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

MINERAL COMMODITY SUMMARIES 2005

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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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>.

INTRODUCTION

The chapters of the 2005 edition of the U.S. Geological Survey (USGS) Mineral Commodity Summaries (MCS) include information on events, trends, and issues for each mineral commodity as well as discussions or tabular presentations on domestic industry structure, Government programs, tariffs, 5-year salient statistics, and world production and resources. The MCS is the earliest comprehensive source of 2004 mineral production data for the world. More than 90 individual minerals and materials are covered by 2-page synopses.

Data for 2004 presented in the mineral commodity chapters have been estimated from information available by November 2004 and generally include industry responses to the USGS Mineral Industry Surveys covering activities through September 30, 2004. Most data presented in Tables 1 and 2 on page 8 reflect data available by December 23, 2004, although the mine production figures in Table 1 are estimated based on information available in November 2004. The principal sources for the reserves and reserve base information provided for most mineral commodities are trade journals and Government reports from Australia, Brazil, Canada, Chile, China, Germany, India, Japan, Mexico, Morocco, Peru, South Africa, the United Kingdom, and the United States. Estimates for reserves and reserve base are expressed to two significant digits. Most production, consumption, and trade data are rounded to three significant digits except where noted.

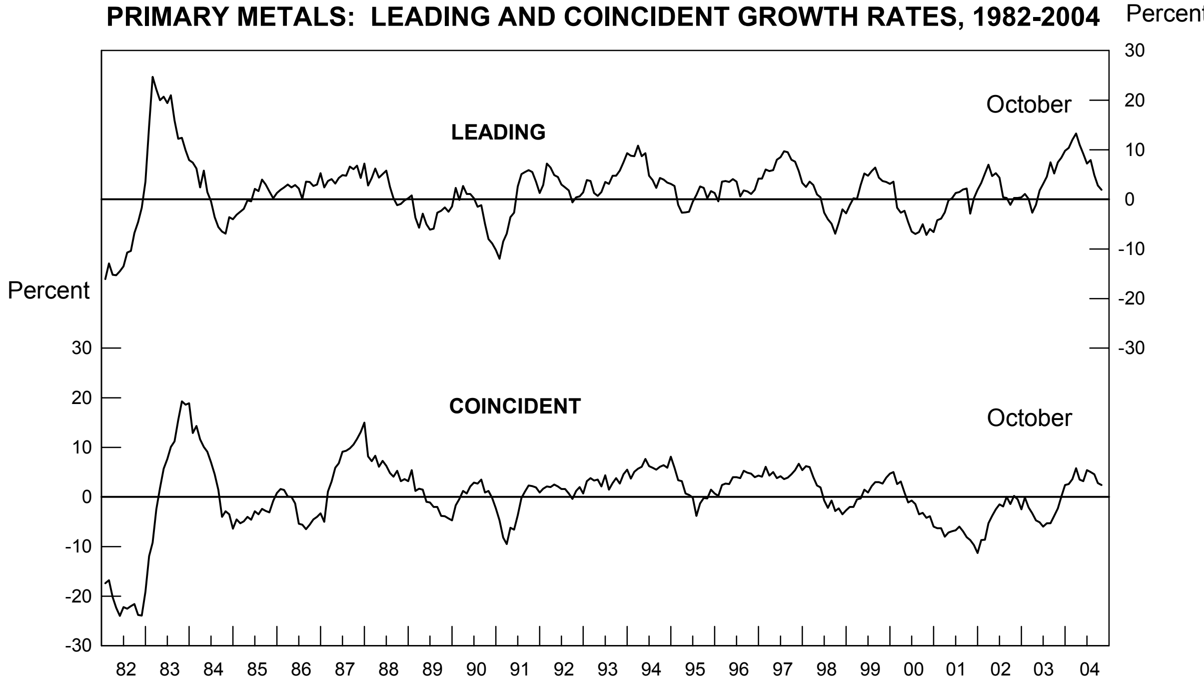
The "Significant Events, Trends, and Issues" section is an overview of domestic and international events affecting minerals that are important to the U.S. economy. Of particular note in 2004 was the increase in value of about 12% compared with 2003 for U.S. raw nonfuel mineral mine production. The increasingly important role of China and India as both producers and consumers of minerals is discussed here as well as in many of the mineral commodity chapters.

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

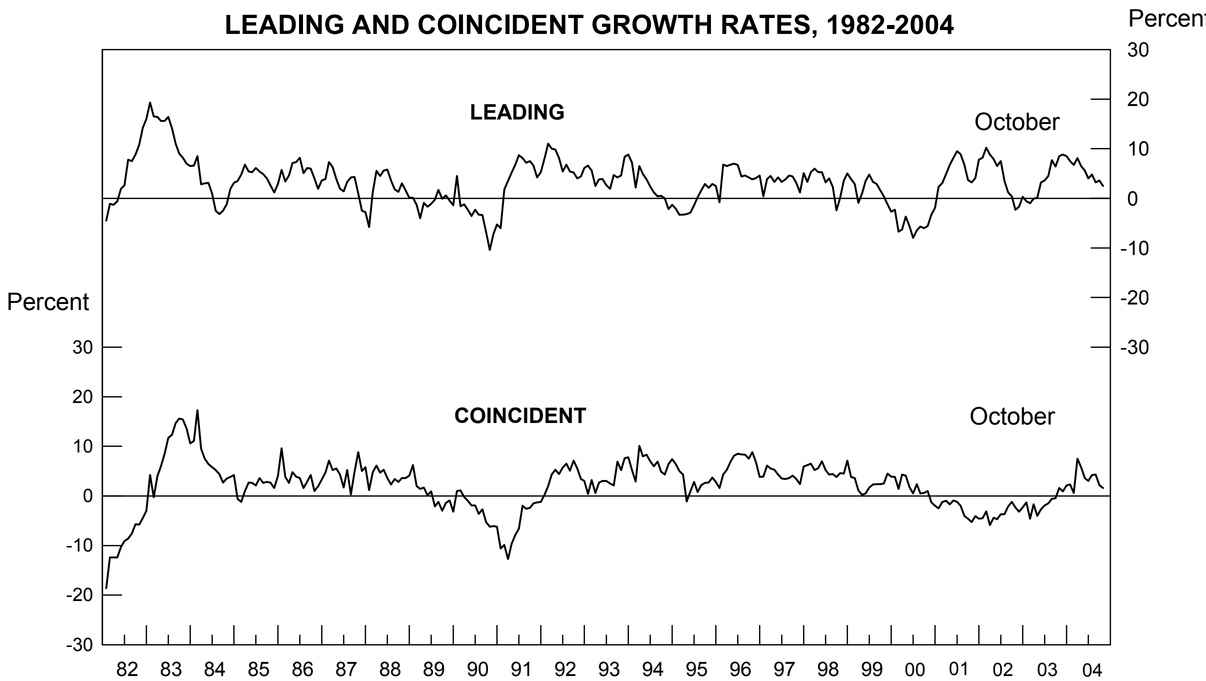
The USGS continually strives to improve the value of its publications to users. Constructive comments and suggestions by readers of the MCS 2005 are welcomed.

GROWTH RATES OF LEADING AND COINCIDENT INDEXES FOR MINERAL PRODUCTS

PRIMARY METALS: LEADING AND COINCIDENT GROWTH RATES, 1982-2004



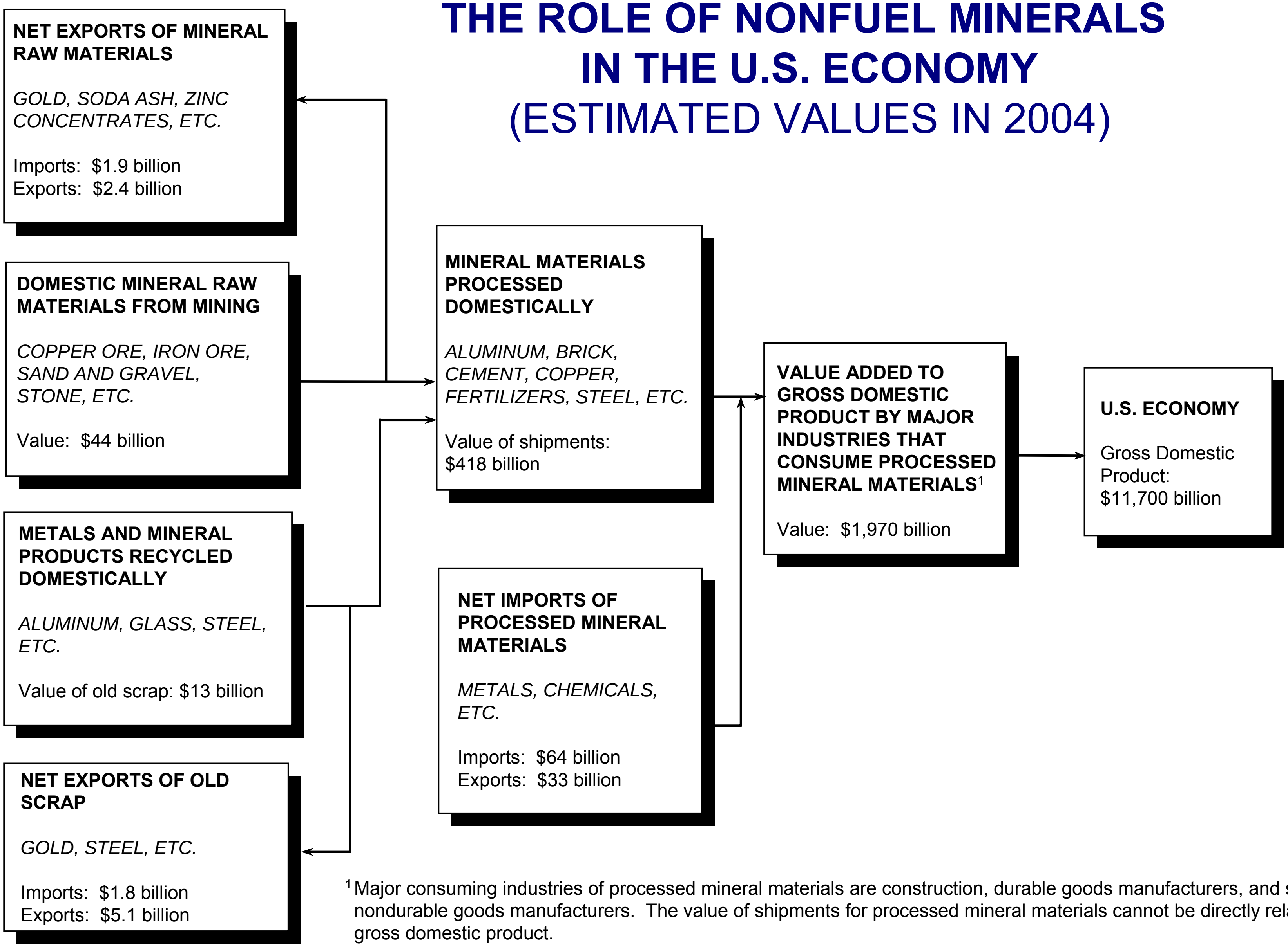
NONMETALLIC MINERAL PRODUCTS: LEADING AND COINCIDENT GROWTH RATES, 1982-2004



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 2004)



[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.

2004 U.S. NET IMPORT RELIANCE FOR SELECTED NONFUEL MINERAL MATERIALS

Commodity	Percent	Major Import Sources (2000-03)[1]
ARSENIC (trioxide)	100	China, Chile, Morocco, 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, Japan, France
MANGANESE	100	South Africa, Gabon, Australia, France
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, France, Russia, United Kingdom
THORIUM	100	France
VANADIUM	100	Czech Republic, South Africa, Canada, China
YTTRIUM	100	China, Japan, Austria, Netherlands
GALLIUM	99	France, China, Russia, Kazakhstan
GEMSTONES	99	Israel, India, Belgium
PLATINUM	91	South Africa, United Kingdom, Germany, Canada, Russia
BISMUTH	90	Belgium, Mexico, China, United Kingdom
TIN	88	Peru, China, Bolivia, Brazil
ANTIMONY	85	China, Mexico, South Africa, Belgium
DIAMOND (natural industrial stone)	85	Ireland, Switzerland, United Kingdom, Russia
STONE (dimension)	85	Italy, Canada, India, Spain
TITANIUM (sponge)	85	Kazakhstan, Japan, Russia
PALLADIUM	81	Russia, South Africa, United Kingdom, Belgium, Germany
TANTALUM	80	Australia, Kazakhstan, Canada, China
BARITE	79	China, India
RHENIUM	79	Chile, Kazakhstan, Mexico
COBALT	76	Finland, Norway, Russia, Canada
IODINE	74	Chile, Japan, Russia
TUNGSTEN	73	China, Canada
CHROMIUM	72	South Africa, Kazakhstan, Zimbabwe, Russia
POTASH	70	Canada, Belarus, Russia, Germany
MAGNESIUM METAL	68	Canada, Russia, China, Israel
TITANIUM MINERAL CONCENTRATES	65	South Africa, Australia, Canada, Ukraine
PEAT	56	Canada
SILICON	56	South Africa, Norway, Brazil, Russia
ZINC	56	Canada, Mexico, Peru
BERYLLIUM	55	Kazakhstan, Japan, Brazil, Spain
SILVER	54	Mexico, Canada, United Kingdom, Peru
NICKEL	49	Canada, Russia, Norway, Australia
MAGNESIUM COMPOUNDS	48	China, Australia, Canada, Austria
COPPER	43	Canada, Chile, Peru, Mexico
ALUMINUM	41	Canada, Russia, Venezuela, Mexico
DIAMOND (dust, grit and powder)	40	Ireland, China, Ukraine
NITROGEN (fixed), AMMONIA	38	Trinidad and Tobago, Canada, Russia
MICA, scrap and flake (natural)	35	Canada, India, China, Finland
GARNET (industrial)	34	Australia, India, China
GYPSUM	26	Canada, Mexico, Spain
PUMICE	26	Greece, Italy, Turkey
CEMENT	23	Canada, Thailand, China, Venezuela
PERLITE	23	Greece
SALT	20	Canada, Chile, Mexico, The Bahamas
SULFUR	20	Canada, Mexico, Venezuela
IRON and STEEL	18	European Union, Canada, Mexico, Republic of Korea
IRON ORE	8	Canada, Brazil, Australia, Chile
PHOSPHATE ROCK	6	Morocco
IRON and STEEL SLAG	5	Canada, France, Italy, Japan
FELDSPAR	2	Mexico, Turkey
TALC	1	China, Canada, France, Japan

[1]In descending order of import share

SIGNIFICANT EVENTS, TRENDS, AND ISSUES[1]

The Mineral Sector of the U.S. Economy

The mineral sector is a fundamental part of the U.S. economy; it contributes to the real gross domestic product (GDP) at several levels—basic (mining), intermediate (processing), and manufacturing. The estimated average growth rate for the real GDP of the United States for 2004 was 3.9%. The nominal GDP was about $11.7 trillion, which reflects an estimated annualized 5.2% increase for the fourth quarter from the third quarter of 2004 and an annualized increase of about 6.2% compared with the fourth quarter of 2003. Housing starts were up by slightly more than 4% for the year, and the unemployment decreased to about 5.5% in 2004 from 6% in 2003. Interest rates continued to be low (prime rate was 5.25% in December 2004) but have risen gradually, following rising inflation. Consumer confidence was slightly lower than in 2003; this is an important indicator because consumer spending fuels about two-thirds of GDP, which is the broadest measure of economic output (Browning, 2004b).

