110 plants in 26 States and the U.S. Virgin Islands. Mining of elemental sulfur using the Frasch method, ended in 2000. Byproduct sulfuric acid, representing almost 8% of production of sulfur in all forms, was recovered at 9 nonferrous smelters in 7 States by 8 companies. Domestic elemental sulfur provided 69% of domestic consumption, and byproduct acid accounted for 6%. The remaining 25% 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 70% of reported sulfur demand; petroleum refining, 20%; and metal mining, 5%. Other uses, accounting for 5% 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:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production:					
Frasch[e]	1,780	900	—	—	—
Recovered elemental	8,360	8,590	8,490	8,500	8,800
Other forms	1,320	1,030	982	772	750
Total[e] (may be rounded)	11,500	10,500	9,470	9,270	9,550
Shipments, all forms	11,300	10,700	9,450	9,260	9,500
Imports for consumption:					
Recovered, elemental	2,580	2,330	1,730	2,560	2,900
Sulfuric acid, sulfur content	447	463	462	346	410
Exports:					
Frasch and recovered elemental	685	762	675	687	680
Sulfuric acid, sulfur content	51	62	69	48	210
Consumption, apparent, all forms	13,800	12,700	10,900	11,400	11,900
Price, reported average value, dollars per ton of elemental sulfur, f.o.b., mine and/or plant	37.81	24.73	10.01	11.84	25.00
Stocks, producer, yearend	451	208	232	181	200
Employment, mine and/or plant, number	3,000	3,000	2,700	2,700	2,700
Net import reliance[1] as a percentage of apparent consumption	16	18	13	19	20

Recycling: Between 3 million and 5 million tons of spent sulfuric acid was reclaimed from petroleum refining and chemical processes.

Import Sources (1999-2002): Elemental: Canada, 71%; Mexico, 20%; Venezuela, 7%; and other, 2%. Sulfuric acid: Canada, 53%; Mexico, 19%; Japan, 6%; Germany, 4%, and other, 18%. Total sulfur imports: Canada, 68%; Mexico, 20%; Venezuela, 6%; and other, 6%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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 was slightly higher in 2003 than it was in 2002 because sulfur recovered at oil refineries increased, but production at natural gas facilities decreased. Production of elemental sulfur from petroleum refineries will continue to grow steadily, supported by new facilities being installed to increase refining capacity and the capability of current operations to handle higher sulfur crude oil. Additional equipment will be installed at many refineries to reduce the sulfur in gasoline and diesel fuel to comply with the environmental regulations that were enacted in 2000 and 2001 and that will go into effect in 2006. Recovered sulfur from domestic natural gas processing may continue to decline as a result of the natural depletion of some large natural gas deposits and projects to reinject acid gas rather than produce recovered elemental sulfur. Byproduct sulfuric acid production continued at low rates because four U.S. copper smelters remained closed with little likelihood of reopening. Despite continued decreases in native sulfur and pyrites production because of environmental and cost considerations, total world sulfur production remained about the same as a result of expanded recovered production.

Domestic phosphate fertilizer production was about the same in 2002 as in 2003, with no change in demand for sulfur in that end use. Increased worldwide sulfur demand drove prices higher, which made increased imports, especially from Canada, more likely. Additional facilities for importing formed sulfur were under consideration to increase the alternative sources available.

World Production, Reserves, and Reserve Base:

	Production—All forms 2002	Production—All forms 2003[e]
United States	9,270	9,550
Australia	959	970
Canada	8,538	9,000
Chile	1,275	1,300
China	5,730	5,800
Finland	690	700
France	1,000	1,000
Germany	1,240	1,250
India	945	950
Iran	1,000	1,100
Italy	702	700
Japan	3,200	3,200
Kazakhstan	2,100	2,200
Korea, Republic of	1,280	1,300
Kuwait	634	600
Mexico	1,450	1,500
Netherlands	497	500
Poland	1,220	1,000
Russia	6,350	6,500
Saudi Arabia	2,230	2,300
Spain	685	700
United Arab Emirates	1,900	2,000
Other countries	4,800	5,000
World total (rounded)	57,700	59,000

Reserves and reserve base[2]

Previously published reserve 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 reserves from Saudi Arabia actually may be recovered at oil 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 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 resource is about one-fifth of the world total. Elemental sulfur deposits have become marginal reserves even at deposits that are already developed. Sulfur from petroleum and metal sulfides may be recovered where it is refined, which may be in the country of origin or in an importing nation. The rate of sulfur recovery from refineries is dependent on the environmental regulations where refining is accomplished, most of which are becoming more stringent.

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. — Zero.
[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 2003 domestic talc production was $19 million. There were nine talc-producing mines in five States in 2003. Companies in Montana, New York, Texas, and Vermont accounted for most of the domestic production. Domestically produced ground talc was used in paint, 32%; ceramics, 28%; paper, 18%; roofing, 6%; plastics, 6%; rubber, 4%; cosmetics, 3%; and other, 3%. One company in California and two companies in North Carolina mined pyrophyllite. Production of pyrophyllite declined slightly from that of 2002. Consumption was, in decreasing order, in refractory products, ceramics, and paint.

Salient Statistics—United States:[1]	1999	2000	2001	2002	2003[e]
Production, mine	925	851	863	775	817
Sold by producers	881	821	784	791	789
Imports for consumption	208	270	180	232	250
Exports	147	154	137	166	180
Shipments from Government stockpile excesses	([2])	—	—	—	([2])
Consumption, apparent	986	967	906	841	887
Price, average, processed dollars per ton	116	116	108	96	114
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill	690	640	520	510	500
Net import reliance[3] as a percentage of apparent consumption	6	12	5	8	8

Recycling: Insignificant.

Import Sources (1999-2002): China, 45%; Canada, 28%; France, 8%; Japan, 4%; and other, 15%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Crude, not ground	2526.10.0000	Free.
Ground, washed, 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—9-30-03[4]
(Metric tons)

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Talc, block and lump	900	—	900	[5]1,810	—
Talc, ground	988	—	988	—	—

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

TALC AND PYROPHYLLITE

Events, Trends, and Issues: Production of talc increased 5%, and sales were essentially unchanged from those of 2002. Apparent consumption increased 5%. Exports increased by 8% compared with those of 2002. Canada remained the major destination for U.S. talc exports, accounting for about 40% of the tonnage. U.S. imports of talc increased by 8% compared with those of 2002. In 2003, Canada, China, and Italy supplied approximately 87% of the imported talc.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	2002	2003[e]		
United States[1]	775	817	140,000	540,000
Brazil	450	600	180,000	250,000
China	3,600	3,500	Large	Large
India	550	560	4,000	9,000
Japan	665	630	100,000	160,000
Korea, Republic of	1,100	1,000	14,000	18,000
Other countries	1,730	1,750	Large	Large
World total (rounded)	8,870	8,860	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. Revised data from the Brazilian government resulted in a large increase in the estimated reserves and reserve base for pyrophyllite and talc in that country.

Substitutes: The major substitutes for talc are clays and pyrophyllite in ceramics, kaolin and mica in paint, kaolin in paper, clays and mica in plastics, and kaolin and mica in rubber.

[e]Estimated. NA Not available. — 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: There has been no significant domestic tantalum mining since 1959. Domestic tantalum resources are of low grade, some mineralogically complex, and most are not commercially recoverable. Most metal, alloys, and compounds were produced by three companies; tantalum units were obtained from imported concentrates and metal and from foreign and domestic scrap. Tantalum was consumed mostly in the form of metal powder, ingot, fabricated forms, compounds, and alloys. The major end use for tantalum was in the production of electronic components, more than 60% of use, mainly in tantalum capacitors. Major end uses for tantalum capacitors include automotive electronics, pagers, personal computers, and portable telephones. The value of tantalum consumed in 2003 was estimated at about $170 million.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, mine	—	—	—	—	—
Imports for consumption:					
Mineral concentrates[e]	320	650	690	710	550
Tantalum metal and tantalum-bearing alloys[e]	244	251	316	266	210
Exports, concentrate, metal, alloys, waste, scrap[e]	480	530	600	490	540
Government stockpile releases[e, 1]	5	242	(53)	16	216
Consumption, apparent	555	650	550	500	500
Price, tantalite, dollars per pound[2]	34.00	220.00	37.00	31.00	27.50
Net import reliance[3] as a percentage of apparent consumption	80	80	80	80	80

Recycling: Tantalum was recycled mostly from new scrap that was generated during the manufacture of tantalum-related electronic components and new and old scrap products of tantalum-containing cemented carbides and superalloys. Combined prompt industrial and obsolete scrap consumed represented about 20% of apparent consumption.

Import Sources (1999-2002): Australia, 54%; Canada, 8%; China, 8%; Kazakhstan, 8%; and other, 22%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
Synthetic tantalum-columbium concentrates	2615.90.3000	Free.
Tantalum ores and concentrates	2615.90.6060	Free.
Tantalum oxide	2825.90.9000	3.7% ad val.
Potassium fluotantalate	2826.90.0000	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: For fiscal year 2003, the Defense National Stockpile Center (DNSC) sold about 1 ton of tantalum capacitor-grade metal powder valued at about $107,000, about 18 tons of tantalum vacuum-grade metal ingots valued at about $2.17 million, and about 196 tons of tantalum contained in tantalum-columbium minerals valued at about $10.1 million and disposed of about 3 tons of tantalum contained in tantalum oxide from the National Defense Stockpile (NDS). There were no sales of tantalum carbide powder in fiscal year 2003. The DNSC announced maximum disposal limits in fiscal year 2004 of about 2 tons[4] of tantalum contained in tantalum carbide powder, about 18 tons[4] of tantalum contained in tantalum metal ingots, about 18 tons[4] of tantalum contained in tantalum metal powder, about 227 tons of tantalum contained in tantalum minerals, and about 9 tons of tantalum contained in tantalum oxide. The NDS uncommitted inventories shown below include about 129 tons of tantalum contained in nonstockpile-grade tantalum minerals.

Prepared by **Larry D. Cunningham [(703) 648-4977, lcunning@usgs.gov, fax: (703) 648-7757]**

TANTALUM

Stockpile Status—9-30-03[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Tantalum:					
Carbide powder	6	—	6	2	—
Metal:					
Powder	17	17	17	[4]23	1
Ingots	27	7	27	18	18
Minerals	670	175	670	227	196
Oxide	28	—	28	9	3

Events, Trends, and Issues: Total consumption of tantalum was about the same compared with that in 2002. Overall tantalum imports decreased. Imports for consumption of tantalum mineral concentrates were down by more than 20%, with Australia supplying about 85% of quantity and about 90% of value. Exports increased; Brazil, Germany, Israel, Japan, Mexico, and the United Kingdom were the major recipients of the tantalum materials. In October, quoted spot price ranges for tantalum ore (per pound tantalum pentoxide content), in three published sources, were $20 to $25, $20 to $30, and $30 to $40. The most recent published industry source (August 1999) on tantalum product prices indicated that the average selling prices per pound tantalum content for some tantalum products were as follows: capacitor-grade powder, $135 to $260; capacitor wire, $180 to $270; and vacuum-grade metal for superalloys, $75 to $100. Public information on current prices for these tantalum products was not available; pricing is normally established by negotiation between buyer and seller.

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

	Mine production[6] 2002	Mine production[6] 2003[e]	Reserves[7]	Reserve base[7]
United States	—	—	—	Negligible
Australia	940	820	40,000	80,000
Brazil	200	200	NA	73,000
Burundi	28	15	NA	NA
Canada	58	58	3,000	NA
Congo (Kinshasa)	60	30	NA	NA
Ethiopia	35	40	NA	NA
Mozambique	12	12	NA	NA
Nigeria	3	10	NA	NA
Rwanda	53	20	NA	NA
Uganda	5	5	NA	NA
Zimbabwe	144	17	NA	NA
Other countries[8]	—	—	NA	NA
World total (rounded)	1,540	1,230	43,000	150,000

World Resources: Most of the world's resources of tantalum occur outside the United States. On a worldwide basis, identified resources of tantalum are considered adequate to meet projected needs. These resources are largely in Australia, Brazil, and Canada. The United States has about 1,500 tons of tantalum resources in identified deposits, all of which were considered uneconomic at 2003 prices.

Substitutes: The following materials can be substituted for tantalum, but usually with less effectiveness: columbium in carbides; aluminum and ceramics in electronic capacitors; columbium, glass, platinum, titanium, and zirconium in corrosion-resistant equipment; and columbium, hafnium, iridium, molybdenum, rhenium, and tungsten in high-temperature applications.

[e]Estimated. NA Not available. — Zero.
[1]Net quantity (uncommitted inventory). Parentheses indicate negative number (increase in inventory).
[2]Yearend average value, contained pentoxides.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]Actual quantity limited to remaining sales authority or inventory.
[5]See Appendix B for definitions.
[6]Excludes production of tantalum contained in tin slags.
[7]See Appendix C for definitions.
[8]Bolivia, China, Russia, and Zambia also produce (or are believed to produce) tantalum mineral concentrates, but available information is inadequate to make reliable estimates of output levels.

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. Primary and intermediate producers further refined 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, to improve machinability without reducing conductivity; in lead, 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 also 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's other uses include those in photoreceptor and thermoelectric devices for electronic applications, as an ingredient in blasting caps, and as a pigment to produce various colors in glass and ceramics.

In 2003, the estimated distribution of uses, worldwide, was as follows: iron and steel products, 50%; catalysts and chemicals, 25%; additives to nonferrous alloys, 10%; photoreceptors and thermoelectric devices, 8%; and other, 7%.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production, refinery	W	W	W	W	W
Imports for consumption, unwrought, waste and scrap[1]	38	52	28	28	43
Exports[1]	NA	NA	NA	NA	NA
Consumption, apparent	NA	NA	NA	NA	NA
Price, dollars per pound, 99.7% minimum[2]	15	14	15	16	17
Stocks, producer, refined, yearend	W	W	W	W	W
Employment, number	NA	NA	NA	NA	NA
Net import reliance[3] as a percentage of apparent consumption	NA	NA	NA	NA	NA

Recycling: There is little or no scrap from which to extract secondary tellurium because the uses of tellurium are nearly all dissipative in nature. None is recovered currently in the United States, but a small amount may be recovered in Europe or elsewhere from scrapped selenium-tellurium photoreceptors employed in plain paper copiers.

Import Sources (1999-2002): Philippines, 39%; United Kingdom, 17%; Belgium, 15%; Canada, 13%; and other, 16%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/03**
Metal	2804.50.0020	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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

TELLURIUM

Events, Trends, and Issues: Domestic tellurium production was estimated to have decreased in 2003, compared with that of 2002. Domestic tellurium demand remained constant in 2003, while world tellurium demand increased slightly over the same period. World production of tellurium, a byproduct of copper refining, was up slightly, despite a marginal decrease in copper production, owing to its coproduct status with selenium. Selenium, which was in strong demand, experienced a surge in production from waste and anode slimes that contained coproduct tellurium. Detailed information on the world tellurium market was not available.

Tellurium supply and demand has remained in fairly close balance for the past decade. In the short term, significant increases are not anticipated in either consumption or production, although reductions in copper production may reduce tellurium supply. An increase in demand for high-purity tellurium for cadmium telluride solar cells might have a major impact on tellurium consumption. Tellurium consumption is increasing in thermal elements for small ice packs and refrigerators.

Tellurium alloyed with germanium and antimony used in digital video discs (DVD) consumes only small amounts of tellurium and will, therefore, have minimal impact on tellurium demand.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[4]	Reserve base[4]
	2002	2003[e]		
United States	W	W	3,000	6,000
Canada	45	50	650	1,500
Japan	29	30	—	—
Peru	20	20	1,600	2,800
Other countries[5]	NA	NA	16,000	37,000
World total (rounded)	[6]94	[6]100	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 in the unrefined (blister) copper anodes is actually recovered.

More than 90% of tellurium is produced from anode muds collected from electrolytic copper refining, and the remainder, if any, is derived from skimmings at lead refineries and from flue dusts and gases generated during the smelting of bismuth, copper, and lead ores. As tellurium is recovered only from the electrolysis of smelted copper, growth in the popularity of leaching-electrowinning processes has exerted downward pressure on tellurium supply.

Substitutes: Several substitutes can replace tellurium in many, perhaps most, of it 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 the tellurides. The selenides and sulfides of niobium and tantalum can serve as electrically conducting solid lubricants in place of the tellurides of those metals.

The selenium-tellurium photoreceptors used in some xerographic copiers and laser printers are being replaced in newer machines by organic photoreceptors. 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. — Zero.
[1]Imports and exports of boron and tellurium are grouped together under the Harmonized Tariff Schedule; however, imports of boron are considered to be small relative to tellurium, while exports of boron may represent a significant portion of the combined total.
[2]Yearend prices quoted by the sole producer for specialty product. Price quotes for nonspecialty products show a considerable discount.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions. Estimates include tellurium contained in copper resources only.
[5]In addition to the countries listed, Australia, Belgium, China, Germany, Kazakhstan, the Philippines, Russia, and the United Kingdom produce refined tellurium, but output is not reported and available information is inadequate for formulation of reliable production estimates.
[6]Excludes refinery production from the United States and "Other countries."

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 its compounds continued for most of their established end uses. These uses included a semiconductor material for selenium rectifiers, an activator in gamma radiation detection equipment, an electrical resistance component in infrared radiation detection and transmission equipment, and a crystalline filter for light diffraction in acousto-optical measuring devices. Other uses included an alloying component with mercury for low-temperature measurements, an additive in glass to increase its refractive index and density, a catalyst or intermediate in the synthesis of organic compounds, and a high-density liquid for sink-float separation of minerals. Also, the use of radioactive thallium compounds for medical purposes in cardiovascular imaging continued in 2003.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production, mine	—	—	—	—	—
Imports for consumption[1]	838	100	2,110	307	250
Exports	NA	NA	NA	NA	NA
Consumption[2]	380	300	800	500	500
Price, metal, dollars per kilogram[3]	1,295	1,295	1,295	1,250	1,300
Net import reliance[4] as a percentage of estimated consumption	100	100	100	100	100

Recycling: None.

Import Sources (1999-2002): Belgium, 81%; Canada, 13%; France, 3%; Russia, 2%; and United Kingdom, 1%.

Tariff: Item	Number	Normal Trade Relations[5] 12/31/03
Unwrought; powders; scrap (until 12/31/01)	8112.91.6000	4.0% ad val.
Unwrought and powders (starting 01/01/02)	8112.51.0000	4.0% ad val.
Waste and scrap (starting 01/01/02)	8112.52.0000	Free.
Other (starting 01/01/02)	8112.59.0000	4.0% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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

THALLIUM

Events, Trends, and Issues: Research and development activities of both a basic and applied nature were conducted during 2003 to improve and expand the use of thallium. These activities included the development of high-temperature superconducting materials for such applications as magnetic resonance imaging, storage of magnetic energy, magnetic propulsion, and electric power generation and transmission. The development of improved methods for manufacturing high-temperature superconductor tapes and films, such as thallium-barium-calcium-copper oxides, also received attention during the year. These tapes and films could be significant energy saving devices when applied in, for example, ultrafast computer and power transmission systems. Further use of radioactive thallium in clinical diagnostic applications, including cardiovascular and oncological imaging, also was studied during 2003. In addition, 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.

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. In 2003, the U.S. Environmental Protection Agency (EPA) continued health assessments on thallium and several other metals and chemicals for inclusion in the agency's Integrated Risk Information System database. Further scientific information on health effects that may result from exposure to these substances was requested from the public in order to complete the assessments. The assessment for thallium was expected to be completed in 2005. The EPA also initiated studies at its National Risk Management Research Laboratory on thallium removal from mine wastewaters. The U.S. Department of Health and Human Services, Food and Drug Administration, issued a guidance document announcing an approved drug for treatment of internal bodily contamination by radioactive or nonradioactive thallium. The drug, a form of industrial and artists' pigment (prussian blue), effectively increases the rate of elimination of thallium from the body by interrupting the process of thallium readsorption into the gastrointestinal tract from the intestines.

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

	Mine production		Reserves[7]	Reserve base[7]
	2002	2003		
United States	([8])	([8])	32,000	120,000
Other countries	15,000	15,000	350,000	530,000
World total (may be rounded)	15,000	15,000	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 at 0.7 part per million.

Substitutes: While other light-sensitive materials can substitute for thallium and its compounds in specific electronic applications, ample supplies of thallium discourage development of substitute materials.