Overall, the value of minerals mined in the United States in 2004 rose significantly mainly owing to increased unit prices for most metals and some industrial minerals. Production trends were mixed, however; output increased in some metal and industrial mineral sectors but decreased or ceased in others. The mining of aggregates (crushed stone and sand and gravel), copper, iron ore, and zinc increased; the manufacturing of such industrial minerals as cement and the production of pig iron and steel also increased. The production of precious metals and lead declined. Two opposing factors drove mining and mineral production in opposite directions—high fuel costs tended to reduce profitability and in some cases caused lower production, but strong demand from China—especially for copper, iron, and steel—led to increased production.

Overall Performance

The estimated value of all mineral materials processed in the United States during 2004 totaled $418 billion, an increase of about 13% (p. 5). The total value of U.S. raw nonfuel mineral mine production alone was about $44 billion (table 1), about 12% more than in 2003. Metals accounted for about 25% of the total value, and industrial minerals accounted for 75%.

The value of net imports of raw and processed mineral materials during 2004 increased by about 30% from the 2003 level; although the unit value of exports was generally up, the total tonnage was down significantly. The United States is increasingly reliant on foreign sources for raw and processed mineral materials (p. 6). Imports of raw and processed mineral materials increased by about 2.5% from the previous year's level to a value of about $66 billion. As in recent years, aluminum, copper, and steel were among the leading imports in terms of value. Exports of raw and processed mineral materials during 2004 declined by 17% in value to about $35 billion. The total value of imports and exports of metal ore and concentrates and raw industrial minerals was less than $5 billion. Companies in the metals and minerals sectors were among the few that consistently retained their value on the stock market in 2004.

The construction industry led the demand for mineral materials, especially during reconstruction following four devastating hurricanes in the fall of 2004 in the Southeastern United States. The value of new highway construction increased by 5% to $66 billion, although anticipated major highway and airport bills introduced in Congress have not yet been passed. Housing starts are estimated to have increased by about 4% to about 1.9 million units for 2004, based on data through October 2004 from the U.S. Census Bureau. This trend is supported by the continuation of low mortgage rates. Construction accounted for most of the consumption of clay, cement, glass, sand and gravel, crushed and dimension stone, and steel. Aggregates production was estimated to be about 4% more than in 2003, and it is estimated that aggregates production will increase by 3% in 2005 based on the expected volume of work on the infrastructure. Light vehicle sales increased slightly in 2004, and the industry continued to use large quantities of steel and other metals as well as glass and plastics (table 2). About 35% of domestically produced aluminum is used in the transportation sector.

Although changes in U.S. metal mining were relatively small and domestic metal mining generally remained depressed by historical standards, results were mixed. Production of precious metals and lead was down from that of the previous year, while copper, zinc, and iron ore production increased. Copper mining, which in 2003 was at its lowest level since 1985, rose in response to a projected global shortage and higher prices. Some copper production curtailments from previous years were reversed in the second half of the year. Copper production is expected to increase in 2005. One mine that had been indefinitely closed changed ownership and was recommissioned in the third quarter of the year, and one new project was expected to begin production by yearend 2005.

Supply shortages, weakness in the U.S. dollar, and demand from China led to nearly an across-the-board rise in metal prices. This was especially true for prices of some of the lower-volume, specialty, and byproduct metals, some of which rose to record-high levels. Overall value of U.S. metal production increased substantially, reflecting higher metal prices.

Domestic primary aluminum production decreased owing to cutbacks attributed to increased energy and alumina costs. Most of the production decreases continued to take place in the Pacific Northwest, and domestic smelters operated at about 63% of rated or engineered capacity. Imports of aluminum for consumption continued to increase, filling some of the supply deficit created by increases in demand and decreases in domestic production. World aluminum production also continued to increase as capacity

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

TABLE 1.—U.S. MINERAL INDUSTRY TRENDS

	2000	2001	2002	2003	2004[e]
Total mine production:[1]					
Metals	10,100	8,530	8,200	8,500	10,800
Industrial minerals	29,200	29,800	29,700	30,900	33,200
Coal	18,000	19,600	19,700	19,100	19,900
Employment:[2]					
Coal mining	59	63	63	59	61
Metal mining	29	25	21	20	20
Industrial minerals, except fuels	87	83	80	78	80
Chemicals and allied products	588	562	532	525	523
Stone, clay, and glass products	439	427	399	374	383
Primary metal industries	490	447	396	370	361
Average weekly earnings of production workers:[3]					
Coal mining	945	957	934	964	1,029
Metal mining	871	866	879	957	1,033
Industrial minerals, except fuels	721	744	748	771	789
Chemicals and allied products	722	736	760	785	821
Stone, clay, and glass products	605	619	647	665	690
Primary metal industries	735	724	750	768	801

[e]Estimated.

[1]Million dollars.

[2]Thousands of production workers.

[3]Dollars.

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

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

	2000	2001	2002	2003	2004[e]
Gross domestic product (billion dollars)	9,817	10,128	10,487	11,004	11,700
Industrial production (1997=100):					
Total index	115	111	111	111	115
Manufacturing	117	112	112	112	117
Nonmetallic mineral products	106	102	101	101	105
Primary metals:	98	89	90	87	92
Iron and steel	99	90	92	93	101
Aluminum	98	88	96	94	98
Nonferrous metals (except aluminum)	89	81	81	69	75
Chemicals	105	103	108	107	110
Mining:	96	97	93	92	92
Coal	97	102	98	96	98
Oil and gas extraction	97	98	96	95	93
Metals	91	83	76	70	73
Nonmetallic minerals	107	107	105	103	108
Capacity utilization (percent):					
Total industry	82	77	75	76	78
Mining:	90	90	85	87	87
Metals	84	79	76	72	75
Nonmetallic minerals	86	85	84	82	86
Housing starts (thousands)	1,570	1,600	1,710	1,850	1,930
Light vehicle sales (thousands)[1]	14,600	14,200	13,500	13,300	13,400
Highway construction, value, put in place (billion dollars)	53	59	61	63	66

[e]Estimated.

[1]Excludes imports.

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

expansions outside the United States were brought onstream and became fully operational. Production of pig iron and steel in the United States increased significantly compared with that of 2003, as steel prices rose worldwide with relatively high demand from China. The rapid rate of bankruptcy filings for steel companies in 2003 in the United States diminished significantly. However, U.S. imports of steel surged after removal of tariffs in late 2003, resulting in a net import reliance of 18%, the highest level since 2000.

U.S. production of mineral fertilizers increased from the depressed levels of 2003. Output of phosphate rock and potash increased based on domestic and export demands for plant nutrients. Lower overall stock levels at the beginning of the year meant that demand was met by new production and not stock drawdown as had been the case in 2003. Nitrogen output increased marginally but remained well below plant capacity owing to relatively high costs for natural gas and the low price of available imports. Fertilizer consumption at the farm level increased slightly, but total harvested hectares was essentially unchanged. The long-term projections of the U.S. Department of Agriculture for planting of eight major field crops were for a relatively stable 101 million hectares through its 2014 forecast period.

In 2004, 16 States each produced more than $1 billion worth of nonfuel mineral commodities. These States were, in descending order, California, Nevada, Arizona, Texas, Florida, Georgia, Utah, Minnesota, Missouri, Michigan, Pennsylvania, Alaska, Ohio, Wyoming, New York, and Illinois; their production accounted for about 68% of the U.S. total output value (table 3).

In fiscal year 2004, the Defense Logistics Agency (DLA) sold $496 million of excess mineral materials from the National Defense Stockpile (NDS). Additional detailed information can be found in the "Government Stockpile" sections in the mineral commodity reports that follow. Under the authority of the Defense Production Act of 1950, the U.S. Geological Survey advises the DLA on acquisition and disposals of NDS mineral materials. At the end of the fiscal year, mineral materials valued at more than $1.57 billion remained in the stockpile.

Outlook

While the domestic economy appears to be improving in the short term, the U.S. trade deficit, especially with China, Canada, Mexico, and the oil-producing countries, may lead to a downturn in profits for U.S. companies in the minerals industry. The overall U.S. deficit reached a record high $55.5 billion in October, according to the U.S. Department of Commerce. Profits and value increased significantly in U.S. mining and mineral processing industries. Capacity utilization increased slightly in both metals and industrial minerals sectors, as did productivity; both indicators are likely to continue to increase in 2005.

According to the Organisation for Economic Co-operation and Development (OECD), if recent record high oil prices diminish or are not exceeded in 2005 and other cost increases do not develop, economic growth may be expected to continue in the United States and the other major world economies (Organisation for Economic Co-operation and Development, 2004§).[2] The OECD, however, views the U.S. trade deficit as a significant barrier to improved economic health. The administration is supportive of deficit-cutting measures in principle, partly as a way to strengthen the dollar (CNNmoney, 2004§). The relative weakness of the dollar against both the euro and the yen late in 2004 makes U.S. products and materials, including raw and processed minerals and primary metals, attractively priced to non-U.S. buyers. If the dollar strengthens, U.S. products will again be less competitive.

Significant International Events

Economic Conditions

The strong economic growth that the economies of China and the United States were experiencing as 2003 ended spread to other countries in 2004. A major news story of 2004 was rapid growth of the Chinese economy and the emergence of growth in a widening circle of countries that were opening to private ownership and trade. Growth in the developing economies has in it the seeds of the "new world order" (Helprin, 2004). Since the late 1980s, GDP in China has been between 7% and 9% annually, doubling the economy every 8 to 10 years. As China has undergone industrialization and has moved through a series of defined stages (Menzie and others, 2004§), its industries have consumed increasingly large amounts of raw materials, and China has become increasingly important in global trade and in the economic growth of other countries (Hutzler and Brown, 2004).

In the first quarter of 2004, China's GDP grew at an annual rate of 9.8%; the United States', 5%; and Japan's, 5.6%. Elsewhere in Asia, India's economy grew by 8.2%, and Malaysia, Thailand, the Philippines, and the Republic of Korea grew by 7.6%, 6.5%, 6.4%, and 5.3%, respectively. Economic growth in the euro economies remained slow at 1.3%, while growth in Eastern Europe was higher—7.4% in Russia and 6.9% in Poland. In some economies, demand for raw materials outstripped supply. Consequently, there was little excess production capacity to handle supply disruptions, and the price of petroleum and other mineral commodities rose rapidly (Browne, 2004§). To control growth without throwing the economy into recession, China announced a target GDP growth for 2004 of 7% and took actions to slow the fixed assets and real estate sectors of the economy (Areddy, 2004; Yam, 2004§). Growth slowed for a short time, but fears of inflation prompted the China central bank to raise interest rates in October for the first time in 9 years (Nag, 2004§).

Another problem was brought about by the reliance of China and other Asian countries on exports, a large part of which went to the United States. A growing U.S. trade deficit and substantial budget deficit caused the U.S. dollar to drop against foreign currencies except the yuan, which has a fixed rate of exchange against the dollar (Henderson, 2004). European countries

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

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2004[p, 1]

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$982,000	17	2.23	Cement (portland), stone (crushed), lime, sand and gravel (construction), cement (masonry).
Alaska	1,320,000	12	3.01	Zinc, lead, gold, silver, sand and gravel (construction).
Arizona	3,000,000	3	6.83	Copper, sand and gravel (construction), cement (portland), molybdenum concentrates, stone (crushed).
Arkansas	514,000	29	1.17	Bromine, stone (crushed), cement (portland), sand and gravel (construction), lime.
California	3,620,000	1	8.23	Sand and gravel (construction), cement (portland), boron minerals, stone (crushed), diatomite.
Colorado	762,000	22	1.73	Sand and gravel (construction), molybdenum concentrates, cement (portland), gold, stone (crushed).
Connecticut[2]	132,000	42	0.30	Stone (crushed), sand and gravel (construction), stone (dimension), clays (common), gemstones.
Delaware[2]	20,800	50	0.05	Sand and gravel (construction), magnesium compounds, gemstones.
Florida	2,220,000	5	5.05	Phosphate rock, stone (crushed), cement (portland), sand and gravel (construction), cement (masonry).
Georgia	1,830,000	6	4.15	Clays (kaolin), stone (crushed), clays (fuller's earth), cement (portland), sand and gravel (construction).
Hawaii	74,800	45	0.17	Stone (crushed), sand and gravel (construction), gemstones.
Idaho	322,000	37	0.73	Phosphate rock, sand and gravel (construction), molybdenum concentrates, silver, cement (portland).
Illinois	1,030,000	16	2.35	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), lime.
Indiana	774,000	21	1.76	Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry).
Iowa	533,000	28	1.21	Stone (crushed), cement (portland), sand and gravel (construction), lime, gypsum (crude).
Kansas	741,000	23	1.69	Cement (portland), helium (Grade-A), salt, stone (crushed), helium (crude).
Kentucky	674,000	24	1.53	Stone (crushed), lime, cement (portland), sand and gravel (construction), clays (ball).
Louisiana	364,000	34	0.83	Salt, sand and gravel (construction), stone (crushed), sand and gravel (industrial), lime.
Maine	122,000	43	0.28	Sand and gravel (construction), cement (portland), stone (crushed), stone (dimension), cement (masonry).
Maryland	478,000	32	1.09	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry), stone (dimension).
Massachusetts[2]	221,000	38	0.50	Stone (crushed), sand and gravel (construction), lime, stone (dimension), clays (common).
Michigan	1,530,000	10	3.49	Cement (portland), iron ore (usable), sand and gravel (construction), stone (crushed), salt.
Minnesota[2]	1,590,000	8	3.62	Iron ore (usable), sand and gravel (construction), stone (crushed), sand and gravel (industrial), lime.
Mississippi	189,000	40	0.43	Sand and gravel (construction), clays (fuller's earth), cement (portland), stone (crushed), clays (ball).
Missouri	1,540,000	9	3.50	Stone (crushed), cement (portland), lead, lime, zinc.
Montana	582,000	27	1.32	Platinum metal, palladium metal, copper, sand and gravel (construction), cement (portland).
Nebraska[2]	94,800	44	0.22	Cement (portland), sand and gravel (construction), stone (crushed), lime, cement (masonry).
Nevada	3,250,000	2	7.40	Gold, sand and gravel (construction), lime, silver, stone (crushed).
New Hampshire[2]	64,600	47	0.15	Sand and gravel (construction), stone (crushed), stone (dimension), gemstones.
New Jersey	330,000	36	0.75	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), greensand marl, peat.
New Mexico	811,000	20	1.85	Copper, potash, sand and gravel (construction), cement (portland), stone (crushed).

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2004[p, 1]—Continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
New York	$1,060,000	15	2.41	Stone (crushed), salt, cement (portland), sand and gravel (construction), wollastonite.
North Carolina	822,000	19	1.87	Stone (crushed), phosphate rock, sand and gravel (construction), sand and gravel (industrial), feldspar.
North Dakota	52,300	48	0.12	Sand and gravel (construction), lime, clays (common), stone (crushed), sand and gravel (industrial).
Ohio	1,090,000	13	2.48	Stone (crushed), sand and gravel (construction), salt, lime, cement (portland).
Oklahoma	498,000	30	1.13	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), iodine (crude).
Oregon	356,000	35	0.81	Stone (crushed), sand and gravel (construction), cement (portland), diatomite, lime.
Pennsylvania[2]	1,400,000	11	3.18	Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry).
Rhode Island[2]	$37,200	49	0.08	Sand and gravel (construction), stone (crushed), sand and gravel (industrial), gemstones.
South Carolina[2]	586,000	26	1.33	Cement (portland), stone (crushed), cement (masonry), sand and gravel (construction), clays (kaolin).
South Dakota	210,000	39	0.48	Cement (portland), sand and gravel (construction), gold, stone (crushed), stone (dimension).
Tennessee	660,000	25	1.50	Stone (crushed), cement (portland), sand and gravel (construction), clays (ball), sand and gravel (industrial).
Texas	2,400,000	4	5.47	Cement (portland), stone (crushed), sand and gravel (construction), lime, salt.
Utah	1,740,000	7	3.95	Copper, cement (portland), sand and gravel (construction), magnesium metal, salt.
Vermont[2]	69,100	46	0.16	Stone (dimension), stone (crushed), sand and gravel (construction), talc (crude), gemstones.
Virginia	868,000	18	1.97	Stone (crushed), cement (portland), sand and gravel (construction), lime, clays (fuller's earth).
Washington	447,000	33	1.02	Sand and gravel (construction), cement (portland), stone (crushed), gold, diatomite.
West Virginia	179,000	41	0.41	Stone (crushed), cement (portland), lime, sand and gravel (industrial), salt.
Wisconsin[2]	487,000	31	1.11	Stone (crushed), sand and gravel (construction), lime, sand and gravel (industrial), stone (dimension).
Wyoming	1,090,000	14	2.48	Soda ash, clays (bentonite), helium (Grade-A), cement (portland), sand and gravel (construction).
Undistributed	192,000	XX	0.44	
Total	44,000,000	XX	100.00	

[p]Preliminary. XX Not applicable.

[1]Data are rounded to three significant digits; may not add to totals shown.

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

complained because the costs of their exports were rising. Mineral-producing countries, such as South Africa, suffered because their costs were paid in local currency while their revenues were received in devalued dollars. Some saw the falling dollar as a de facto devaluation and called on the United States to put its economic house in order. The United States responded that the yuan should float against the dollar; this would make Chinese goods more expensive and therefore decrease the U.S. trade deficit (Economist, The, 2004).

Minerals Markets

The rapid development of infrastructure, manufacturing, and even consumer goods in China resulted in strong demand for steel. Growth in steel consumption was so rapid it became difficult to gauge whether a surplus or a shortfall was likely (Mathews, 2004). In fact, demand for steel was so strong the Government of France requested the European Commission to suspend antidumping duties (Mining Journal, 2004f). In contrast, analysts in 2001 argued that 10% to 20% of steel capacity was unneeded. World steel production for the first 9 months rose by 8.7%. Strong demand for steel caused strong demand for coal, iron ore, and nickel.

In January, Companhia Vale do Rio Doce, Rio Tinto plc, and BHP Billiton plc (BHPB) increased iron-ore prices for 2004 by 18.6% (Mining Journal, 2004e). High prices led to several developments in Australia. BHPB expanded its operations to 110 million metric tons per year in 2004 and signed an agreement with Chinese steel producers to supply 12 million metric tons per year of iron ore for 25 years. Additionally, work is planned to begin in 2005 on Kumba Resources' Hope Downs project in Western Australia. The price of nickel began the year at more than $16,000 per metric ton and fell to about $14,000 per metric ton late in the year. Increased consumption of stainless steel fueled high prices in 2003 and early 2004, when nickel stocks declined, but substitution slowed demand later in 2004 as stocks rebuilt (Mining Journal, 2004c). Inco Limited's projects in Canada and New Caledonia advanced in 2004.

Global demand for aluminum has grown by more than 7% annually in recent years and was strong in 2004. In January, stocks were more than 1.4 million metric tons and prices were less than $1,600 per metric ton. Stocks fell to about 700,000 metric tons in late November. A number of projects to build or expand existing smelters were announced during 2004. LME spot copper prices were about $2,400 per metric ton in January, and potential global exchange stocks stood at about 700,000 metric tons. Early in 2004, shortages of concentrate, partly owing to a rockslide at Freeport-McMoRan Copper & Gold Inc.'s Grasberg Mine (Indonesia), forced smelters in China and India to reduce output. Exchange stocks fell during the year to about 100,000 metric tons, and prices rose to about $3,300 per metric ton. A significant expansion in copper mine capacity, however, is expected during the next few years. In March, central banks extended the agreement limiting gold sales for 5 years. Gold prices began the year at little more than $400 per troy ounce and were greater than $450 per troy ounce in early December. A number of gold projects advanced during the year.

Mergers and Acquisitions

Consolidation in the industry was slow during early 2004. Rumors of a sale of Noranda Inc. have circulated since Branscom Corp. indicated an interest in selling its 42% of Noranda's shares. In September, Noranda entered exclusive talks with state-owned China Minmetals Corp., which was seeking to buy all outstanding Noranda shares; after November 16, discussions continued on a nonexclusive basis (Stueck, 2004).

In October, Harmony Gold Mining Company Limited announced a hostile bid for Gold Fields Limited. Harmony had the support of MMC Norilsk Nickel, the largest shareholder in Gold Fields. On December 20, Gold Fields began discussing with Harmony and Norilsk Nickel alternatives to the Harmony takeover (Gold Fields Limited, 2004§).

Also in October, Ispat International NV, announced plans to acquire privately listed LNM Holdings NV. Simultaneously, the boards of directors of Ispat and International Steel Group agreed to a merger between the two companies. The merger would create the world's leading steel producer, Mittal Steel Co. NV. In addition to steel production of about 58 million metric tons per year, Mittal will also produce iron ore, coke, and coal (Glader, 2004; Reed and Arndt, 2004§).

Exploration

Global nonferrous mineral exploration budgets were expected to increase by about 58% from 2003 to $3.8 billion in 2004, the highest since 1997 (Metals Economics Group, 2004§). All regions saw significant increases in planned exploration expenditures, but Latin America continued to draw the most interest. Both major and junior companies increased their planned expenditures as high gold prices made raising capital easier for juniors (Mining Engineering, 2004).

Government Involvement

Rising mineral prices and corporate profits and increased mineral exploration have led governments to demand a larger share of mineral rents. In June, the Peruvian Congress approved a plan to impose a royalty of about 1% to 3% on mine production. Proceeds were earmarked for mining regions. The mining industry has opposed the royalties, and recently a number of companies withdrew from an auction for concessions in the Las Bambas District (Peru) in part owing to plans to introduce a royalty (Mining Journal, 2004a). In August, the Chilean Congress rejected a similar measure.

Diamonds have been a major factor underlying civil unrest and military intervention in Africa. Governments, industry, and groups from civil society introduced the Kimberley process to limit illegal flows of rough diamonds that were used to fund civil wars and unrest. In July, following a report by a review commission, Congo (Brazzaville) was removed from participation, excluding it from trade in rough diamonds with KP participants.

Environment/Sustainability

The board of directors of the World Bank Group reviewed policies related to loans, and it expressed the belief there is a continuing role for the World Bank Group in supporting the extractive industries, provided it supports poverty reduction and sustainable development (World Bank, 2004§).

When the geographic broadening of mineral exploration began in the 1980s, many developing countries lacked environmental regulations, and their populations were largely uninvolved in environmental issues. That situation is changing as events in two countries that have received large mineral investments demonstrate. In Indonesia, closure of the Minahasa gold mine has been accompanied by a dispute between the Government and Newmont over alleged mercury and arsenic contamination in Buyat Bay (Wall Street Journal, 2004). In Peru, public response to environmental issues has been mixed. In April, residents of the city of La Oroya threatened to march on Lima to protest the Government's refusal to allow The Doe Run Company to extend a deadline for environmental compliance (Mining Journal, 2004d). In September, public protests disrupted operations at Newmont's Yanacocha gold mine contending exploration was affecting the quantity and quality of local water (Mining Journal, 2004g).

Coal consumption for electrical generation is rising rapidly in China and India and is causing increased emissions of greenhouse gases and mercury, which are becoming a transnational issue because of a long residence time in the atmosphere (Pottinger and others, 2004). Industry started dealing with criticism related to the use of cyanide in gold processing. Six major companies announced a commitment to the Cyanide Management Code, developed as a result of Aurul S.A.'s Baia Mare (Romania) tailings spill in 2000 (Mining Journal, 2004b).

Outlook

Analysts for pension funds, insurance companies, and university endowments invested in mineral commodities in 2004 as analysts have concluded that demand for raw materials reflected fundamental economic factors rather than cyclical movements or currency strength (Sesit, 2004). Many analysts who expect the market to rise are basing forecasts on an assumption that commodity prices in general and oil prices in particular have peaked. Other analysts expect stock prices to remain the same or fall owing to rising commodity prices (Browning, 2004a).

Coal and iron ore contracts for the year beginning in April should be early indicators of what may happen with minerals. Regardless of what transpires in the short term, barring a disruption in the development cycle that China is in and that India is entering, the real prices of many minerals could move upward for the medium term. Real prices of mineral commodities declined from the mid-1970s through 2004. Therefore, a world economy with rapidly developing, populous countries, such as China and India, may resemble the post-World War II period (1945-75), when real prices of most major mineral commodities rose, more than it resembles the last 30 years.

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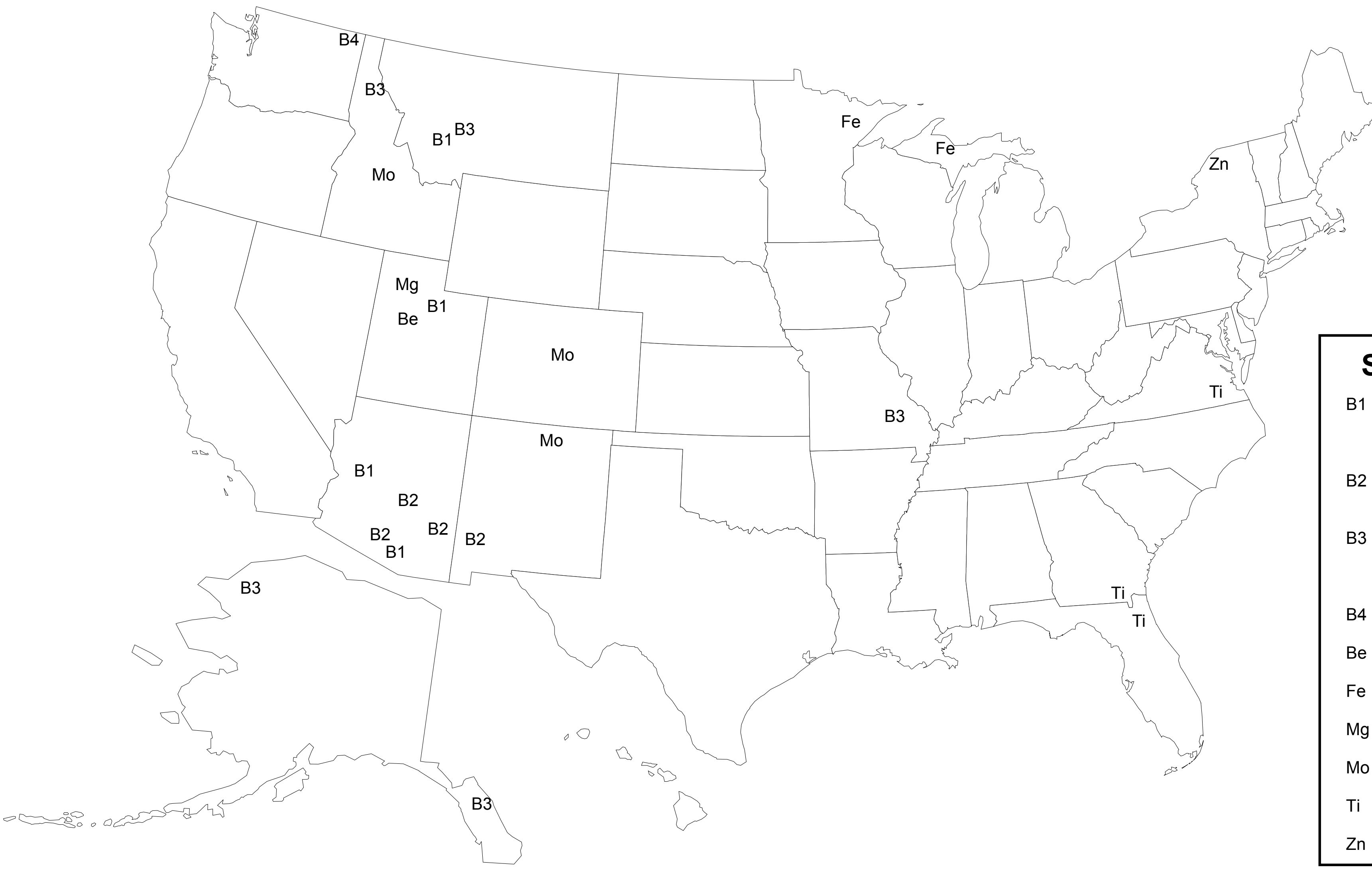
MAJOR BASE AND SPECIALTY METAL PRODUCING AREAS