[e]Estimated. NA Not available. — Zero.
[1]Unwrought; waste and scrap; powders, including thallium contained in compounds.
[2]Based on reported imports and estimated drawdown of private stocks.
[3]Estimated price of 99.999%-pure granules in 100-gram lots.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]By the North American Free Trade Agreement, there is no tariff for Canada or Mexico.
[6]Estimates are based on thallium content of zinc ores.
[7]See Appendix C for definitions.
[8]Thallium contained in mined base-metal ores, estimated at 450 to 500 kilograms per year, is separated from the base metals but not extracted for commercial use.

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 2003, 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 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 increased to about $180,000.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production, refinery[1]	—	—	—	—	—
Imports for consumption:					
Thorium ore and concentrates (monazite), gross weight	—	—	—	—	—
Thorium ore and concentrates (monazite), ThO_2 content	—	—	—	—	—
Thorium compounds (oxide, nitrate, etc.), gross weight	5.29	11.10	1.85	0.65	4.14
Thorium compounds (oxide, nitrate, etc.), ThO_2 content	3.91	8.20	1.37	0.48	3.06
Exports:					
Thorium ore and concentrates (monazite), gross weight	—	—	—	—	—
Thorium ore and concentrates (monazite), ThO_2 content	—	—	—	—	—
Thorium compounds (oxide, nitrate, etc.), gross weight	2.52	4.64	7.30	1.93	2.42
Thorium compounds (oxide, nitrate, etc.), ThO_2 content	1.86	3.43	5.40	1.43	1.79
Shipments from Government stockpile excesses ($ThNO_3$)	—	—	—	—	—
Consumption:					
Reported, (ThO_2 content[e])	7.0	6.0	—	NA	NA
Apparent	3.1	7.7	NA	NA	NA
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	82.50	82.50
99.99% purity[4]	107.25	107.25	107.25	107.25	107.25
Net import reliance[5] as a percentage of apparent consumption	100	100	NA	NA	NA

Recycling: None.

Import Sources (1999-2002): Monazite: None. Thorium compounds: France, 99.4%; Netherlands, 0.4%; and other, 0.2%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/03**
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Thorium compounds	2844.30.1000	5.5% ad val.

Depletion Allowance: Monazite, 23% on thorium content, 15% on rare-earth and yttrium content (Domestic); 14% (Foreign).

Government Stockpile:

Stockpile Status—9-30-03[6]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2003**	**Disposals FY 2003**
Thorium nitrate (gross weight)	3,219	—	3,219	3,221	0.154

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 2003. 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 2003. In 2003, apparent consumption, primarily for use in catalyst applications, is estimated to have decreased. On the basis of data through August 2003, the average value of imported thorium compounds increased to $40.23 per kilogram from the 2003 average of $34.00 per kilogram (gross weight). The average value of exported thorium compounds was $136.45 per kilogram based on data through August 2003. Price increases were the result of real and potential costs associated with handling and shipping radioactive materials and not based on supply-demand factors. The use of thorium in the United States 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 forecast that thorium's use will continue to decline unless a low-cost disposal process is developed or new technology creates renewed demand.

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

	Refinery production		Reserves[8]	Reserve base[8]
	2002	2003		
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 largest 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, 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. E Net exporter. 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., f.o.b. port of entry, duty paid, ThO_2 basis.
[4]Source: Rhodia Electronics and Catalysis, Inc., 1-950 kilogram quantities, f.o.b. port of entry, duty paid.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]See Appendix B for definitions.
[7]Estimates, based on thorium contents of rare-earth ores.
[8]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 domestically since 1993. Production of tin at the only U.S. tin smelter, at Texas City, TX, stopped in 1989. Twenty-five firms used about 77% of the primary tin consumed domestically in 2003. The major uses were as follows: cans and containers, 27%; electrical, 23%; construction, 10%; transportation, 10%; and other, 30%. On the basis of the New York composite price, the estimated values of some critical items were as follows: primary metal consumed, $283 million; imports for consumption, refined tin, $290 million; and secondary production (old scrap), $31 million.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:					
Secondary (old scrap)	7,750	6,560	6,700	3,590	4,000
Secondary (new scrap)	8,650	9,140	7,200	6,410	7,000
Imports for consumption, refined tin	47,500	44,900	37,500	42,200	37,000
Exports, refined tin	6,770	6,640	4,350	2,940	4,020
Shipments from Government stockpile excesses	765	12,000	12,000	8,960	9,000
Consumption, reported:					
Primary	38,000	38,100	34,200	34,000	36,000
Secondary	8,890	8,940	7,630	5,830	8,460
Consumption, apparent	59,700	57,200	48,250	52,330	44,980
Price, average, cents per pound:					
New York market	255	255	211	195	224
New York composite	366	370	315	292	357
London	245	246	203	184	214
Kuala Lumpur	241	244	201	184	214
Stocks, consumer and dealer, yearend	10,700	10,400	9,620	9,100	10,100
Net import reliance[1] as a percentage of apparent consumption	85	88	86	93	91

Recycling: About 11,000 tons of tin from old and new scrap was recycled in 2003. Of this, about 4,000 tons was recovered from old scrap at 3 detinning plants and 70 secondary nonferrous metal processing plants.

Import Sources (1999-2002): Peru, 34%; China, 28%; Bolivia, 13%; Brazil, 12%; Indonesia, 12%; and other, 1%.

Tariff: Most major imports of tin, including unwrought metal, waste and scrap, and unwrought tin alloys, enter duty free.

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

Government Stockpile: The Defense National Stockpile Center (DNSC) continued its longtime tin sales program. The DNSC Annual Materials Plan for tin for fiscal year 2003 (October 1, 2002, to September 30, 2003) remained at 12,000 tons. DNSC will continue to have at least one long-term negotiated "contract" sale for each fiscal year. The remaining tonnage will be sold using the DSNC Basic Ordering Agreement (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. BOA sales began in June 2002. In fiscal year 2003, DNSC had only one long-term sale, and that was in June. Tin is in Federal depots at four locations: Baton Rouge, LA; Hammond, IN; New Haven, IN; and Point Pleasant, WV.

Stockpile Status—9-30-03[2]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Pig tin	35,663	8,382	35,663	12,000	9,753

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

TIN

Events, Trends, and Issues: The Steel Recycling Institute, a business unit of the American Iron and Steel Institute, announced that the steel can (tin-plated) recycling rate in the United States was 59% in 2002, compared with 58% in 2001. Tin, as well as steel, is recovered in can recycling.

Tin prices stabilized in 2003, trading in a narrow range of about $3.00 to $3.35 per pound through the end of summer. World tin consumption was believed to have declined somewhat during the year because many countries continued to experience an economic slowdown.

The world tinplate industry continued to be characterized by more mergers and consolidations. In most cases, this trend resulted in the loss of tin mill capacity. During the past 3 years, several domestic steel producers that make tinplate have declared bankruptcy, thus raising concerns about the status of future domestic tinplate sources.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	2002	2003[e]		
United States	—	—	20,000	40,000
Australia	6,270	9,000	110,000	300,000
Bolivia	15,200	13,200	450,000	900,000
Brazil	13,000	14,000	540,000	2,500,000
China	80,000	90,000	1,700,000	3,500,000
Indonesia	54,000	61,000	800,000	900,000
Malaysia	4,200	4,500	1,000,000	1,200,000
Peru	65,400	65,000	710,000	1,000,000
Portugal	1,000	1,100	70,000	80,000
Russia	2,900	2,000	300,000	350,000
Thailand	1,100	2,000	170,000	200,000
Vietnam	4,700	2,500	NA	NA
Other countries	1,000	1,000	180,000	200,000
World total (rounded)	249,000	265,000	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. Sufficient world resources, principally in western Africa, southeastern Asia, Australia, Bolivia, Brazil, China, and Russia are available to sustain recent annual production rates well into the 21st century.

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 2003 was about $500 million. The major coproduct of mining from ilmenite and rutile deposits was zircon. About 97% of titanium mineral concentrates was consumed by domestic TiO_2 pigment producers. The remainder was used in welding rod coatings and for manufacturing carbides, chemicals, and metal.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production[2] (ilmenite and rutile, rounded)	300	300	300	300	300
Imports for consumption:					
Ilmenite and slag	776	647	737	599	565
Rutile, natural and synthetic	324	413	303	368	419
Exports,[e] all forms	6	12	5	2	8
Consumption, reported:					
Ilmenite and slag[3]	963	919	856	951	950
Rutile, natural and synthetic	413	497	448	452	450
Price, dollars per metric ton:					
Ilmenite, bulk, 54% TiO_2, f.o.b. Australian ports	98	94	100	93	93
Rutile, yearend, bulk, f.o.b. Australian ports	473	485	475	450	430
Slag:[e]					
80% TiO_2, f.o.b. Sorel, Quebec	390	362	335	340	340
85% TiO_2, f.o.b. Richards Bay, South Africa	406	425	419	445	408
Stocks, mine, consumer, yearend:					
Ilmenite	343	262	221	197	200
Rutile	96	101	118	75	75
Employment, mine and mill, number[e]	366	360	360	366	269
Net import reliance[4] as a percentage of reported consumption	75	79	78	74	70

Recycling: None.

Import Sources (1999-2002): South Africa, 43%; Australia, 32%; Canada, 14%; Ukraine, 6%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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: Global consumption of titanium mineral concentrates was estimated to have increased slightly in 2003 compared with that of 2002. Domestic consumption of titanium mineral concentrates was nearly unchanged. The United States relied heavily on imports primarily from Australia and South Africa.

In the United States, preparations were underway to expand dry mining in northern Florida and southern Georgia in 2004. A 1,000-ton-per-hour separation unit is expected to be operational in 2004. As part of a cost reduction program, the 200,000-ton-per-year synthetic rutile plant near Mobile, AL, was permanently idled. The plant was based on a hydrochloric leach process and was the only domestic source of synthetic rutile.

Two new titanium slag furnaces were commissioned in KwaZulu-Natal, South Africa. When fully operational, the two furnaces will produce up to 250,000 tons per year of titanium slag. Ilmenite feedstock will be supplied to the furnaces from the Hillendale mine about 10 kilometers from Richards Bay.

On a global basis, declining ore grades of active mining operations have encouraged the exploration and development for new sources of titanium minerals. Projects under development include the following: Athabasca oil sands (Alberta, Canada), Corridor Sands (Gaza, Mozambique), Douglas (Murray Basin, Australia), Kwale (Mombasa, Kenya), Moma (Nampula, Mozambique), Pooncarie (Murray Basin, Australia), Truro (Nova Scotia, Canada), and Wemen (Murray Basin, Australia).

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	2002	2003[e]		
Ilmenite:				
United States[2]	[6]300	[6]300	6,000	59,000
Australia	1,170	1,090	[7]200,000	[7]250,000
Canada[8]	720	720	31,000	36,000
India	248	240	30,000	38,000
Norway[8]	338	340	40,000	40,000
South Africa[8]	978	950	63,000	220,000
Ukraine	281	290	5,900	13,000
Other countries	382	380	49,000	84,000
World total (ilmenite, rounded)	4,400	4,300	420,000	740,000
Rutile:				
United States	([9])	([9])	400	1,800
Australia	207	220	[7]22,000	[7]34,000
India	17	16	6,600	7,700
South Africa	94	110	8,300	24,000
Ukraine	67	67	2,500	2,500
Other countries	2	2	8,000	17,000
World total (rutile, rounded)	[10]390	[10]420	48,000	87,000
World total (ilmenite and rutile, rounded)	4,800	4,700	470,000	830,000

World Resources: Ilmenite supplies about 90% of the world's demand for titanium minerals. World ilmenite resources total about 1 billion tons of titanium dioxide. Identified world resources of rutile (including anatase) total about 230 million tons of contained TiO_2.

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.
[1]See also Titanium and Titanium Dioxide.
[2]Rounded to the nearest 0.1 million ton to protect proprietary data.
[3]Excludes ilmenite used to produce synthetic rutile.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.
[6]Includes rutile to avoid disclosing company proprietary data.
[7]Derived from data published by the Australian Geological Survey Organisation.
[8]Mine production is primarily used to produce titaniferous slag. Reserves and reserve base are ilmenite.
[9]Included with ilmenite to avoid disclosing company proprietary data.
[10]Excludes U.S. production.

TITANIUM AND TITANIUM DIOXIDE[1]

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: Titanium sponge metal was produced by two operations in Nevada and Utah. Ingot was made by the two sponge producers and by nine other firms in seven States. Numerous firms consumed ingot to produce forged components, mill products, and castings. In 2003, an estimated 55% of the titanium metal used was in aerospace applications. The remaining 45% was used in armor, chemical processing, marine, medical, power generation, sporting goods, and other nonaerospace applications. The value of sponge metal consumed was about $107 million, assuming an average selling price of $6.50 per kilogram. The value of ingot produced from sponge and scrap was estimated to be $215 million.

In 2003, titanium dioxide (TiO_2) pigment, valued at about $2.8 billion, was produced by four companies at eight facilities in seven States. Estimated use of TiO_2 pigment by end use was paint (includes lacquers and varnishes) 53%; plastic and rubber, 27%; paper, 15%; and other, 5%. Other uses of TiO_2 included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Titanium sponge metal:					
Production	W	W	W	W	W
Imports for consumption	6,000	7,240	13,300	10,700	10,000
Exports	807	1,930	2,170	2,810	5,150
Shipments from Government stockpile excesses	515	4,900	7,640	5,400	5,490
Consumption, reported	18,100	18,200	26,200	17,300	16,500
Price, dollars per kilogram, yearend	9.37	9.37	7.89	8.02	6.50
Stocks, industry yearend[e]	7,970	5,010	6,340	11,700	10,000
Employment, number[e]	300	300	300	300	300
Net import reliance[2] as a percentage of reported consumption	44	72	67	46	73
Titanium dioxide:					
Production	1,350,000	1,400,000	1,330,000	1,410,000	1,410,000
Imports for consumption	225,000	218,000	209,000	231,000	238,000
Exports	384,000	464,000	415,000	540,000	590,000
Consumption, apparent	1,160,000	1,150,000	1,100,000	1,120,000	1,070,000
Price, rutile, list, dollars per pound, yearend	1.01	1.01	1.05	0.90	0.90
Stocks, producer, yearend	137,000	141,000	159,000	137,000	130,000
Employment, number[e]	4,600	4,600	4,600	4,500	4,500
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 15,000 tons in 2003. Estimated use of titanium as scrap and ferrotitanium by the steel industry was about 5,900 tons; by the superalloy industry, 1,400 tons; and, in other industries, 650 tons. Old scrap reclaimed totaled about 500 tons.

Import Sources (1999-2002): Sponge metal: Japan, 40%; Kazakhstan, 39%; Russia, 18%; and other, 3%. Titanium dioxide pigment: Canada, 31%; Germany, 12%; France, 8%; Spain, 6%; and other, 43%.

Tariff:

Item	**Number**	**Normal Trade Relations 12/31/03**
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.
Wrought titanium metal	8108.90.6000	15.0% ad val.
Other titanium metal articles	8108.90.3000	5.5% ad val.

Depletion Allowance: Not applicable.

Prepared by **Joseph Gambogi [(703) 648-7718, jgambogi@usgs.gov, fax: (703) 648-7975]**

TITANIUM AND TITANIUM DIOXIDE

Government Stockpile: The Defense National Stockpile Center (DNSC) continued to solicit offers for the sale of titanium sponge held in the Government stockpile. For fiscal year 2004, 6,350 tons of sponge is planned for disposal. In support of an armor upgrade program, DNSC provided the U.S. Army with 227 tons of titanium sponge metal. The quantities shown below include stockpile and nonstockpile-grade sponge.

Stockpile Status—9-30-03[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Titanium sponge	8,910	1,050	8,910	6,350	6,380

Events, Trends, and Issues: Estimated domestic production of TiO_2 pigment was 1.41 million tons, nearly unchanged compared with that of 2002. Imports of TiO_2 pigment increased 3% compared with 2002, while exports increased 9%. Apparent consumption of pigment decreased 4% and published prices of rutile-grade pigment were unchanged. Capacity at several domestic TiO_2 pigment operations was being increased through process improvements. Despite a plant closure in 2001, domestic TiO_2 pigment capacity has increased by about 100,000 tons per year since 1999.

Depressed sales of commercial aircraft continued to limit demand for titanium metal. Domestic consumption of titanium sponge metal in 2003 decreased an estimated 5% compared with that of 2002. Imports of titanium sponge metal decreased by an estimated 7%. Owing in part to shipments from the Government stockpile, exports of titanium sponge increased 83%. Published prices for titanium sponge, ingot, and mill products decreased significantly. Numerous projects were underway to develop a low-cost method for producing titanium metal products.

World Sponge Metal Production and Sponge and Pigment Capacity:

	Sponge production		Capacity 2003[4]	
	2002	2003[e]	Sponge	Pigment
United States	W	W	8,940	1,580,000
Australia	—	—	—	213,000
Belgium	—	—	—	100,000
Canada	—	—	—	81,000
China[e]	3,300	3,600	6,900	450,000
Finland	—	—	—	120,000
France	—	—	—	225,000
Germany	—	—	—	411,000
Italy	—	—	—	80,000
Japan	25,200	20,000	31,000	317,000
Kazakhstan[e]	14,000	12,000	22,000	1,000
Mexico	—	—	—	120,000
Russia[e]	23,000	23,000	26,000	20,000
Spain	—	—	—	80,000
Ukraine[e]	6,100	6,700	6,700	120,000
United Kingdom	—	—	—	330,000
Other countries	—	—	—	641,000
World total (rounded)	[5]72,000	[5]65,000	100,000	4,900,000

World Resources:[6] Resources and reserves of titanium minerals (ilmenite and rutile) are discussed in Titanium Mineral Concentrates. Titanium for domestic sponge production was obtained from rutile or rutile substitutes. The feedstock sources for pigment production were ilmenite, slag, and synthetic rutile.

Substitutes: Although there are few substitutes for titanium in aircraft and space use today, intermetallic and composite materials may displace some titanium used in future military aircraft. For industrial uses, high-nickel steel, zirconium, and, to a limited extent, the superalloy metals may be substituted for titanium alloys. Ground calcium carbonate, precipitated calcium carbonate, kaolin, and talc compete with titanium dioxide as a white pigment.

[e]Estimated. E Net exporter. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]See also Titanium Mineral Concentrates.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.
[4]Operating capacity.
[5]Excludes U.S. production.
[6]See Appendix C for definitions.

TUNGSTEN

(Data in metric tons of tungsten content, unless otherwise noted)

Domestic Production and Use: The last reported U.S. production of tungsten concentrates was in 1994. In 2003, approximately seven 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. Approximately 70 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, oil- and gas-drilling, mining, and construction industries. The remaining tungsten was consumed in making heavy metal alloys; lamp filaments, electrodes, and other components for the electrical and electronics industries; steels, superalloys, and wear-resistant alloys; and chemicals for catalysts and pigments. The total estimated value of tungsten consumed in 2003 was $170 million.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:					
Mine	—	—	—	—	—
Secondary	4,980	5,210	5,390	4,380	4,300
Imports for consumption:					
Concentrate	2,870	2,370	2,680	4,090	4,900
Other forms	8,230	7,810	8,150	6,510	7,700
Exports:					
Concentrate	26	70	220	94	10
Other forms	2,860	2,800	4,860	3,220	5,000
Government stockpile shipments:					
Concentrate	([1])	1,240	2,200	1,140	600
Other forms	([1])	591	986	177	200
Consumption:					
Reported, concentrate	[2]2,100	W	W	W	W
Apparent, all forms	12,900	14,400	14,500	11,900	11,700
Price, concentrate, dollars per mtu WO_3,[3] average:					
U.S. spot market, Platts Metals Week	47	47	64	55	50
European market, Metal Bulletin	40	45	65	38	45
Stocks, industry, yearend:					
Concentrate	W	W	W	W	W
Other forms	2,490	2,280	2,110	1,610	1,600
Net import reliance[4] as a percentage of apparent consumption	65	66	64	69	69

Recycling: During 2003, the tungsten content of scrap consumed by processors and end users was estimated at 4,300 tons. This represented approximately 37% of apparent consumption of tungsten in all forms.

Import Sources (1999-2002): Tungsten content of ores and concentrates, intermediate and primary products, wrought and unwrought tungsten, and waste and scrap: China, 49%; Russia, 11%; Canada, 10%; and other, 30%. In 2002, imports of tungsten materials from Russia decreased to 1%, and imports from Canada increased to 27% of total tungsten imports.