SYMBOLS

B1 Copper and molybdenum +/- gold, silver

B2 Copper +/- gold, silver

B3 Lead, zinc +/- copper +/- gold +/- silver

B4 Zinc + lead

Be Beryllium

Fe Iron

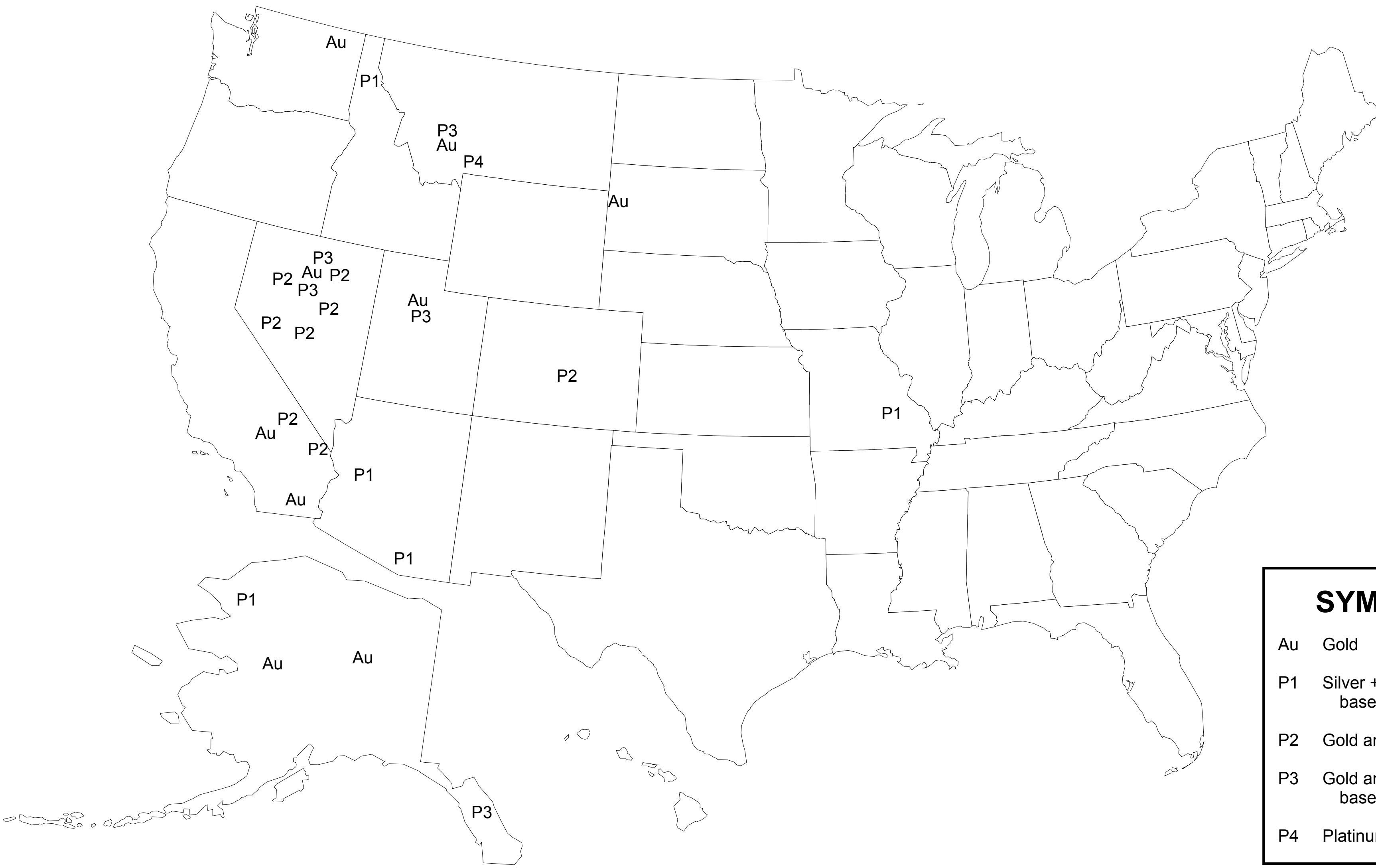
Mg Magnesium

Mo Molybdenum

Ti Titanium minerals

Zn Zinc

MAJOR PRECIOUS METAL PRODUCING AREAS



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

SYMBOLS

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

MAJOR INDUSTRIAL ROCK AND MINERAL PRODUCING AREAS - PART II

ABRASIVES (MANUFACTURED)

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

Domestic Production and Use: Fused aluminum oxide was produced by two companies at four plants in the United States and Canada. Production of regular-grade fused aluminum oxide had an estimated value of $7.30 million, and production of high-purity fused aluminum oxide was estimated to have a value of more than $3.40 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 $22 million. Bonded and coated abrasive products accounted for most abrasive uses of fused aluminum oxide and silicon carbide.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production,[1] United States and Canada (crude):					
Fused aluminum oxide, regular	90,000	50,000	20,000	20,000	25,000
Fused aluminum oxide, high-purity	10,000	10,000	10,000	5,000	5,000
Silicon carbide	45,000	40,000	30,000	35,000	35,000
Imports for consumption (U.S.):					
Fused aluminum oxide	227,000	203,000	187,000	164,000	213,000
Silicon carbide	190,000	133,000	165,000	169,000	197,000
Exports (U.S.):					
Fused aluminum oxide	9,020	8,950	10,300	11,800	13,600
Silicon carbide	10,000	10,500	13,600	13,200	14,900
Consumption, apparent (U.S.):					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	NA	NA	181,000	189,000	222,000
Price, dollars per ton United States and Canada:					
Fused aluminum oxide, regular	331	302	271	279	323
Fused aluminum oxide, high-purity	566	530	494	514	555
Silicon carbide	585	603	532	529	622
Net import reliance[2] as a percentage of apparent consumption (U.S.)					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	NA	NA	83	82	84

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

Import Sources (2000-03): Fused aluminum oxide, crude: China, 57%; Canada, 26%; Venezuela, 16%; and other, 1%. Fused aluminum oxide, grain: China, 50%; Canada, 20%; Germany, 8%; Austria, 8%; and other, 14%. Silicon carbide, crude: China, 84%; Canada, 5%; and other, 11%. Silicon carbide, grain: China, 39%; Brazil, 21%; Norway, 8%; Venezuela, 8%; and other, 24%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-04**
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 2004, the Department of Defense sold 1,812 tons of fused aluminum oxide abrasive grain from the National Defense Stockpile for $606,237.

Stockpile Status—9-30-04[3]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2004**	**Disposals FY 2004**
Fused aluminum oxide, grain	8,289	2,246	8,289	5,443	7,589

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

ABRASIVES (MANUFACTURED)

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

World Production Capacity:

	Fused aluminum oxide capacity		Silicon carbide capacity	
	2003	2004[e]	2003	2004[e]
United States and Canada	96,600	96,600	47,000	47,000
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	600,000	700,000	455,000	455,000
France	40,000	40,000	16,000	16,000
Germany	80,000	80,000	36,000	36,000
India	40,000	40,000	5,000	5,000
Japan	25,000	25,000	60,000	60,000
Mexico	—	—	45,000	45,000
Norway	—	—	80,000	80,000
Venezuela	—	—	30,000	30,000
Other countries	80,000	80,000	190,000	190,000
World total (rounded)	1,120,000	1,220,000	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 2004, 6 companies operated 14 primary aluminum reduction plants; 6 smelters continued to be temporarily idled. Based upon published market prices, the value of primary metal production was $4.5 billion. Aluminum consumption was centered in the East Central United States. Transportation accounted for an estimated 38% of domestic consumption; the remainder was used in packaging, 29%; building, 13%; consumer durables, 6%; electrical, 6%; and other, 8%.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production:					
Primary	3,668	2,637	2,707	2,703	2,500
Secondary (from old scrap)	1,370	1,210	1,170	1,070	1,200
Imports for consumption	3,910	3,740	4,060	4,130	4,300
Exports	1,760	1,590	1,590	1,540	1,700
Consumption, apparent[2]	7,530	6,230	6,320	6,130	6,300
Price, ingot, average U.S. market (spot), cents per pound	74.6	68.8	64.9	68.1	82.0
Stocks:					
Aluminum industry, yearend	1,550	1,300	1,320	1,400	1,500
LME, U.S. warehouses, yearend[3]	([4])	28	45	207	100
Employment, number[5]	77,800	71,200	61,700	58,300	58,200
Net import reliance[6] as a percentage of apparent consumption	33	38	39	38	41

Recycling: In 2004, aluminum recovered from purchased scrap was about 3 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 19% of apparent consumption.

Import Sources (2000-03): Canada, 59%; Russia, 17%; Venezuela, 5%; Mexico, 2%; and other, 17%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 decreased owing to cutbacks attributed to increased energy and alumina costs. Most of the production decreases continued to take place in the Pacific Northwest. Domestic smelters operated at about 63% of rated or engineered capacity.

Imports for consumption continued to increase, filling some of the supply deficit created by increases in demand and decreases in domestic production. Canada and Russia continued to account for approximately three-fourths of total imports. U.S. exports also increased in 2004. Canada, Mexico, and China, in descending order, received more than 80% of total U.S. exports.

Although the price of primary aluminum fluctuated through September 2004, it generally trended upward. In January, the average monthly U.S. market price for primary ingot quoted by Platts Metals Week was 76.6 cents per pound; in September, the price was 84.4 cents per pound. Prices on the London Metal Exchange (LME) followed the trend of U.S. market prices, but contracts traded in a slightly narrower range. The monthly average LME cash price for September was 78.2 cents per pound.

World production continued to increase as capacity expansions outside the United States were brought onstream and became fully operational. Inventories of metal held by producers, as reported by the International Aluminium Institute, increased slightly through the end of August to about 3.1 million tons. Inventories of metal held by the LME decreased dramatically during the year. At the beginning of 2004, LME inventories exceeded 1.4 million tons, but by the end of September, inventories had fallen to 681 thousand tons, the lowest level since August 2001.

World Smelter Production and Capacity:

	Production		Yearend capacity	
	2003	2004[e]	2003	2004[e]
United States	2,703	2,500	4,140	4,000
Australia	1,860	1,880	1,850	1,880
Brazil	1,380	1,450	1,420	1,450
Canada	2,790	2,640	2,790	2,850
China	5,450	6,100	5,700	6,800
Mozambique	405	510	410	540
Norway	1,150	1,250	1,200	1,300
Russia	3,480	3,600	3,500	3,600
South Africa	738	820	730	850
Venezuela	601	600	640	640
Other countries	7,160	7,500	8,100	8,400
World total (rounded)	27,700	28,900	30,500	32,300

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]Alumina and aluminum production workers (North American Industry Classification System—3313). Source: U.S. Department of Labor, 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 2004. 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, one each in Montana and Texas, using foreign feedstock. Secondary antimony was recovered, mostly in alloy form, at lead smelters; its value, based on the price of antimony metal, was about $11 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:	2000	2001	2002	2003	2004[e]
Production:					
Mine (recoverable antimony)	W	—	—	—	—
Smelter:					
Primary	13,300	9,100	W	W	W
Secondary	7,700	5,380	5,350	5,600	4,100
Imports for consumption	41,600	37,900	28,500	26,700	24,400
Exports of metal, alloys, oxide, and waste and scrap[1]	7,120	7,610	4,250	3,680	4,440
Shipments from Government stockpile	4,540	4,620	4,630	2,070	—
Consumption, apparent[2]	39,000	42,000	34,500	32,000	27,040
Price, metal, average, cents per pound[3]	66	65	88	108	127
Stocks, yearend	6,780	4,990	5,060	6,370	3,390
Employment, plant, number[e]	40	40	35	30	30
Net import reliance[4] as a percentage of apparent consumption	90	87	84	83	85

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; the trend to low-maintenance batteries has tilted the balance of consumption away from antimony and toward calcium as an additive.

Import Sources (2000-03): Metal: China, 79%; Mexico, 8%; Hong Kong, 6%; and other, 7%. Ore and concentrate: China, 47%; Australia, 19%; Mexico, 13%; Austria, 11%; and other, 10%. Oxide: China, 40%; Mexico, 29%; South Africa, 13%; Belgium, 12%; and other, 6%. Total: China, 51%; Mexico, 23%; South Africa, 9%; Belgium, 8%; and other, 9%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: None.

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

ANTIMONY

Events, Trends, and Issues: In 2004, antimony production from domestic source materials was derived entirely from the recycling of lead-acid batteries. Recycling supplied only a minor portion of estimated domestic consumption. In recent years, the number of primary antimony smelters has been cut in half, as smelters in New Jersey and Texas were closed. It was announced that the Texas refinery would be closed by yearend 2004.

The price of antimony metal started the year at about $1.00 per pound and then rose steadily to about $1.35 per pound by May, after which it drifted down to about $1.15 per pound by the end of July. In August, the price spiked to about $1.48 per pound. Compared with that of recent years, the price of antimony showed considerably more strength in 2004.

During 2004, the United States and most major antimony-consuming countries experienced a continuing trend toward lower demand. The downturn was experienced in virtually all consumption categories, and industry observers attributed it partly to a lack of available material and some substitution as the price rose dramatically.

World Mine Production, Reserves, and Reserve Base: Data for reserves and reserve base have been revised from those previously published for South Africa based on information reported by the only antimony producer in South Africa.

	Mine production		Reserves[5]	Reserve base[5]
	2003	2004[e]		
United States	—	—	80,000	90,000
Bolivia	2,300	2,600	310,000	320,000
China	70,000	100,000	790,000	2,400,000
Russia (recoverable)	NA	NA	350,000	370,000
South Africa	5,300	5,300	44,000	200,000
Tajikistan	1,800	2,500	50,000	150,000
Other countries	2,200	2,000	150,000	330,000
World total (rounded)	81,600	112,000	1,800,000	3,900,000

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

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

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Gross weight, for metal, alloys, waste, and scrap.
[2]Domestic mine production + secondary production from old scrap + net import reliance.
[3]New York dealer price for 99.5% to 99.6% metal, c.i.f. U.S. ports.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.