Tariff: Item	Number	Normal Trade Relations[5] 12/31/03
Ore	2611.00.3000	Free.
Concentrate	9902.26.1100	Free.
Ferrotungsten	7202.80.0000	5.6% ad val.
Tungsten powders	8101.10.0000	7.0% ad val.
Ammonium tungstate	2841.80.0010	5.5% ad val.
Tungsten carbide	2849.90.3000	6.0% ad val.
Tungsten oxide	2825.90.3000	5.5% 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: Sales of National Defense Stockpile tungsten began in 1999. Included in the data listed in the table below, as of September 30, 2003, are 6,410 tons of tungsten contained in uncommitted nonstockpile-grade ores and concentrates authorized for disposal.

Stockpile Status—9-30-03[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Ferrotungsten	263	41	263	136	141
Metal powder	463	—	463	136	28
Ores and concentrates	28,700	728	28,700	1,810	1,370

Events, Trends, and Issues: World tungsten supply continued to be dominated by Chinese production and exports. Beginning in 1999 and continuing into 2003, the Chinese Government took several steps to control the release of Chinese tungsten into the world market. In addition to regulating production and the total volume of tungsten exports, the Government was gradually shifting the balance of export quotas towards value added downstream tungsten materials and products. China was also becoming a larger tungsten consumer. During the past decade, the growth in China's economy has resulted in a significant increase in consumption of tungsten materials to produce finished products for the domestic market, such as cemented carbide tools.

World Mine Production, Reserves, and Reserve Base:

	Mine production 2002	Mine production 2003[e]	Reserves[7]	Reserve base[7]
United States	—	—	140,000	200,000
Austria	1,400	1,400	10,000	15,000
Bolivia	500	450	53,000	100,000
Canada	2,550	3,000	260,000	490,000
China	49,500	49,500	1,800,000	4,200,000
Korea, North	600	600	NA	35,000
Portugal	700	700	25,000	25,000
Russia	3,400	3,400	250,000	420,000
Other countries	430	450	360,000	690,000
World total (rounded)	59,100	59,500	2,900,000	6,200,000

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: Cemented tungsten carbide remained a primary cutting-tool insert material because of its versatility in meeting technical requirements in many turning and milling operations. However, ceramics, ceramic-metallic composites, and other materials continued to be developed and utilized as substitutes to meet the changing needs of the world market. Increased quantities of carbide cutting-tool inserts were coated with alumina, diamond, titanium carbide, and/or titanium nitride to extend the life of the inserts. Tungsten remained the preferred and essentially unsubstitutable material for electrodes or filaments in incandescent, halogen, fluorescent, and gas discharge lighting applications. A nontungsten electrodeless lamp based on induction technology has been developed for commercial and industrial use. The use of light-emitting diodes (LEDs) in lighting applications is expected to increase. As LEDs substitute for traditional lighting technologies, the overall impact on tungsten consumption will depend on whether tungsten-copper heat sinks are used to dissipate heat from the LED devices.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Less than ½ unit.
[2]Excludes 6 months of withheld data.
[3]A metric ton unit (mtu) of tungsten trioxide (WO_3) contains 7.93 kilograms of tungsten.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]Special tariff rates apply for Canada and Mexico.
[6]See Appendix B for definitions.
[7]See Appendix C for definitions.

VANADIUM

(Data in metric tons of vanadium content, unless otherwise noted)

Domestic Production and Use: Eight firms make up the U.S. vanadium industry. These firms produce 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 iron slag. Metallurgical use, primarily as an alloying agent for iron and steel, accounts for about 90% of the vanadium consumed domestically. 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:	1999	2000	2001	2002	2003[e]
Production, mine, mill	W	—	—	—	—
Imports for consumption:					
Ash, ore, residues, slag	1,650	1,890	1,670	1,870	1,600
Vanadium pentoxide, anhydride	208	902	600	406	660
Oxides and hydroxides, other	—	14	1,080	42	30
Aluminum-vanadium master alloys (gross weight)	1,210	16	10	98	300
Ferrovanadium	1,930	2,510	2,550	2,520	1,100
Exports:					
Vanadium pentoxide, anhydride	747	653	670	453	290
Oxides and hydroxides, other	70	100	385	443	330
Aluminum-vanadium master alloys (gross weight)	514	677	363	529	1,800
Ferrovanadium	213	172	70	142	480
Consumption, reported	3,620	3,520	3,210	3,080	3,400
Price, average, dollars per pound V_2O_5	1.99	1.82	1.37	1.34	1.50
Stocks, consumer, yearend	348	303	251	221	220
Employment, mine and mill, number	400	400	400	400	400
Net import reliance[1] as a percentage of reported consumption	76	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 used. The vanadium content of other recycled steels was lost to slag during processing and was not recovered.

Import Sources (1999-2002): Ferrovanadium: South Africa, 26%; Czech Republic, 22%; Canada, 17%; China, 16%; and other, 19%. Vanadium pentoxide: South Africa, 91%; Mexico, 7%; and other, 2%.

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

Item	Number	Normal Trade Relations 12/31/03
Vanadium pentoxide anhydride	2825.30.0010	6.6% ad val.
Vanadium oxides and hydroxides, other	2825.30.0050	6.6% ad val.
Vanadates	2841.90.1000	6.1% 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 2003 increased about 10% over that of the previous year. Among the major uses for vanadium, production of high-strength low-alloy, full-alloy, and carbon steels accounted for 33%, 29%, and 27% of domestic consumption, respectively. Steel production in 2003 was expected to be level with that of 2002.

Both ferrovanadium and vanadium pentoxide prices remained low during 2003. Industry publications attributed the low prices primarily to an oversupply of material on the market and flat demand in the steel and aerospace industries. The oversupply on the world market was reduced in 2003 by the closure of the Windimurra Mine in Australia (5,400 tons annual production capacity) and the temporary shutdown of the Tulachermet plant in Russia owing to management realignment. While supply and demand were almost balanced in 2003, high stock levels related to overproduction from 1999 to 2002 remained.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[2]	Reserve base[2]
	2002	2003[e]		
United States	—	—	45,000	4,000,000
China	33,000	35,000	5,000,000	14,000,000
Russia	8,000	9,000	5,000,000	7,000,000
South Africa	18,000	15,000	3,000,000	12,000,000
Other countries	1,000	1,000	NA	1,000,000
World total (rounded)	60,000	60,000	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 and recover vanadium in the United States.

Substitutes: Steels containing various combinations of other alloying elements can be substituted for steels containing vanadium. Metals, such as columbium (niobium), 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. 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.

VERMICULITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Two companies with mining and processing facilities produced vermiculite concentrate. One company had its operation in South Carolina, and the other company had an operation in Virginia and an operation in South Carolina (which was operated by its subsidiary company). Most of the vermiculite concentrate was shipped to 18 exfoliating plants in 10 States. The end uses for exfoliated vermiculite were estimated to be agricultural, insulation, and other, 73%; and lightweight concrete aggregates (including cement premixes, concrete, and plaster), 27%.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production[1]	[e, 2]150	[e, 3]150	NA	NA	[4]100
Imports for consumption[e]	71	59	65	56	48
Exports[e]	13	5	7	10	10
Consumption, apparent, concentrate	[e]208	[e]204	NA	NA	138
Consumption, exfoliated[e]	175	165	140	115	110
Price, base value, concentrate, dollars per ton, ex-plant[5]	143	143	143	143	143
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number[e]	130	120	100	90	90
Net import reliance[6] as a percentage of apparent consumption	[e]28	[e]26	NA	NA	28

Recycling: Insignificant.

Import Sources (1999-2002): South Africa, 73%; China, 25%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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: Stansbury Holdings Corp. indicated that it might not pursue its vermiculite activities in Montana but instead concentrate on its garnet operation. The company had done some initial mining and processing of vermiculite at its Dillon, MT, and Los Banos, CA, operations.[7]

During the past 2 or 3 years, concern had been expressed over vermiculite supplied from the mine near Libby, MT, including material that was used in attic insulation. The mine was closed in 1990 but had previously been a major supplier of the mineral. In May 2003, the U.S. Environmental Protection Agency issued guidelines and information on vermiculite insulation used in some home attics. If homeowners are concerned about vermiculite insulation in their attic, the guidelines recommend leaving the material undisturbed, if possible. Any dealing with or removing of the insulation should be handled by professionals.[8]

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[9]	Reserve base[9]
	2002	2003[e]		
United States	NA	[4]100	25,000	100,000
Brazil	22	23	NA	NA
China	50	50	NA	NA
Russia	25	25	NA	NA
South Africa	210	220	14,000	80,000
Zimbabwe	24	20	NA	NA
Other countries	45	42	11,000	20,000
World total (rounded)	[10]376	480	50,000	200,000

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.

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, slate, and slag. 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]Moeller, E.M., 2000, Vermiculite: Mining Engineering, v. 52, no. 6, June, p. 66-67.
[3]Moeller, E.M., 2001, Vermiculite: Mining Engineering, v. 53, no. 6, June, p. 6.
[4]U.S. Geological Survey estimate.
[5]Industrial Minerals magazine, yearend prices.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]Industrial Minerals, 2003, Stansbury drops Montana vermiculite to focus on garnet: Industrial Minerals, no. 426, March, p. 10.
[8]U.S. Environmental Protection Agency, 2003, Current best practices for vermiculite attic insulation—May 2003, accessed November 4, 2003, at URL http://www.epa.gov/asbestos/insulation.html.
[9]See Appendix C for definitions.
[10]Does not include U.S. data.

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 2003.

Yttrium was used in many applications. 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 2002 by end use was as follows: lamp and cathode-ray-tube phosphors, 79%; oxygen sensors, laser crystals, 10%; ceramics and abrasives, 10%; and miscellaneous, 1%.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production, mine	—	—	—	—	—
Imports for consumption:					
In monazite (yttrium oxide content[e])	—	—	—	—	—
Yttrium compounds, greater than 19% to less than 85% oxide equivalent (gross weight)	268	99	130	73	62
Exports, in ore and concentrate	NA	NA	NA	NA	NA
Consumption, estimated[2]	428	454	473	334	400
Price, dollars:					
Monazite concentrate, per metric ton[3]	400	400	400	400	400
Yttrium oxide, per kilogram, 99.0% to 99.99% purity[4]	22-85	25-200	22-88	22-88	22-88
Yttrium metal, per kilogram, 99.0% to 99.9% purity[4]	80-100	95-115	95-115	95-115	95-115
Stocks, processor, yearend	NA	NA	NA	NA	NA
Net import reliance[e, 5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Small quantities, primarily from laser crystals and synthetic garnets.

Import Sources (1999-2002):[e] Yttrium compounds, >19% to < 85% weight percent yttrium oxide equivalent: China, 78%; France, 12%; Japan, 7%; Germany, 1%; and other, 2%. Import sources based on Journal of Commerce data (year 2002 only): China, 70%; Japan, 19%; Germany, 5%; Netherlands, 5%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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%, 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: Yttrium demand in the United States decreased in 2002, but increased slightly in 2003 as the U.S. economy experienced growth towards yearend. International yttrium markets continued to be competitive, although China was the source of most of the world's supply. Yttrium was consumed primarily in the form of high-purity oxide and nitrate compounds.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e, 6]		Reserves[7]	Reserve base[7]
	2002	2003		
United States	—	—	120,000	130,000
Australia	—	—	100,000	110,000
Brazil	4	4	2,200	6,200
Canada	—	—	3,300	4,000
China	2,300	2,300	220,000	240,000
India	55	50	72,000	80,000
Malaysia	4	4	13,000	21,000
South Africa	—	—	4,400	5,000
Sri Lanka	2	2	240	260
Thailand	20	20	600	600
Other	26	26	9,000	10,000
World total (rounded)	2,400	2,400	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 columbium-tantalum minerals, and certain uranium ores, especially those of the Blind River District in Canada. It is probable that the world's resources are 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 and Scandium.
[2]Essentially all yttrium consumed domestically was imported or refined from imported ores and concentrates.
[3]Monazite concentrate prices derived from U.S. Census Bureau data.
[4]Yttrium oxide and metal prices from Elements—Rare Earths, Specialty Metals and Applied Technology (a High Tech Materials online publication at www.rareearthsmarketplace.com), Rhodia Rare Earths, Inc., Shelton, CT, and the China Rare Earth Information Center, Baotou, China.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]Includes yttrium contained in rare-earth ores.
[7]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 2003, based on contained zinc recoverable from concentrate, was about $664 million. It was produced in 5 States by 10 mines operated by 7 companies. Alaska, Missouri, and Tennessee accounted for 97% of domestic mine output; the Red Dog Mine in Alaska alone accounted for about three-fourths of total U.S. production. Two primary and 12 large- and medium-sized secondary smelters refined zinc metal of commercial grade in 2003. Of zinc metal consumed, about 75% was used in Illinois, Indiana, Michigan, New York, Ohio, and Pennsylvania, mostly by steel companies. Of the total zinc consumed, about 55% was used in galvanizing, 17% in zinc-base alloys, 13% in brass and bronze, and 15% 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, sulfur, cadmium, silver, gold, and germanium.

Salient Statistics—United States:	1999	2000	2001	2002	2003[e]
Production:					
Mine, zinc in ore[1]	852	852	842	780	770
Primary slab zinc	241	228	203	182	210
Secondary slab zinc	131	143	108	113	120
Imports for consumption:					
Ore and concentrate	75	53	84	122	160
Refined zinc	1,060	915	813	874	780
Exports:					
Ore and concentrate	531	523	696	822	830
Refined zinc	2	3	1	1	1
Shipments from Government stockpile	22	39	23	3	5
Consumption:					
Apparent, refined zinc	1,430	1,330	1,150	1,170	1,110
Apparent, all forms	1,700	1,630	1,410	1,430	1,370
Price, average, cents per pound:					
Domestic producers[2]	53.5	55.6	44.0	38.6	39.0
London Metal Exchange, cash	48.8	51.2	40.2	35.7	36.0
Stocks, slab zinc, yearend	84	77	75	78	78
Employment:					
Mine and mill, number[e]	2,500	2,600	2,400	1,500	1,400
Smelter primary, number[e]	1,000	1,000	900	600	600
Net import reliance[3] as a percentage of apparent consumption:					
Refined zinc	74	72	73	75	70
All forms of zinc	62	60	59	61	57

Recycling: In 2003, an estimated 370,000 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, 320,000 tons was derived from new scrap and 50,000 tons was derived from old scrap. About 50,000 tons of scrap was exported, mainly to China, India, and Taiwan, and 30,000 tons was imported, 95% of which came from Canada.

Import Sources (1999-2002): Ore and concentrate: Peru, 52%; Australia, 26%; Mexico, 13%; and other, 9%. Metal: Canada, 57%; Mexico, 26%; Kazakhstan, 10%; and other, 7%. Combined total: Canada, 53%; Mexico, 24%; Peru, 10%; and other, 13%.

Tariff: Item	Number	Normal Trade Relations[4] 12/31/03
Ore and concentrate	2608.00.0030	Free.
Unwrought metal	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.
Hard zinc spelter	2620.11.0000	Free.
Zinc oxide	2817.00.0000	Free.

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

Prepared by **Jozef Plachy [(703) 648-4982, jplachy@usgs.gov, fax: (703) 648-7757]**

ZINC

Government Stockpile:

Stockpile Status—9-30-03[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2003	Disposals FY 2003
Zinc	102	1	102	45	7

Events, Trends, and Issues: In 2002, the price of zinc on the London Metal Exchange (LME) reached its lowest level in 15 years. At the same time, LME stocks were reaching greater heights, not seen since the beginning of 1996. Reaction of mining companies to declining prices and rising stocks reflected their individual size and financial strength. Smaller companies that operated small underground mines or low-capacity smelters could not absorb prolonged financial loses and were forced to either temporarily suspend production or close their operations. Larger companies with ample financial resources and diversified production were in better position to withstand the problems facing the zinc industry. Some even increased production in order to take advantage of economies of scale to ensure lower unit prices. During the past 3 years, five underground mines were closed in the United States; an additional three were put on care and maintenance, and the largest zinc recycling company filed for Chapter 11 bankruptcy protection. These closures deprived the smelters of domestically produced zinc concentrates, forcing one smelter to convert solely to zinc recycling. These market-imposed closures in the United States and around the world may hasten consolidation of the zinc industry, as favored by many industry experts.

The United States remained one of the largest consumers of zinc and zinc products. However, domestic metal production capacity, both primary and secondary, accounts for less than one-third of the quantity consumed domestically. Canada and Mexico are the leading sources of zinc for the United States because of their geographical proximity and because all three main forms of zinc trade—concentrate, metal, and scrap—can be imported duty free from those sources.

World Mine Production, Reserves, and Reserve Base:

	Mine production[6]		Reserves[7]	Reserve base[7]
	2002	2003[e]		
United States	780	770	30,000	90,000
Australia	1,150	1,600	33,000	80,000
Canada	894	1,000	11,000	31,000
China	1,550	1,700	33,000	92,000
Kazakhstan	390	350	30,000	35,000
Mexico	475	500	8,000	25,000
Peru	1,100	1,250	16,000	20,000
Other countries	2,020	1,300	59,000	87,000
World total (rounded)	8,360	8,500	220,000	460,000

World Resources: Identified zinc resources of the world are about 1.9 billion 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 are used in place of 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]Platts Metals Week price for North American Special High Grade zinc.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]No tariff for Canada and Mexico for items shown.
[5]See Appendix B for definitions.
[6]Zinc content of concentrate and direct shipping ore.
[7]See Appendix C for definitions.

ZIRCONIUM AND HAFNIUM

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: Zircon sand was produced at two mines in Florida and at one mine in Virginia. A new mine was expected to begin operating in Georgia in 2004. Zirconium and hafnium metal were produced from zircon sand by two domestic producers, one in Oregon and the other in Utah. Typically, both metals are in the ore in a zirconium to hafnium ratio of about 50:1. Primary zirconium chemicals were produced by the Oregon metal producer and at a plant in New Jersey. Secondary zirconium chemicals were produced by 10 other companies. Zirconia (ZrO_2) was produced from zircon sand at plants in Alabama, New Hampshire, New York, Ohio, and by the metal producer in Oregon. Zircon ceramics, opacifiers, refractories, and foundry applications are the largest end uses for zirconium. Other end uses of zirconium include abrasives, chemicals, metal alloys, welding rod coatings, and sandblasting. The largest market for hafnium metal is as an addition in superalloys.

Salient Statistics—United States:	**1999**	**2000**	**2001**	**2002**	**2003[e]**
Production, zircon (ZrO_2 content)[1]	100,000	100,000	100,000	100,000	100,000
Imports:					
Zirconium, ores and concentrates (ZrO_2 content)	37,500	42,400	39,400	22,900	31,100
Zirconium, alloys, waste and scrap, and powder (ZrO_2 content)	1,160	1,400	850	750	677
Zirconium, waste and scrap, other	578	628	772	640	609
Zirconium powder (ZrO_2 content)[2]	3,140	3,950	2,950	2,900	2,210
Hafnium, unwrought, waste and scrap	9	11	5	5	5
Exports:					
Zirconium ores and concentrates (ZrO_2 content)	45,200	47,400	43,500	30,600	44,800
Zirconium, alloys, waste and scrap, and powder (ZrO_2 content)	211	243	251	281	293
Zirconium, waste and scrap, other	1,170	1,410	1,660	1,940	2,000
Zirconium oxide (ZrO_2 content)[2]	1,540	1,680	2,100	2,400	2,160
Consumption, zirconium ores and concentrates, apparent (ZrO_2 content)	W	W	W	W	W
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic[3]	300	340	340	370	360
Imported, f.o.b.[4]	311	396	356	400	370
Zirconium sponge, dollars per kilogram[5]	20-26	20-26	20-31	20-31	20-31
Hafnium sponge, dollars per kilogram[5]	165-209	165-209	119-141	119-141	119-141
Net import reliance[6] as a percentage of apparent consumption:					
Zirconium	E	E	E	E	E
Hafnium	NA	NA	NA	NA	NA

Recycling: Scrap zirconium metal and alloys was recycled by four companies, one each in California, Michigan, New York, and Texas. In-plant recycled zirconium came from scrap generated during metal production and fabrication and was recycled by companies in Oregon and Utah. Zircon foundry mold cores and spent or rejected zirconia refractories are often recycled. Recycling of hafnium metal was insignificant.