ARSENIC

(Data in metric tons of arsenic unless otherwise noted)

Domestic Production and Use: Domestic consumption of arsenic was satisfied by imported arsenic trioxide and arsenic metal because arsenic has not been produced in the United States since 1985. Arsenic is obtained from roasting arsenopyrite, the most abundant ore mineral of arsenic, and may also be obtained from copper, gold, and lead smelter flue dusts. Arsenic was mainly used in compound form as arsenic trioxide, which was then mostly converted to arsenic acid for use in the production of chromated copper arsenate (CCA), a widely used preservative for pressure-treated wood products that are used outdoors. In 2003, domestic manufacturers of CCA began a voluntary transition from CCA to alternative wood preservatives in most household uses after consultations with the U.S. Environmental Protection Agency. Arsenic trioxide was also used in fertilizers, herbicides, and insecticides. Arsenic metal was used as an alloying element in ammunition and solders, as an anti-friction additive to metals used for bearings, and to strengthen lead-acid storage battery grids. The electronics industry required high-purity arsenic (99.9999%-pure) for gallium-arsenide semiconductors for telecommunication, solar cells, and space research. The value of arsenic metal and compounds consumed domestically in 2004 was estimated to be less than $5 million.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Imports for consumption:					
Metal	830	1,030	880	990	700
Compounds	23,600	23,900	18,800	20,800	4,400
Exports, metal	41	57	100	173	200
Estimated consumption[1]	24,400	24,900	19,600	21,600	4,900
Value, cents per pound, average:[2]					
Metal (China)	51	75	120	87	88
Trioxide (Mexico)	32	28	33	34	32
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: Arsenic, as old scrap, was not recovered from end-use products. Arsenic, as home scrap, contained in runoff and process water at wood treatment plants, was reused in pressure treatment. Arsenic contained in gallium-arsenide scrap from the manufacture of semiconductor devices was reprocessed for arsenic recovery. No arsenic was recovered from arsenical residues and dusts at domestic nonferrous smelters.

Import Sources (2000-03): Metal: China, 78%; Japan, 16%; Hong Kong, 3%; and other, 3%. Trioxide: China, 62%; Chile, 15%; Morocco, 15%; Mexico, 4%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: Long-term demand for arsenic will be affected by increased regulation because of human health concerns. Estimated arsenic consumption declined drastically in 2004 owing to regulation and the voluntary decision by the wood-preserving industry to stop using CCA as a wood preservative for outdoor residential use, especially deck materials, by yearend 2003. Research into the human health effects of arsenic in ground water, mine drainage, and coal-burning powerplant emissions will continue. Exposure to arsenic reportedly may affect breathing and heart rhythm, and increase the risk for bladder cancer. Research has been conducted on use of arsenic trioxide in the treatment of leukemia.

World Production, Reserves, and Reserve Base:

	Production (arsenic trioxide)		Reserves and reserve base[5] (arsenic content)
	2003	2004[e]	
Belgium	1,000	1,000	World reserves and reserve base are thought to be about 20 and 30 times, respectively, annual world production. The reserve base for the United States is estimated to be 80,000 tons.
Chile	8,000	8,000	
China	16,000	16,500	
France	1,000	1,000	
Kazakhstan	1,500	1,500	
Mexico	2,000	2,500	
Peru	3,000	3,500	
Russia	1,500	1,500	
Other countries	1,100	2,000	
World total (rounded)	35,100	37,500	

World Resources: Global resources of copper and lead contain approximately 11 million tons of arsenic. Arsenic resources are 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: Because of human health concerns and the voluntary transition from the use of CCA by the wood-preserving industry, a number of substitute products are now available. These include alkaline copper quaternary, ammoniacal copper quaternary, ammoniacal copper zinc arsenate, copper azole, and copper citrate. Silver-containing biocides are being considered as an alternative wood preservative treatment. Concrete, steel, plasticized wood scrap, or plastic composites may be substituted for CCA-treated wood; however, CCA-treated wood, which may still be in stock, might 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 2004. Asbestos consumption in the United States was estimated to be 60% for roofing products, 25% for coatings and compounds, and 15% for other applications. The use of asbestos in roofing products declined significantly from 2003 because a major manufacturer stopped production of its asbestos-based products.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production (sales), mine	5	5	3	—	—
Imports for consumption	15	13	7	5	3
Exports[1]	19	22	7	3	([2])
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, estimated	15	13	7	5	3
Price, average value, dollars per ton[3]	210	160	220	220	255
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number	19	15	15	—	—
Net import reliance[4] as a percentage of estimated consumption	100	100	100	100	100

Recycling: None.

Import Sources (2000-03): Canada, 98%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 continues on proposed bans on the use of asbestos in the United States and bills to limit liability from asbestos litigation on companies in the United States.

Exports and imports declined to 850 tons and 2,880 tons, respectively. Consumption declined to an estimated 2,880 tons from 5,000 tons in 2003 as domestic manufacturers phased-out more asbestos-based products. Exports of asbestos were from stocks. All the asbestos used in the United States was chrysotile. Canada remained the leading supplier of asbestos for domestic consumption.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	2003	2004[e]		
United States	—	—	Small	Large
Brazil	195	200	Moderate	Moderate
Canada	241	250	Large	Large
China	260	350	Large	Large
Kazakhstan	353	360	Large	Large
Russia	878	900	Large	Large
Zimbabwe	130	130	Moderate	Moderate
Other countries	93	85	Moderate	Large
World total (rounded)	2,150	2,280	Large	Large

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

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 or rocks, such as perlite, serpentine, silica, and talc, are considered to be possible asbestos substitutes for products in which the reinforcement properties of fibers were not required. No single substitute was as versatile as asbestos.

[e]Estimated. NA Not available. — Zero.
[1]Probably includes nonasbestos materials and reexports.
[2]Less than ½ unit.
[3]Average price for Group 7 Canadian chrysotile, ex-mine.
[4]Defined as imports – exports + adjustments for Government and industry stock changes; however, imports account for essentially all domestic consumption.
[5]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 550,000 tons in 2004 valued at about $17 million, an increase in production of about 18% from 2003. Mines were located in two States. Most sales came from Nevada operations followed by a significantly smaller sales volume from Georgia operations. In 2004, an estimated 2.6 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 from Nevada crushers and grinders went mostly to the Colorado and Wyoming gas-drilling industry. This region produced about 13% of total U.S. natural gas in June 2004. The region's drill rig count had risen from 71 rigs in April 2003 to 146 rigs in September 2004. The imports to the Louisiana and Texas ports (Gulf of Mexico [GOM]) went primarily to the Texas, Louisiana, New Mexico, and Oklahoma region. This region produced about 50% of total U.S. natural gas in June 2004. The region's drill rig count rose from 572 rigs to January 2003 to 856 rigs in September 2004. The Federal offshore GOM drill rig count[1] fell from 95 rigs in June 2003 to about 71 rigs in September 2004; these gas wells produced about 19% of total U.S. natural gas production in June 2004.

Examples of barite 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 an ingredient in the faceplate and funnelglass of television and computer monitor tubes to reduce radiation emissions. In the metal casting industry, barite is part of the mold-release compounds. Barite is a component of brake and clutch pads for automobiles and trucks and also is used in automobile paint primer for metal protection and gloss. It is the raw material for barium chemicals, such as barium carbonate, which is in leaded glass and ceramic frits.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Sold or used, mine	392	400	420	468	550
Imports for consumption:					
Crude barite	2,070	2,470	1,510	1,620	2,100
Ground barite	16	6	5	(2)	(2)
Other	15	35	31	33	26
Exports	36	45	47	44	78
Consumption, apparent[3] (crude barite)	2,460	2,870	1,920	2,070	2,600
Consumption[4] (ground and crushed)	2,100	2,670	1,980	2,230	2,500
Price, average value, dollars per ton, f.o.b. mine	25.10	25.00	28.80	28.90	30.00
Employment, mine and mill, number[e]	330	340	320	340	340
Net import reliance[5] as a percentage of apparent consumption	84	86	78	77	79

Recycling: None.

Import Sources (2000-03): China, 90%; India, 8%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Crude barite	2511.10.5000	$1.25/t.
Ground barite	2511.10.1000	Free.
Oxide, hydroxide, and peroxide	2816.40.2000	2% ad val.
Other chlorides	2827.39.4500	4.2% ad val.
Other sulfates	2833.27.0000	0.6% ad val.
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.

Events, Trends, and Issues: Barite imports for consumption increased by an estimated 28% to 2.1 million tons compared with 2003 levels. Major foreign sources of barite have high-grade deposits, relatively low labor costs, and relatively inexpensive transportation costs within their country but purchasers have had to pay increased costs for shipping to the U.S. Gulf Coast grinding plants. The Nevada producers were competitive in the California market, the Great Plains, and the Canadian markets, and probably sold some product in the Gulf Coast owing to rising ocean transportation costs.

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

BARITE

On the demand side, United States onshore barite consumption increased as the U.S. onshore drill rig count rose from 1,022 in January to 1,155 in September. Offshore drill rig count started at 105 in January, declining to below 100 drill rigs for an average level of 95 rigs from March through October. Damage caused by hurricane Ivan on September 16 disrupted production and transportation of crude petroleum by underwater pipeline to refineries for an extended period of time. Employees were removed from production and drilling platforms for safety reasons. Sea floor mudslides have disrupted oil and gas pipelines. Three major domestic barite suppliers reported flat or slightly declining offshore GOM sales. The onshore drill rig count increases led to increased barite demand. The increases in onshore drill rigs came mostly from the independent exploration and development companies. The total U.S. September 2004 drill rig count rose 15% to about 1,250 rigs compared with about 1,090 in September 2003. In the United States, petroleum-well (both oil- and gas-directed) drilling has been a driving force in the demand for barite, but oil-well drilling has become much less important since early 1998. In 2004, gas-directed drill rig counts remained close to the 86% level of active U.S. drill rigs.

In September 2004, the sum of North American and Latin American oil- and gas-directed drill rigs was about 1,810, about 6% greater than September 2003. The count for the Middle East rose to about 245 rigs, a 14% rise compared with September 2003. The September 2004 drill rig count in the Commonwealth of Independent States rose by 30% to about 212 rigs compared with September 2003, and the September 2004 drill rig count in Asia Pacific rose by about 17% to about 210 rigs compared with September 2003. The drill rig activity for Africa in September 2004 was essentially unchanged compared with September 2003, and the European drill rig count declined 28% to about 63 rigs compared with September 2003.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	2003	2004[e]		
United States	468	550	25,000	55,000
Algeria	50	55	9,000	15,000
Brazil	55	60	2,100	5,000
China	3,500	3,800	62,000	360,000
France	75	75	2,000	2,500
Germany	120	120	1,000	1,500
India	700	800	53,000	80,000
Iran	150	170	NA	NA
Korea, North	70	70	NA	NA
Mexico	256	270	7,000	8,500
Morocco	356	340	10,000	11,000
Russia	60	60	2,000	3,000
Thailand	130	140	9,000	15,000
Turkey	110	120	4,000	20,000
United Kingdom	60	60	100	600
Other countries	540	210	12,000	160,000
World total (rounded)	6,700	6,900	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[6] 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]Gulf of Mexico is "Federal offshore" minus "CA offshore" minus "LA inland water" minus "TX inland water."
[2]Less than ½ unit.
[3]Sold or used by domestic mines – exports + imports.
[4]Domestic and imported crude barite sold or used by domestic grinding establishments.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]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. 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 all four Bayer refineries operating during the year. Domestic bauxite was used in the production of nonmetallurgical products, such as abrasives, chemicals, and refractories.

Salient Statistics—United States:[2]	2000	2001	2002	2003	2004[e]
Production, bauxite, mine	NA	NA	NA	NA	NA
Imports of bauxite for consumption[3]	9,030	8,670	7,710	8,860	10,600
Imports of alumina[4]	3,820	3,100	3,010	2,310	1,600
Exports of bauxite[3]	147	88	52	89	70
Exports of alumina[4]	1,090	1,250	1,270	1,090	1,400
Shipments of bauxite from Government stockpile excesses[3]	1,100	3,640	297	1,710	66
Consumption, apparent, bauxite and alumina (in aluminum equivalents)[5]	3,840	3,670	2,860	3,240	2,600
Price, bauxite, average value U.S. imports (f.a.s.) dollars per ton	23	23	20	19	22
Stocks, bauxite, industry, yearend[3]	1,300	1,740	1,280	960	900
Net import reliance,[6] bauxite and alumina, as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2000-03):[7] Bauxite: Guinea, 36%; Jamaica, 35%; Guyana, 11%; Brazil, 10%; and other, 8%. Alumina: Australia, 57%; Suriname, 22%; Jamaica, 10%; and other, 11%. Total: Australia, 26%; Jamaica, 24%; Guinea, 20%; Suriname, 10%; and other, 20%.

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 2004 had normal-trade-relations status.

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

Government Stockpile:

Stockpile Status—9-30-04[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Bauxite, metal grade:					
Jamaica-type	—	4,120	—	—	—
Suriname-type	—	224	—	—	—
Bauxite, refractory-grade, calcined	—	38	—	68	66

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 and alumina increased compared with that of 2003. Based on production data from the International Aluminium Institute, world alumina production during the first 2 quarters of 2004 increased 7% compared with that for the same period in 2003.

In February, the Defense National Stockpile Center announced the sale of approximately 41,700 calcined tons (41,000 calcined long tons) of refractory-grade bauxite from the National Defense Stockpile (NDS). The material was awarded to Harbison-Walker Refractories Co. for approximately $3.5 million. This completed the sale of refractory-grade bauxite from the NDS.[9]

Increased demand and limited supply caused spot prices for metallurgical-grade alumina, as published by Metal Bulletin, to rise dramatically during the first half of the year. The published price range began the year at $330 to $350 per ton. By the beginning of April, the price range had increased to $470 to $490 per ton. The price range then began a downward slide through mid-September to a year-to-date low of $310 to $330 per ton, before rebounding to $375 to $395 per ton through the end of the month.

World Bauxite Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[10]	Reserve base[10]
	2003	2004[e]		
United States	NA	NA	20,000	40,000
Australia	55,600	56,000	4,400,000	8,700,000
Brazil	13,100	18,500	1,900,000	2,500,000
China	12,500	15,000	700,000	2,300,000
Greece	2,420	2,400	600,000	650,000
Guinea	15,500	15,500	7,400,000	8,600,000
Guyana	1,500	1,700	700,000	900,000
India	10,000	10,000	770,000	1,400,000
Jamaica	13,400	13,500	2,000,000	2,500,000
Russia	4,000	5,000	200,000	250,000
Suriname	4,220	4,200	580,000	600,000
Venezuela	5,200	5,500	320,000	350,000
Other countries	8,500	9,000	3,700,000	4,400,000
World total (rounded)	146,000	156,000	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 U.S. demand, but the United States and most other major aluminum-producing countries have essentially inexhaustible subeconomic resources of aluminum in materials other than bauxite.