Import Sources (1999-2002): Zirconium ores and concentrates: South Africa, 48%; Australia, 46%; and other, 6%. Zirconium, unwrought, waste and scrap: France, 65%; Germany, 16%; Japan, 6%; Canada, 6%; and other, 7%. Hafnium, unwrought, waste and scrap: France, 70%; Germany, 7%; Canada, 6%; China, 4%; and other, 13%.

Tariff: Item	Number	Normal Trade Relations 12/31/03
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.
Zirconium, articles, nesoi	8109.90.0000	3.7% ad val.
Hafnium, unwrought, hafnium powders	8112.92.2000	Free.

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

ZIRCONIUM AND HAFNIUM

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

Government Stockpile: None.

Events, Trends, and Issues: The global supply and demand of zirconium mineral concentrates was nearly balanced in 2003. This situation is expected to continue during the next few years. In the long term, however, supply shortages may occur unless additional production comes online. In 2003, U.S. imports of zirconium ores and concentrates (mostly zircon) increased 36%, while exports were estimated to have increased 46%. A mining operation at Green Cove Springs, FL, was nearing the end of its mine life, and the company shifted to mining the final areas using satellite-mining techniques. A new heavy-mineral sands mine was planned to open in 2004 in southern Georgia. A zircon finishing plant was installed in 2002 at Stony Creek, VA, to improve and upgrade quality and was in full operation in 2003. The availability of hafnium, produced as a byproduct during zirconium metal processing, continued to exceed demand. Baddeleyite production ceased in South Africa in 2001 but production of fused zirconia and zirconium chemicals from zircon concentrate continued. Russia was the sole producer of baddeleyite in 2003.

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[7]	Reserve base[7]	Reserves[7]	Reserve base[7]
			(million metric tons, ZrO_2)		(thousand metric tons, HfO_2)	
	2002	2003[e]				
United States[1]	100	100	3.4	5.3	68	97
Australia	408	400	9.1	30	180	600
Brazil	21	30	2.2	4.6	44	91
China	15	15	0.5	3.7	NA	NA
India	19	20	3.4	3.8	42	46
South Africa	224	280	14	14	280	290
Ukraine	34	34	4.0	6.0	NA	NA
Other countries	9	10	0.9	4.1	NA	NA
World total (rounded)	830	890	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. Columbium (niobium), 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]Rounded to one significant digit to avoid disclosing company proprietary data. ZrO_2 content of zircon is typically 65%.
[2]Includes germanium oxides and zirconium oxides.
[3]E.I. du Pont de Nemours & Co. and Iluka Resources, Inc., average price.
[4]U.S. Census Bureau trade data.
[5]American Metal Market, daily, Miscellaneous prices. Converted from pounds.
[6]Defined as imports – exports.
[7]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 the current fiscal year (FY 2003) or in prior years, but not yet removed from stockpile facilities as of September 30, 2003.

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 2003 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. Fiscal year 2003 is the period October 1, 2002, through September 30, 2003. 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 2003 refers to material sold or traded from the stockpile in fiscal year 2003.

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, 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

[1]Based on U.S. Geological Survey Circular 831, 1980.

also may include the inferred-reserve-base category; it is not a part of this classification system.

Inferred Reserve Base.—The in-place part of an identified resource from which inferred reserves are estimated. Quantitative estimates are based largely on knowledge of the geologic character of a deposit and for which there may be no samples or measurements. The estimates are based on an assumed continuity beyond the reserve base, for which there is geologic evidence.

Reserves.—That part of the reserve base which could be economically extracted or produced at the time of determination. The term reserves need not signify that extraction facilities are in place and operative. Reserves include only recoverable materials; thus, terms such as “extractable reserves” and “recoverable reserves” are redundant and are not a part of this classification system.

Marginal Reserves.—That part of the reserve base which, at the time of determination, borders on being economically producible. Its essential characteristic is economic uncertainty. Included are resources that would be producible, given postulated changes in economic or technological factors.

Economic.—This term implies that profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty.

Subeconomic Resources.—The part of identified resources that does not meet the economic criteria of reserves and marginal reserves.

Undiscovered Resources.—Resources, the existence of which are only postulated, comprising deposits that are separate from identified resources. Undiscovered resources may be postulated in deposits of such grade and physical location as to render them economic, marginally economic, or subeconomic. To reflect varying degrees of geologic certainty, undiscovered resources may be divided into two parts:

Hypothetical Resources.—Undiscovered resources that are similar to known mineral bodies and that may be reasonably expected to exist in the same producing district or region under analogous geologic conditions. If exploration confirms their existence and reveals enough information about their quality, grade, and quantity, they will be reclassified as identified resources.

Speculative Resources.—Undiscovered resources that may occur either in known types of deposits in favorable geologic settings where mineral discoveries have not been made, or in types of deposits as yet unrecognized for their economic potential. If exploration confirms their existence and reveals enough information about their quantity, grade, and quality, they will be reclassified as identified resources.

Restricted Resources/Reserves.—That part of any resource/reserve category that is restricted from extraction by laws or regulations. For example, restricted reserves meet all the requirements of reserves except that they are restricted from extraction by laws or regulations.

Other Occurrences.—Materials that are too low grade or for other reasons are not considered potentially economic, in the same sense as the defined resource, may be recognized and their magnitude estimated, but they are not classified as resources. A separate category, labeled other occurrences, is included in figures 1 and 2. In figure 1, the boundary between subeconomic and other occurrences is limited by the concept of current or potential feasibility of economic production, which is required by the definition of a resource. The boundary is obviously uncertain, but limits may be specified in terms of grade, quality, thickness, depth, percent extractable, or other economic-feasibility variables.

Cumulative Production.—The amount of past cumulative production is not, by definition, a part of the resource. Nevertheless, a knowledge of what has been produced is important to an understanding of 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*

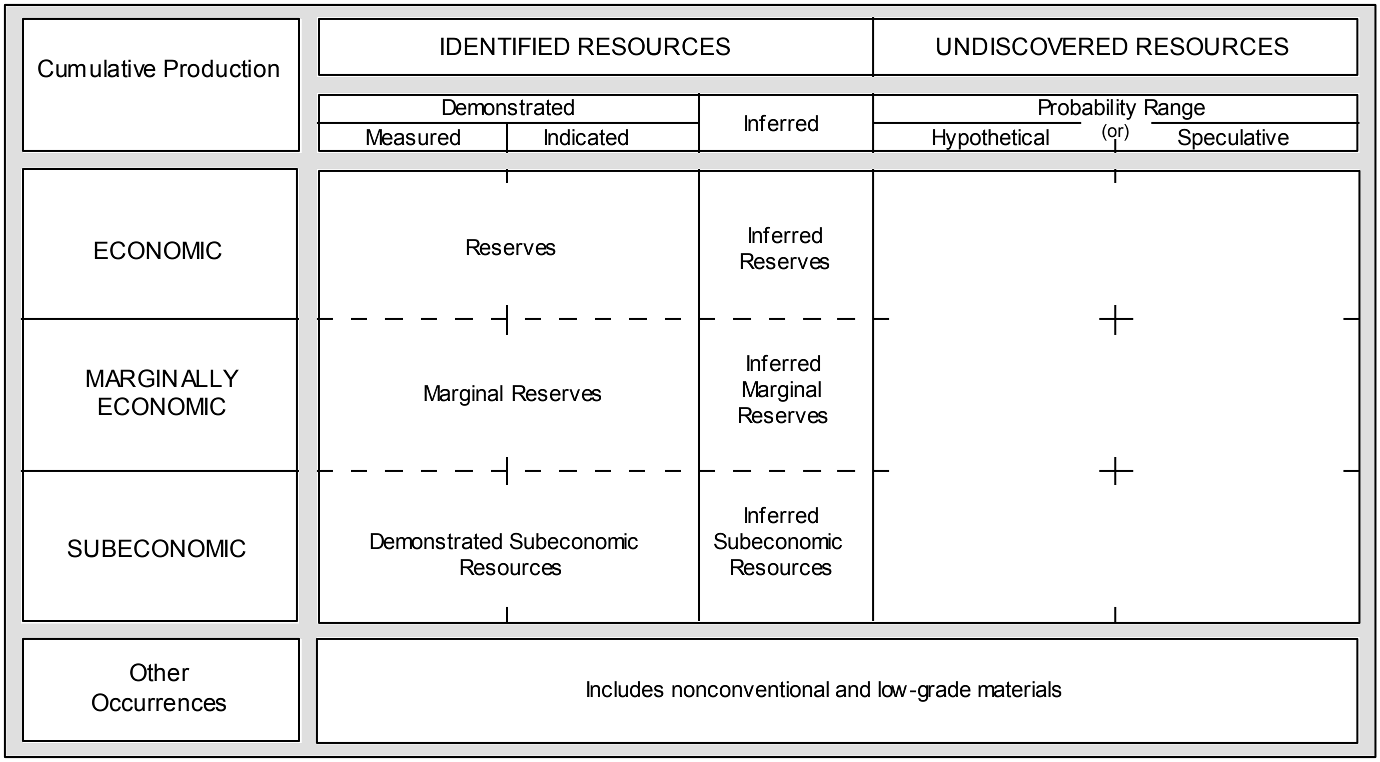
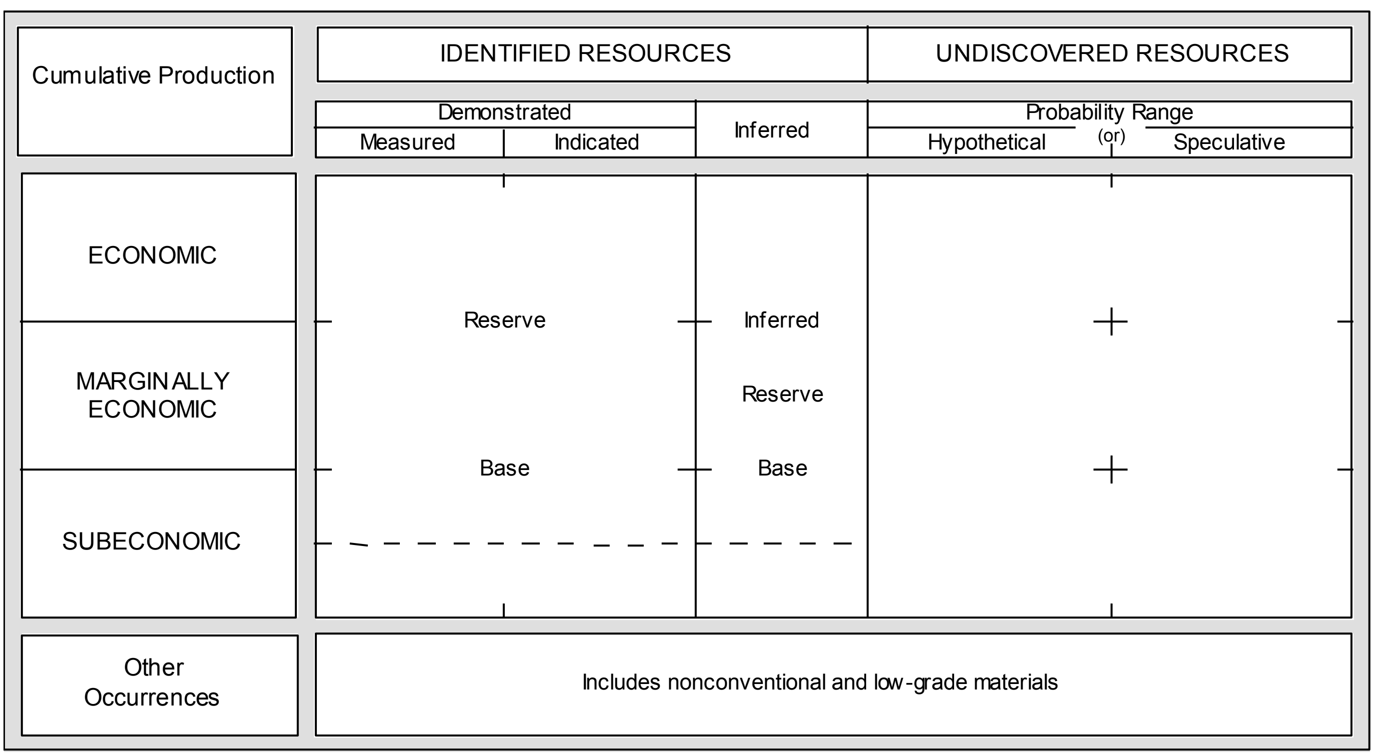