Substitutes: Bauxite is the only raw material used in the production of alumina on a commercial scale in the United States. However, the vast U.S. resources of clay are technically feasible sources of alumina. Other domestic raw materials, such as 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 4% for alumina in 2004. For the years 2000-03, the net import reliance was 100% for bauxite and ranged from 22% to 36% for alumina.

[7]Aluminum equivalents.

[8]See Appendix B for definitions.

[9]Defense Logistics Agency, 2004, Stockpile accepts refractory grade bauxite offers: Fort Belvoir, VA, Defense Logistics Agency news release, February 12, 1 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 220 tons was valued at about $80 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:	2000	2001	2002	2003	2004[e]
Production, mine shipments	180	100	80	85	100
Imports for consumption, ore and metal	20	115	150	60	90
Exports, metal	35	60	120	40	80
Government stockpile releases[e, 1]	220	60	60	50	145
Consumption:					
Apparent	300	230	180	200	220
Reported, ore	240	170	120	140	NA
Price, dollars (yearend):					
Domestic, metal, vacuum-cast ingot, per pound	421	338	NA	NA	NA
Domestic, metal, powder blend, per pound[2]	492	375	375	375	NA
Domestic, beryllium-copper master alloy, per pound of contained beryllium	160	160	160	160	160
Domestic, beryllium oxide, powder, per pound	100	100	NA	NA	NA
Stocks, consumer, yearend	115	100	90	45	NA
Net import reliance[3] as a percentage of apparent consumption	37	57	56	58	55

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 be as much as 10% of apparent consumption.

Import Sources (2000-03): Ore, metal, scrap, and master alloy: Kazakhstan, 28%; Japan, 24%; Brazil, 10%; Spain, 6%; and other, 32%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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—9-30-04[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Beryl ore (11% BeO)	149	60	149	[5]145	112
Beryllium-copper master alloy	—	37	—	[5]44	14
Beryllium metal:					
Vacuum-cast	59	23	59	36	249
Hot-pressed powder	155	—	110	—	—

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 2004, sales of alloy products (strip and bulk) were reported to have increased compared with those of the previous year, owing to strong global demand for beryllium products from the automotive (particularly in Europe), industrial, and telecommunications and computer sectors. Sales of beryllium products, mostly for defense and government, electronics, and medical-related applications, increased slightly. In 2004, U.S. imports for consumption of beryllium increased; Ireland, Japan, Kazakhstan, and the United Kingdom were the leading suppliers. Beryllium exports also increased; Canada, France, Germany, Japan, and the United Kingdom were the major recipients of the materials.

For fiscal year 2004, the Defense National Stockpile Center (DNSC), Defense Logistics Agency, disposed of about 2,790 tons of beryl ore (about 112 tons of beryllium content), about 350 tons of beryllium-copper master alloy (BCMA) (about 14 tons of beryllium content), and about 249 tons of beryllium metal from the National Defense Stockpile. For fiscal year 2005, 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 of 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; 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. Control of potential health hazards adds to the final cost of beryllium products.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e]	
	2003	2004
United States	85	100
China	15	15
Kazakhstan	4	4
Mozambique	3	3
Russia	40	40
Other countries	1	1
World total[7]	148	163

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 quote 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, 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 and is thus highly import dependent for its supply. A small amount of bismuth is recycled by some domestic firms. Bismuth is contained in some lead ores mined domestically, but the bismuth-containing residues are not processed domestically and may be exported. The value of bismuth consumed was approximately $16 million. About 46% of the bismuth was used in fusible alloys, solders, and ammunition cartridges; 29% in metallurgical additives; 24% in pharmaceuticals and chemicals; and 1% in other uses.

The Safe Drinking Water Act Amendment of 1996 required that all new and repaired fixtures and pipes for potable water supply be lead-free after August 1998. Bismuth use in water meters is one particular application that has 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:	2000	2001	2002	2003	2004[e]
Production, refinery	—	—	—	—	—
Imports for consumption, metal	2,410	2,220	1,930	2,320	2,100
Exports, metal, alloys, and scrap	491	541	131	108	120
Consumption, reported	2,130	2,200	2,320	2,120	2,400
Price, average, domestic dealer, dollars per pound	3.70	3.74	3.14	2.87	3.10
Stocks, yearend, consumer	118	95	111	278	130
Net import reliance[1] as a percentage of apparent consumption	95	95	95	95	90

Recycling: All types of bismuth-containing alloy scrap were increasingly recycled and contributed about 10% of the U.S. bismuth consumption, or 240 tons.

Import Sources (2000-03): Belgium, 34%; Mexico, 24%; China, 21%; United Kingdom, 11%; and other, 10%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Bismuth and articles thereof, including waste and scrap	8106.00.0000	Free.

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

Government Stockpile: None.

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

BISMUTH

Events, Trends, and Issues: Demand for bismuth will probably continue to grow during the current decade. Increasingly, bismuth is being used as a nontoxic replacement for lead in brass, pigments, and solders. Consumption of bismuth in the steel sector, although relatively minor compared with that of other use sectors, appears to be rising.

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. In China, the production of bismuth in 2004 dropped as compared with that of 2003. The drop was caused by closures of various metal mines and processing facilities in China that produce bismuth as a byproduct. Global lead and zinc mine output in 2005, however, is projected to increase significantly and could add to the bismuth supply. The dealer price increased through the first half of 2004; in July, however, the price started to decline. The average price for the first 10 months of 2004 was about 7% higher than that for the first 10 months of 2003.

World Mine Production, Reserves, and Reserve Base:

	Mine production 2003	Mine production 2004[e]	Reserves[2]	Reserve base[2]
United States	W	W	9,000	14,000
Bolivia	100	100	10,000	20,000
Canada	200	150	5,000	30,000
China	1,200	1,050	240,000	470,000
Kazakhstan	150	150	5,000	10,000
Mexico	1,000	1,000	10,000	20,000
Peru	1,000	1,000	11,000	42,000
Other countries	160	350	39,000	74,000
World total (rounded)	3,800	3,800	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 based on bismuth content of lead resources because bismuth production is most often a byproduct of processing lead ores; in China, bismuth production is a byproduct of tungsten and other metal ore processing. Bismuth minerals rarely occur in sufficient quantities to be mined as principal products; the Tasna Mine in Bolivia and a mine in China are the only mines that produced bismuth from a bismuth ore. The Tasna Mine has been on standby status since the mid-1990s awaiting a significant 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 2004 was $517 million. Domestic production of boron minerals, primarily as sodium borates, was by three companies in southern California. The leading 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 the raw material. A third company continued to process calcium and calcium sodium borates, and a fourth company was inactive during most of 2003 and all of 2004. Principal consumption of boron minerals and chemicals was in the production of glass by firms in the North Central and the Eastern United States. The estimated distribution pattern for boron compounds consumed in the United States in 2004 was: glass and ceramics, 75%; fire retardants, 4%; soaps and detergents, 4%; agriculture, 3%; and other, 14%.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production[1]	546	536	518	560	562
Imports for consumption, gross weight:					
Borax	1	1	([2])	19	5
Boric acid	39	56	49	47	52
Colemanite	26	35	32	24	7
Ulexite	127	109	125	80	122
Exports, gross weight:					
Boric acid	119	85	84	70	43
Colemanite	NA	NA	5	23	18
Refined sodium borates	413	221	150	131	131
Consumption:					
Apparent	356	482	492	532	509
Reported	360	347	359	348	NA
Price, dollars per ton, granulated pentahydrate borax in bulk, carload, works[3]	376	376	376	400-425	400-425
Stocks, yearend[4]	NA	NA	NA	NA	NA
Employment, number	1,300	1,300	1,300	1,300	1,300
Net import reliance[5] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2000-03): Boric acid: Turkey, 49%; Chile, 34%; Italy, 7%; Peru, 5%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 leading producer of refined boron compounds during 2004, and about one-half of domestic production was exported. U.S. processed products had fewer impurities, lower emissions, and higher productivity per worker hour 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 were fiberglass, 64%; borosilicate glass, 6%; fire retardants, 4%; soaps and detergents, 4%; agriculture, 3%; frits and ceramics, 3%; and other uses, 16%.

The second leading producing 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 2004 by importing boron compounds.

During 2004, the first commercial magnetic levitation (maglev) train using boron magnets went into service between the Shanghai airport and downtown. Trains on the $1.2 billion system travel 32 kilometers (20 miles) in less than 8 minutes. The top speed was 461 kilometers per hour (287 miles per hour). Two German manufacturers are bidding for a planned $16 billion maglev line between Shanghai and Beijing.

The National Center for Environmental Assessment, a division of the U.S. Environmental Protection Agency, and the European Food Safety Agency established a safe level for the mineral boron. In humans, there is evidence that boron may influence the metabolism of other nutrients, such as vitamin D, that in turn stimulate the absorption of calcium. Boron is a mineral supplement has been used to treat arthritis in amounts of 200 parts per million.

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

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

	Production—all forms		Reserves[7]	Reserve base[7]
	2003	2004[e]		
United States	1,150	1,130	40,000	80,000
Argentina	545	550	2,000	9,000
Bolivia	34	33	NA	NA
Chile	500	300	NA	NA
China	130	130	25,000	47,000
Iran	3	3	1,000	1,000
Kazakhstan	30	30	NA	NA
Peru	9	7	4,000	22,000
Russia	1,000	1,000	40,000	100,000
Turkey	1,400	1,400	60,000	150,000
World total (rounded)	4,800	4,600	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 $191 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.

A major domestic producer of bromine and bromine compounds voluntarily ceased production of pentapolybrominated diphenyl ether and octapolybrominated diphenyl ether (PBDEs) at yearend 2004 after traces were detected in samples of human blood and breast milk; these two PBDEs were widely used flame-retardant chemicals that will be replaced with Firemaster 550, which is not persistent, does not bioaccumulate, and is not ecotoxic.

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

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production[1]	228	212	222	216	222
Imports for consumption, elemental bromine and compounds[2]	20	16	7	7	10
Exports, elemental bromine and compounds	10	11	13	13	8
Consumption, apparent[3]	238	214	216	210	220
Price, cents per kilogram, bulk, purified bromine	90.0	67.0	99.2	72.0	70
Employment, number	1,700	1,700	1,700	1,700	1,500
Net import reliance[4] as a percentage of apparent consumption	4	—	—	E	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, but is included in data collected by the U.S. Census Bureau.

Import Sources (2000-03): Israel, 90%; United Kingdom, 4%; Indonesia, 2%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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	5.5% ad val.
Ethylene dibromide	2903.30.0500	5.5% 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	5.5% 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.

A major domestic producer of bromine and bromine compounds was creating three technology centers that included bromine and bromination technology to help in emerging scientific fields. The centers are expected to add a long-range dimension to new product development capability and expand its technology acquisition capability. The company acquired the bromine fine chemicals business of a French producer located at Port-de-Bouc.

Under the Montreal Protocol, the United States, along with other developed countries, phased out the use of methyl bromide in 2005 as a crop pesticide, except for those uses that were exempted. Imports of crops grown and treated with methyl bromide in Mexico are expected to continue; however, because Mexico is classified as a developing country, it 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]
	2003	2004[e]		
United States[1]	216	222	11,000	11,000
Azerbaijan	2	2	300	300
China	42	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	20	20	([9])	([9])
Jordan	20	50	([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	35	35	([7])	([7])
World total (rounded)	550	590	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. Bromine is also recovered from seawater that has been evaporated to produce salt. The bromine content of underground water in Poland has been estimated to be 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 that do not harm the permeability of the production zone and that control well "blowouts." Because plastics have a low ignition temperature, alumina, magnesium hydroxide, organic chlorine compounds, and phosphorous compounds can be substituted for bromine as fire retardants in some uses. Bromine compounds and bromine acting as a synergist with other materials are used as fire retardants in plastics such as those found in electronics.

[e]Estimated. E Net exporter. — 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.
[9]From seawater.

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 2004. 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 $790,000 in 2004. During the past 4 years, consumption of cadmium 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:	2000	2001	2002	2003	2004[e]
Production, refinery[1]	1,890	680	700	670	600
Imports for consumption, metal	425	107	25	18	10
Exports of metal, alloys, scrap	314	272	168	558	400
Shipments from Government stockpile excesses	323	34	693	80	—
Consumption, apparent	2,010	659	561	530	500
Price, metal, dollars per pound[2]	0.16	0.23	0.52	0.50	0.60
Stocks, yearend, producer and distributor	1,200	1,090	1,750	1,430	1,140
Employment, smelter and refinery	NA	NA	NA	NA	NA
Net import reliance[3] as a percentage of apparent consumption	6	E	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 2004, the U.S. steel industry generated about 0.7 million ton of EAF dust, typically containing 0.003% to 0.07% cadmium.

Import Sources (2000-03): Metal: Australia, 47%; Belgium, 29%; Canada, 18%; and other, 6%.

Tariff: Item	Number	Normal Trade Relations[4] 12-31-04
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 and powders	8107.20.0000	Free.
Cadmium waste and scrap	8107.30.0000	Free.

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

Government Stockpile: None.

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

CADMIUM

Events, Trends, and Issues: 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 various standards used by these agencies, the U.S. Environmental Protection Agency (EPA) created a list of persistent and bioaccumulative toxic pollutants. Cadmium is 1 of 11 metals on the list, and its use in the United States is targeted by the EPA for a 50% reduction by 2005. The European Union is evaluating a proposal to ban all NiCd 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. Declining production in developed countries was offset by increased production in developing countries, mainly in China, where higher production was driven by increased consumption by the battery manufacturing industry.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[5]	Reserve base[5]
	2003	2004[e]		
United States	670	600	90,000	270,000
Australia	350	350	110,000	300,000
Belgium	120	100	—	—
Canada	1,400	1,400	55,000	100,000
China	2,500	2,600	90,000	380,000
Germany	450	450	6,000	8,000
India	480	490	3,000	5,000
Japan	2,500	2,600	10,000	15,000
Kazakhstan	1,350	2,000	50,000	100,000
Korea, Republic of	1,850	2,200	—	—
Mexico	1,400	1,400	35,000	40,000
Russia	950	1,000	16,000	30,000
Other countries	2,880	2,010	140,000	550,000
World total (rounded)	16,900	17,200	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 C for definitions.

CEMENT

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2004, about 90 million tons of portland cement and almost 5 million tons of masonry cement were produced at 114 plants in 37 States and at 2 plants in Puerto Rico. Sales prices increased significantly during the year. The value of cement production, excluding Puerto Rico, was about $8 billion, and the value of total sales (including imported cement) was about $10 billion. Most of the cement was used to make concrete, worth at least $45 billion. Imported cement and clinker (to make cement) accounted for about 20% of the cement sold; total imports rose significantly, owing to very high demand coupled with production shortfalls. Clinker, the main intermediate product in cement manufacture, was produced at 108 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 115 million tons. California, Texas, Pennsylvania, Michigan, Missouri, and Alabama, in descending order, were the six leading producing States and accounted for about one-half of U.S. production. About 75% of cement sales went to ready-mixed concrete producers, 14% to concrete product manufacturers, 6% to contractors (mainly road paving), 3% to building materials dealers, and 2% to other users.

Salient Statistics—United States:[1]	2000	2001	2002	2003	2004[e]
Production:					
Portland and masonry cement[2]	87,846	88,900	89,732	92,843	95,000
Clinker	78,138	78,451	81,517	81,882	85,000
Shipments to final customers, includes exports	110,048	113,136	108,778	112,927	119,000
Imports of hydraulic cement for consumption	24,561	23,694	22,198	21,015	23,000
Imports of clinker for consumption	3,673	1,782	1,603	1,808	2,000
Exports of hydraulic cement and clinker	738	746	834	837	840
Consumption, apparent[3]	110,470	112,810	110,020	114,100	121,200
Price, average mill value, dollars per ton	78.56	76.50	76.00	75.00	85.00
Stocks, cement, yearend	7,566	6,600	7,680	6,610	2,600
Employment, mine and mill, number[e]	18,000	18,000	18,100	18,100	18,100
Net import reliance[4] as a percentage of apparent consumption	24	21	20	20	23

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 is not directly recycled, but there is a small amount of recycling of concrete for use as aggregate.

Import Sources (2000-03):[5] Canada, 21%; Thailand, 17%; China, 11%; Venezuela, 7%; and other, 44%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: Very low interest rates and continued strong residential construction spending in 2004 offset stagnant private nonresidential and public sector construction spending relative to 2003. Owing to strong cement demand at the beginning of 2004, cement companies were unable to build clinker stockpiles ahead of kiln maintenance shutdowns and, instead, delayed the shutdowns in expectation of a relaxation in cement demand that never came. Exceptionally strong construction demand for cement by late spring could not be satisfied owing to the need to conduct deferred maintenance and an inability to increase imports as much as necessary because of a shortage of ships and significantly higher shipping costs. Shortages and/or rationing of cement (and of concrete) resulted in at least 20 States, but especially in Florida (pre-hurricane season), the Carolinas, and California. Significant price increases happened during the year because of the tight supplies.

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

CEMENT

A number of environmental issues, especially its large carbon dioxide emissions, affected the cement industry. Carbon dioxide reduction strategies by the cement industry were aimed at lowering emissions per ton of cement product rather than by plant. These 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 growing concern to the cement industry; stagnant cement prices prior to 2004 made the cost increases difficult to pass on to customers. Some cement companies burn waste materials in their kilns as a low-cost substitute for fossil fuels. Cement kilns can be an effective and benign way of destroying such wastes. The viability of the practice and the type of waste burned hinge on current and future environmental regulations and their associated costs. The trend appears to be toward increased use of waste fuels.

Although supplementary cementitious materials (SCM), such as pozzolans, are little used by cement companies in the United States, there is growing consumption of SCM directly by concrete manufacturers 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 unit monetary and environmental costs of the cement component of concrete.

World Production and Capacity:

	Cement production[e]		Yearend clinker capacity[e]	
	2003	**2004**	**2003**	**2004**
United States (includes Puerto Rico)	[6]94,300	*96,500	[6]102,000	103,000
Brazil	[6]38,000	38,000	45,000	45,000
China	[6]813,000	850,000	750,000	750,000
Egypt	29,100	35,000	35,000	35,000
France	20,000	19,000	22,000	22,000
Germany	30,000	28,000	31,000	31,000
India	110,000	110,000	120,000	130,000
Indonesia	35,000	30,000	50,000	50,000
Iran	30,000	30,000	33,000	35,000
Italy	38,000	38,000	46,000	46,000
Japan	71,000	69,000	78,000	78,000
Korea, Republic of	[6]59,200	60,000	62,000	62,000
Mexico	32,000	35,000	40,000	40,000
Russia	41,000	46,000	65,000	65,000
Saudi Arabia	23,000	25,000	24,000	24,000
Spain	42,000	40,000	40,000	40,000
Thailand	[6]32,500	35,000	49,000	50,000
Turkey	33,000	34,000	35,000	35,000
Other countries (rounded)	380,000	380,000	330,000	350,000
World total (rounded)	1,950,000	2,000,000	1,960,000	2,000,000

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

Substitutes: Virtually all portland cement is used either in making concrete or mortars and, as such, competes in the construction sector with concrete substitutes such as aluminum, asphalt, clay brick, rammed earth, fiberglass, glass, steel, stone, and wood. Pozzolans and similar materials, especially fly ash and ground granulated blast furnace slag, are increasingly being used as partial substitutes for portland cement in some concrete applications.

[e]Estimated. *Corrected on March 14, 2005.
[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, though there are occurrences of pollucite, the principal ore mineral of cesium, in pegmatites in South Dakota and Maine. Pollucite is a hydrated aluminosilicate that occurs in lithium-rich granite pegmatites. Pollucite is imported from Canada by one U.S. company for production of specialty, high-density drilling fluids used in the global oil and gas exploration industry. Cesium is also used in DNA separation techniques, infrared detectors, night vision devices, photoelectric cells, and traffic controls. It was once researched as a possible rocket fuel by the aerospace industry. Cesium is an important component in the U.S. Naval Observatory's atomic clocks that are accurate to a few hundred trillionths of a second. Jet aircraft that track returning U.S. space shuttles are synchronized using cesium clocks, and the accuracy of cesium clocks is important for internet and cell phone transmissions, missile guidance, and global positioning satellites. Cesium-137, a reactor-produced radioactive isotope of cesium, may be used in cancer treatment, specifically brachytherapy, where the radioactive source is placed within the body; in industrial gauges, mining, and geophysical instruments; and for sterilization of food, sewage, and surgical equipment.

Salient Statistics—United States: Cesium production, consumption, import, and export data are not available, and world mine production and U.S. consumption data have not been available since the late 1980s. Annual consumption is estimated to amount to a few thousand kilograms. There is no trading of the metal and 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 2004, one company offered 1-gram ampoules of 99.8% (metals basis) cesium for $41.30 each and 99.98% (metals basis) cesium for $54.30. The price for 50 grams of 99.8% (metals basis) cesium was $542.00, and 100 grams of 99.98% (metals basis) cesium was priced at $1,489.00.

Recycling: None.

Import Sources (2000-03): The United States is 100% import reliant. Canada is the chief source of cesium ore imported by the United States.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: Unless the cesium market changes enough to make domestic deposits economic, the United States will continue to depend on foreign sources of cesium, mainly Canada. The high cost of cesium and its reactivity limit its applications. Special cesium drilling muds, which are used in petroleum exploration, are readily biodegradable and have minimal environmental impact. No 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 physical properties of cesium and its compounds are similar to those of rubidium and its compounds, and 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 2004, the United States consumed about 10% 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 $264 million.

Salient Statistics—United States:[1]	2000	2001	2002	2003	2004[e]
Production, from scrap	139	122	137	129	130
Imports for consumption	453	239	263	317	300
Exports	86	43	29	46	50
Government stockpile releases	85	9	101	70	70
Consumption:					
Reported (excludes scrap)	220	196	237	247	300
Apparent[2] (includes scrap)	590	327	473	468	450
Price, chromite, yearend:					
South African, dollars per metric ton, South Africa[3]	63	NA	NA	NA	NA
Turkish, dollars per metric ton, Turkey[3]	141	NA	NA	NA	NA
Unit value, average annual import (dollars per metric ton):					
Chromite ore (gross weight)	64	61	60	54	100
Ferrochromium (chromium content)	797	709	646	835	1,150
Chromium metal (gross weight)	5,976	6,116	5,767	5,272	5,380
Stocks, yearend, held by U.S consumers	16	17	8	10	7
Net import reliance[4] as a percentage of apparent consumption	77	63	69	73	72

Recycling: In 2004, chromium contained in reported stainless steel scrap receipts accounted for 28% of apparent consumption.

Import Sources (2000-03): Chromium contained in chromite ore and chromium ferroalloys and metal: South Africa, 51%; Kazakhstan, 28%; Zimbabwe, 8%; Russia, 5%; and other, 8%.

Tariff:[5] Item	Number	Normal Trade Relations 12-31-04
Ore and concentrate	2610.00.0000	Free.
Ferrochromium:		
Carbon more than 4%	7202.41.0000	1.9% ad val.
Carbon more than 3%	7202.49.1000	1.9% ad val.
Other:		
Carbon more than 0.5%	7202.49.5010	3.1% ad val.
Other	7202.49.5090	3.1% ad val.
Ferrochromium silicon	7202.50.0000	10% ad val.
Chromium metal:		
Unwrought powder	8112.21.0000	3% ad val.
Waste and scrap	8112.22.0000	Free.
Other	8112.29.0000	3% ad val.

Depletion Allowance: 23% (Domestic), 15% (Foreign).

Government Stockpile: The Defense Logistics Agency, U.S. Department of Defense, submitted the Annual Materials Plan for fiscal year (FY) 2005 in February 2004. Quantity available for sale will be limited to sales authority or inventory. The Agency reported sales in FY 2004 of 70,760 tons of chemical-grade chromite ore, 13,608 tons of refractory-grade chromite ore, 54,852 tons of high-carbon ferrochromium, 14,025 tons of low-carbon ferrochromium, and 499 tons of chromium metal. Ferrochromium silicon and metallurgical-grade chromite ore stocks have been exhausted. The last of the ferrochromium silicon stocks were shipped in June 2002; metallurgical-grade chromite ore, in December 2003.

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

CHROMIUM

Stockpile Status—9-30-04[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004	Average chromium content
Chromite ore:						
Chemical-grade	—	46.3	—	90.7	32.2	28.6%
Metallurgical-grade	—	—	—	—	51.9	28.6%
Refractory-grade	—	121	—	90.7	35.1	[e]23.9%
Ferrochromium:						
High-carbon	408	3.63	408	99.8	72.1	71.4%
Low-carbon	192	22.4	192	—	4.24	71.4%
Chromium metal	6.67	—	6.67	0.454	0.475	100%

Events, Trends, and Issues: The rising cost of ferrochromium production and a strengthening South African rand, along with increased demand for ferrochromium and limited supply of stainless steel scrap, caused the price of ferrochromium to reach historically high levels in 2003. The price of ferrochromium continued to rise in 2004. As yearend approached, prices showed signs of leveling off or decreasing as the conditions that influenced price started to change. The South African rand continued strengthening with respect to the U.S. dollar; the price of metallurgical coke, used in ferrochromium production, started to decline, however. World stainless steel production is the source of ferrochromium demand. China's importance as a consumer of raw materials increased owing to its strong economic growth in 2003 and 2004. World stainless steel production responded to Chinese demand, which slowed at midyear. The high price of ferrochromium permitted China and India, two of the world's higher cost ferrochromium producers, to continue to export that metal commodity to the world market. It also bolstered Kazakhstani 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 cost of nickel reached a 15-year high. High chromium and nickel prices result in higher stainless steel prices, which may stimulate 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. A several percent shift to nickel-free stainless steel grades has been noted by industry analysts. The U.S. Environmental Protection Agency regulates chromium releases into the environment. The U.S. Occupational Health and Safety Administration regulates workplace exposure to chromium.

World Mine Production, Reserves, and Reserve Base:

	Mine production[7] 2003	Mine production[7] 2004[e]	Reserves[8] (shipping grade)[9]	Reserve base[8] (shipping grade)[9]
United States	—	—	—	7,000
India	2,210	2,300	25,000	57,000
Kazakhstan	2,930	3,200	290,000	470,000
South Africa	7,410	8,000	100,000	200,000
Other countries	2,950	3,500	390,000	1,100,000
World total (rounded)	15,500	17,000	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 lleading U.S. chromium resource is in the Stillwater Complex in Montana.

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

[e]Estimated. NA Not available. — Zero.
[1]Data in thousand metric tons of contained chromium unless otherwise noted.
[2]Calculated consumption for chromium is production (from mines and scrap) + imports – exports + stock adjustments.
[3]This price series was discontinued in 2001.
[4]Defined as imports – exports + adjustments for Government and industry stock changes.
[5]In addition to the tariff items listed, certain imported chromium materials (see United States Code, title 26, sections 4661, 4662, and 4672) are subject to excise tax.
[6]See Appendix B for definitions.
[7]Mine production units are thousand metric tons, gross weight, of marketable chromite ore.
[8]See Appendix C for definitions.
[9]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 2004, clay and shale production was reported in 41 States. About 240 companies operated approximately 810 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. Domestic producers estimated that sales or use will be about 49 million tons valued at $1.70 billion in 2004. Based on trends exhibited by the brick, construction, and paper industries, however, sales or use probably will be nearer to 42 million tons than 49 million tons. The 49 million tons probably includes crude clay production tonnages which contain considerable water content. Major domestic uses for specific clays were estimated to be as follows: ball clay—31% floor and wall tile, 20% sanitaryware, and 49% other uses; bentonite—25% pet waste absorbent, 20% drilling mud, 19% foundry sand bond, 13% iron ore pelletizing, and 23% other uses; common clay—55% brick, 19% cement, 16% lightweight aggregate, and 10% other uses; fire clay—79% refractories and 21% other uses; fuller's earth—76% absorbent uses and 24% other uses; and kaolin—54% paper, 14% refractories, and 32% other uses.