FIGURE 2.—*Reserve Base* and *Inferred Reserve Base* Classification Categories



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	George J. Coakley
Bahrain	Philip M. Mobbs
Benin	Thomas R. Yager[1]
Botswana	George J. Coakley
Burkina Faso	Thomas R. Yager[1]
Burundi	Thomas R. Yager
Cameroon	Philip M. Mobbs[1]
Cape Verde	Thomas R. Yager[1]
Central African Republic	Thomas R. Yager[1]
Chad	Philip M. Mobbs
Comoros	Thomas R. Yager
Congo (Brazzaville)	George J. Coakley
Congo (Kinshasa)	George J. Coakley
Côte d'Ivoire	George J. Coakley[1]
Cyprus	Philip M. Mobbs
Djibouti	Thomas R. Yager
Egypt	Philip M. Mobbs
Equatorial Guinea	Philip M. Mobbs
Eritrea	Thomas R. Yager
Ethiopia	Thomas R. Yager
Gabon	George J. Coakley[1]
The Gambia	Thomas R. Yager[1]
Ghana	George J. Coakley
Guinea	Thomas R. Yager[1]
Guinea-Bissau	Thomas R. Yager[1]
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	George J. Coakley
Liberia	Thomas R. Yager[1]
Libya	Philip M. Mobbs
Madagascar	Thomas R. Yager
Malawi	Thomas R. Yager
Mali	Philip M. Mobbs[1]
Mauritania	Philip M. Mobbs[1]
Mauritius	Thomas R. Yager
Morocco & Western Sahara	Philip M. Mobbs[1]
Mozambique	Thomas R. Yager
Namibia	George J. Coakley
Niger	Philip M. Mobbs[1]
Nigeria	Philip M. Mobbs
Oman	Philip M. Mobbs
Qatar	Philip M. Mobbs
Reunion	Thomas R. Yager
Rwanda	Thomas R. Yager
São Tomé & Principe	Philip M. Mobbs[1]
Saudi Arabia	Philip M. Mobbs
Senegal	Thomas R. Yager[1]
Seychelles	Thomas R. Yager
Sierra Leone	Thomas R. Yager[1]
Somalia	Thomas R. Yager
South Africa	George J. Coakley
Sudan	Thomas R. Yager
Swaziland	George J. Coakley
Syria	Thomas R. Yager
Tanzania	Thomas R. Yager
Togo	Thomas R. Yager[1]
Tunisia	Philip M. Mobbs
Turkey	Philip M. Mobbs
Uganda	Thomas R. Yager
United Arab Emirates	Philip M. Mobbs
Yemen	Philip M. Mobbs
Zambia	George J. Coakley
Zimbabwe	George J. Coakley

Asia and the Pacific

Afghanistan	Travis Q. Lyday
Australia	Travis Q. Lyday
Bangladesh	Chin S. Kuo
Bhutan	Chin S. Kuo
Brunei	John C. Wu
Burma	John C. Wu
Cambodia	John C. Wu
China	Pui-Kwan Tse
Christmas Island	Travis Q. Lyday
Fiji	Travis Q. Lyday
India	Chin S. Kuo
Indonesia	Pui-Kwan Tse
Japan	John C. Wu
Korea, North	Pui-Kwan Tse
Korea, Republic of	Pui-Kwan Tse
Laos	John C. Wu
Malaysia	John C. Wu
Mongolia	Pui-Kwan Tse
Nepal	Chin S. Kuo
New Caledonia	Travis Q. Lyday
New Zealand	Travis Q. Lyday
Pakistan	Travis Q. Lyday
Papua New Guinea	Travis Q. Lyday
Philippines	Travis Q. Lyday
Singapore	Pui-Kwan Tse
Solomon Islands	Travis Q. Lyday
Sri Lanka	Chin S. Kuo
Taiwan	Pui-Kwan Tse
Thailand	John C. Wu
Tonga	Travis Q. Lyday
Vanuatu	Travis Q. Lyday
Vietnam	John C. Wu

Europe and Central Eurasia

Albania	Walter G. Steblez
Armenia	Richard M. Levine
Austria	Harold R. Newman
Azerbaijan	Richard M. Levine
Belarus	Richard M. Levine

Belgium	Harold R. Newman
Bosnia and Herzegovina	Walter G. Steblez
Bulgaria	Walter G. Steblez
Croatia	Walter G. Steblez
Czech Republic	Walter G. Steblez
Denmark, Faroe Island, and Greenland	Chin S. Kuo
Estonia	Chin S. Kuo
Finland	Chin S. Kuo
France	Harold R. Newman
Georgia	Richard M. Levine
Germany	Harold R. Newman
Greece	Harold R. Newman
Hungary	Walter G. Steblez
Iceland	Chin S. Kuo
Ireland	Harold R. Newman
Italy	Harold R. Newman
Kazakhstan	Richard M. Levine
Kyrgyzstan	Richard M. Levine
Latvia	Chin S. Kuo
Lithuania	Chin S. Kuo
Luxembourg	Harold R. Newman
Macedonia	Walter G. Steblez
Malta	Harold R. Newman
Moldova	Richard M. Levine
Netherlands	Harold R. Newman
Norway	Chin S. Kuo
Poland	Walter G. Steblez
Portugal	Harold R. Newman
Romania	Walter G. Steblez
Russia	Richard M. Levine
Slovakia	Walter G. Steblez
Slovenia	Walter G. Steblez
Spain	Harold R. Newman
Sweden	Chin S. Kuo
Switzerland	Harold R. Newman
Tajikistan	Richard M. Levine
Turkmenistan	Richard M. Levine
Ukraine	Richard M. Levine
United Kingdom	Harold R. Newman
Uzbekistan	Richard M. Levine
Yugoslavia	Walter G. Steblez

North America, Central America, and the Caribbean

Antigua and Barbuda	Ivette E. Torres[1]
Aruba	Ivette E. Torres[1]
The Bahamas	Ivette E. Torres[1]
Barbados	Ivette E. Torres[1]
Belize	Pablo Velasco
Bermuda	Ivette E. Torres[1]
Canada	Alfredo C. Gurmendi
Costa Rica	Pablo Velasco
Cuba	Ivette E. Torres
Dominica	Ivette E. Torres[1]
Dominican Republic	Ivette E. Torres
El Salvador	Pablo Velasco
Grenada	Ivette E. Torres[1]
Guadeloupe	Ivette E. Torres[1]
Guatemala	Pablo Velasco
Haiti	Ivette E. Torres[1]
Honduras	Pablo Velasco
Jamaica	Ivette E. Torres[1]
Martinique	Ivette E. Torres[1]
Mexico	Ivette E. Torres
Montserrat	Ivette E. Torres[1]
Netherlands Antilles	Ivette E. Torres[1]
Nicaragua	Pablo Velasco
Panama	Pablo Velasco
St. Kitts and Nevis	Ivette E. Torres[1]
St. Lucia	Ivette E. Torres[1]
St. Vincent & the Grenadines	Ivette E. Torres[1]
Trinidad and Tobago	Ivette E. Torres[1]

South America

Argentina	Ivette E. Torres
Bolivia	Pablo Velasco
Brazil	Alfredo C. Gurmendi
Chile	Pablo Velasco
Colombia	Ivette E. Torres
Ecuador	Pablo Velasco
French Guiana	Alfredo C. Gurmendi[1]
Guyana	Alfredo C. Gurmendi[1]
Paraguay	Pablo Velasco
Peru	Alfredo C. Gurmendi
Suriname	Alfredo C. Gurmendi[1]
Uruguay	Pablo Velasco
Venezuela	Ivette E. Torres

[1]Interim

Country specialist	Telephone	E-mail
George J. Coakley	(703) 648-7738	gcoakley@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
Travis Q. Lyday	(703) 648-7749	tlyday@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
Ivette E. Torres	(703) 648-7746	itorres@usgs.gov
Pui-Kwan Tse	(703) 648-7750	ptse@usgs.gov
Pablo Velasco	(703) 648-7747	pvelasco@usgs.gov
John C. Wu	(703) 648-7751	jwu@usgs.gov
Thomas R. Yager	(703) 648-7739	tyager@usgs.gov