Salient Statistics—United States:[1]	**2000**	**2001**	**2002**	**2003**	**2004**[e]
Production, mine:					
Ball clay	1,140	1,100	1,120	1,310	1,460
Bentonite	3,760	3,970	3,970	3,940	4,550
Common clay	23,700	23,200	23,000	23,100	29,700
Fire clay[2]	476	383	446	400	398
Fuller's earth	2,910	2,890	2,730	3,600	3,960
Kaolin	8,800	8,110	8,010	7,680	8,780
Total[3]	40,800	39,600	39,300	40,000	48,900
Imports for consumption:					
Artificially activated clay and earth	18	21	27	21	9
Kaolin	63	114	158	224	175
Other	16	13	32	50	41
Total[3]	96	148	217	325	225
Exports:					
Ball clay	100	174	127	150	110
Bentonite	761	628	722	680	787
Fire clay[2]	216	238	251	275	355
Fuller's earth	136	146	60	50	47
Kaolin	3,690	3,440	3,350	3,400	3,765
Clays, not elsewhere classified	357	344	449	420	516
Total[3]	5,260	4,970	4,960	4,980	5,580
Consumption, apparent	35,600	34,800	34,600	35,300	43,500
Price, average, dollars per ton:					
Ball clay	42	42	42	43	39
Bentonite	41	42	45	45	40
Common clay	6	6	6	6	5
Fire clay	16	16	24	25	25
Fuller's earth	87	89	90	95	86
Kaolin	106	103	119	122	108
Stocks, yearend[4]	NA	NA	NA	NA	NA
Employment, number:[e]					
Mine	1,500	1,400	1,350	1,320	1,250
Mill	5,800	5,800	5,200	5,000	4,980
Net import reliance[5] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2000-03): Brazil, 68%; Mexico, 9%; United Kingdom, 8%; Canada, 3%; 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 12-31-04
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); clay 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: Domestic producers estimated that sales or use of clays will be 49 million tons in 2004. This tonnage probably includes crude clay production which contains significant water content. Compensating for this problem, actual sales or use of common clay probably will be about 24 million tons, sales or use of fuller's earth will be about 3.5 million tons, and sales or use of kaolin will be about 7.6 million tons. Sales or use of ball clay, bentonite, and fire clay will be 1.46 million tons, 4.55 million tons, and 398,000 tons, respectively. Imports for consumption decreased to an estimated 225,000 tons. The major sources of imported clay were Brazil (kaolin), Canada (bentonite), Mexico (activated clay), and the United Kingdom (kaolin). Exports increased to 5.6 million tons. Major markets for exported clays, by descending order of tonnage, were Canada, Japan, Mexico, Finland, and Taiwan.

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

	Mine production					
	Bentonite		Fuller's earth		Kaolin	
	2003	2004[e]	2003	2004[e]	2003	2004[e]
United States (sales)	3,940	4,550	3,600	3,960	7,680	8,780
Brazil (beneficiated)	175	175	—	—	1,700	1,800
Commonwealth of Independent States (crude)	750	750	—	—	5,620	5,700
Czech Republic (crude)	175	175	—	—	4,000	4,100
Germany (sales)	500	500	500	500	1,800	1,800
Greece (crude)	950	950	—	—	60	60
Italy	500	500	30	30	10	10
Korea, Republic of (crude)	—	—	—	—	2,500	2,500
Mexico	425	450	153	155	800	800
Turkey	600	600	—	—	400	400
United Kingdom (sales)	—	—	140	140	2,400	2,000
Other countries	2,220	1,830	330	300	14,000	13,000
World total (rounded)	10,200	10,500	4,750	5,100	41,000	41,000

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.

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 2004; however, negligible amounts of byproduct cobalt were produced as intermediate products from some mining operations. U.S. supply comprised imports, stock releases, and secondary materials, such as cemented carbide scrap, spent catalysts, and superalloy scrap. 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, seven companies were known to produce cobalt compounds. More than 70 industrial consumers were surveyed on a monthly or annual basis. Data reported by these consumers indicate that approximately 44% of U.S. cobalt use was in superalloys, which are used mainly in aircraft gas turbine engines; 9% was in cemented carbides for cutting and wear-resistant applications; 21% was in various other metallic uses; and the remaining 26% was in a variety of chemical uses. The total estimated value of cobalt consumed in 2004 was $500 million.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production:					
Mine	—	—	—	—	—
Secondary	2,550	2,780	2,800	2,140	2,500
Imports for consumption	8,770	9,410	8,450	8,080	8,600
Exports	2,630	3,210	2,080	2,710	2,700
Shipments from Government stockpile excesses	2,960	3,050	524	2,380	1,700
Consumption:					
Reported (includes secondary)	8,980	9,540	7,940	7,640	8,000
Apparent[1] (includes secondary)	11,600	11,800	9,860	10,000	10,200
Price, average annual spot for cathodes, dollars per pound	15.16	10.55	6.91	10.60	24.50
Stocks, industry, yearend	1,180	1,370	1,200	1,060	950
Net import reliance[2] as a percentage of apparent consumption	78	76	72	79	76

Recycling: In 2004, cobalt contained in purchased scrap represented an estimated 31% of total reported cobalt consumption.

Import Sources (2000-03): Cobalt content of metal, oxide, and salts: Finland, 22%; Norway, 18%; Russia, 16%; Canada, 9%; and other, 35%.

Tariff: Item	Number	Normal Trade Relations[3] 12-31-04
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 2005.

Stockpile Status—9-30-04[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Cobalt	2,660	46	2,660	2,720	1,920

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

COBALT

Events, Trends, and Issues: The availability of refined cobalt increased during the first half of 2004 as compared with the first half of 2003. World refinery production was higher, and shipments of cobalt from the National Defense Stockpile continued to contribute to supply. Cobalt prices remained high during the first 10 months of 2004, reflecting strong demand. High prices have begun to impact consumption, however. For example, several producers of rechargeable batteries have developed lithium-ion cells that substitute cobalt with a lower cost mix of cobalt, nickel, and manganese.

Health, safety, and environmental issues are becoming increasingly significant to metals such as cobalt. The European Commission's new chemicals policy, if implemented as proposed, would affect all suppliers of cobalt materials to the European market by requiring them to collect and submit risk assessment data on each material produced in or imported into the European Union.

World Mine Production, Reserves, and Reserve Base: Reserve estimate for Australia was revised downward from that previously published based on information reported by the Government of Australia. Reserve and reserve base estimates for Canada were revised upward based on information reported by major Canadian nickel sulfide ore producers.

	Mine production		Reserves[5]	Reserve base[5]
	2003	2004[e]		
United States	—	—	NA	860,000
Australia	6,900	7,000	1,400,000	1,700,000
Brazil	1,300	1,300	35,000	40,000
Canada	4,300	5,200	140,000	350,000
Congo (Kinshasa)	12,000	11,000	3,400,000	4,700,000
Cuba	3,000	3,400	1,000,000	1,800,000
Morocco	1,300	1,300	20,000	NA
New Caledonia[6]	1,400	1,500	230,000	860,000
Russia	4,800	4,800	250,000	350,000
Zambia	11,300	9,000	270,000	680,000
Other countries	2,100	2,400	200,000	1,500,000
World total (rounded)	48,400	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; cobalt-manganese-nickel in lithium-ion batteries; and cerium, iron, lead, manganese, or vanadium in paints.

[e]Estimated. NA Not available. — Zero.
[1]The sum of U.S. secondary production, as estimated from consumption of purchased scrap, and net import reliance.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]No tariff for Canada or Mexico.
[4]See Appendix B for definitions.
[5]See Appendix C for definitions.
[6]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 2004, was about $80 million. Major end-use distribution of reported columbium consumption was as follows: superalloys, 25%; carbon steels, 24%; high-strength low-alloy steels, 24%; alloy steels, 13%; stainless and heat-resisting steels, 13%; and other, 1%.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production, mine	—	—	—	—	—
Imports for consumption:					
Mineral concentrates[e]	300	290	290	180	170
Columbium metal and alloys[e]	607	1,050	673	743	900
Columbium oxide[e]	1,190	1,360	660	590	600
Ferrocolumbium[e]	4,400	4,480	4,030	4,080	4,600
Exports, concentrate, metal, alloys[e]	100	110	100	170	300
Government stockpile releases[e, 1]	217	(4)	9	223	72
Consumption, reported, ferrocolumbium[e, 2]	4,090	4,230	3,150	3,650	3,900
Consumption, apparent	4,300	4,400	4,100	4,300	4,500
Price:					
Columbite, dollars per pound[3]	6.25	NA	NA	NA	NA
Ferrocolumbium, dollars per pound[4]	6.88	6.88	6.60	6.58	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 be as much as 20% of apparent consumption.

Import Sources (2000-03): Brazil, 70%; Canada, 10%; Estonia, 5%; Germany, 4%; and other, 11%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 2004, the Defense National Stockpile Center (DNSC), Defense Logistics Agency, disposed of about 204 tons of columbium contained in columbium-tantalum mineral concentrates (no columbium value was obtained, as the columbium was contained within tantalum minerals) and about 9 tons of columbium metal valued at about $304,000 from the National Defense Stockpile. 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 2005 of about 254 tons[6] of columbium contained in columbium concentrates and about 9 tons[6] of columbium metal ingots.

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

COLUMBIUM (NIOBIUM)

Stockpile Status—9-30-04[7]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Columbium:					
Carbide powder	—	—	—	—	—
Concentrates	309	12	309	254	204
Ferrocolumbium	—	—	—	—	—
Metal	28	—	28	9	9

Events, Trends, and Issues: For the first half of 2004, domestic demand for columbium ferroalloys in steelmaking and demand for columbium in superalloys (mostly for aircraft engine components) increased compared with that of the same period of 2003. Also, for the first half of the year, overall columbium imports increased; Brazil accounted for about 80% of the quantity and about 75% of the value. Overall exports rose substantially owing to a significant increase in ferrocolumbium exports to Canada. 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. Public information on current prices for other columbium products was not available. According to industry sources, the price for columbium oxide, columbium metal, other columbium chemicals, and various columbium alloys that are derived from either pyrochlore or other columbium-bearing sources is variable and depends on product specifications, volume, and processing considerations. Pricing is normally established by negotiation between buyer and seller.

World Mine Production, Reserves, and Reserve Base:

	Mine production 2003	Mine production 2004[e]	Reserves[8]	Reserve base[8]
United States	—	—	—	Negligible
Australia	230	240	29,000	NA
Brazil	29,000	29,000	4,300,000	5,200,000
Canada	3,280	3,300	110,000	NA
Congo (Kinshasa)	13	13	NA	NA
Ethiopia	6	6	NA	NA
Mozambique	34	35	NA	NA
Namibia	1	1	NA	NA
Nigeria	190	200	NA	NA
Rwanda	22	30	NA	NA
Uganda	3	3	NA	NA
Other countries[9]	—	—	NA	NA
World total (rounded)	32,800	32,800	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 2004 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]Actual quantity limited to remaining sales authority; additional legislative authority is required.
[7]See Appendix B for definitions.
[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 2004 rose to 1.16 million tons and was valued at about $3.4 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 four other States. Although copper was recovered at 22 mines operating in the United States, just 14 mines accounted for more than 99% of production. Three primary smelters, 4 electrolytic and 3 fire refineries, and 12 solvent extraction-electrowinning facilities (may include multiple units) 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, 48%; electric and electronic products, 21%; transportation equipment, 10%; industrial machinery and equipment, 10%; and consumer and general products, 11%.[1]

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production:					
Mine	1,450	1,340	1,140	1,120	1,160
Refinery:					
Primary	1,590	1,630	1,440	1,250	1,280
Secondary	209	172	70	53	55
Copper from all old scrap	357	316	208	206	225
Imports for consumption:					
Ores and concentrates	([2])	46	72	27	35
Refined	1,060	991	927	882	800
Unmanufactured	1,350	1,400	1,230	1,140	1,060
Exports:					
Ores and concentrates	116	45	23	9	30
Refined	94	23	26	93	120
Unmanufactured	650	556	506	703	750
Consumption:					
Reported refined	3,030	2,620	2,370	2,290	2,460
Apparent unmanufactured[3]	3,100	2,500	2,610	2,430	2,640
Price, average, cents per pound:					
Domestic producer, cathode	88.2	76.9	75.8	85.2	132
London Metal Exchange, high-grade	82.2	71.6	70.7	80.7	128
Stocks, yearend, refined, held by U.S. producers, consumers, and metal exchanges	334	952	1,030	657	130
Employment, mine and mill, thousands	9.1	8.2	7.0	6.8	7.0
Net import reliance[4] as a percentage of apparent consumption	37	22	37	40	43

Recycling: Old scrap, converted to refined metal and alloys, provided 225,000 tons of copper, equivalent to 9% of apparent consumption. Purchased new scrap, derived from fabricating operations, yielded 800,000 tons of contained copper; about 86% 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 71%; copper smelters and refiners, 5%; ingot makers, 12%; and miscellaneous manufacturers, foundries, and chemical plants, 12%. Copper in all old and new, refined or remelted scrap contributed 30% of the U.S. copper supply.

Import Sources (2000-03): Unmanufactured: Canada, 28%; Chile, 26%; Peru, 23%; Mexico, 9%; and other, 14%. Refined copper accounted for 75% of unwrought copper imports.

Tariff: Item	Number	Normal Trade Relations[5] 12-31-04
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: World mine production of copper rose by about 900,000 tons (6.6%) in 2004, despite a landslide that reduced output at a major mining operation in Indonesia. Chile and Peru accounted for about two-thirds of the increased output owing to increased capacities and restoration of production cut during 2003. According to projections by the International Copper Study Group,[6] world refined copper production grew by only about 560,000 tons (3.7%), while world use grew by almost 900,000 tons (5.7%). Consequently, the production deficit, estimated at 375,000 tons in 2003, was projected to grow to 700,000 tons in 2004. Copper use in China was projected to increase by 6.6% in 2004, down from an 11.6% increase in 2003. In response to the shortage of copper, global inventories declined throughout the year, while prices rose. By the first week in October, inventories on the world commodity exchanges had fallen by about 650,000 tons, and the COMEX price peaked at $1.47 per pound before moderating.

In the United States, Phelps Dodge Corp., in response to projected production shortfalls, increased output in the second half of the year at its Bagdad and Sierrita mines in Arizona and resumed concentrate production at its Chino Mine in New Mexico (closed in 2001).[7] Other domestic increases resulted from a full year of operation of the Continental Mine in Montana and startup under new ownership of the Robinson Mine in Nevada in the fourth quarter (Robinson had last operated in 1999). These increases were partially offset by reductions at other operations. The copper and brass fabricating industry filed a petition with the U.S. Department of Commerce claiming that exports of scrap to China were causing a short supply of copper raw materials and seeking controls on copper scrap exports. Though the petition was accepted, Commerce subsequently found no injury had been demonstrated and rejected controls. Mine production was projected to reach 1.3 million tons in 2005 following restarts in the second half of 2004.

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

	Mine production		Reserves[8]	Reserve base[8]
	2003	2004[e]		
United States	1,120	1,160	35,000	70,000
Australia	830	850	24,000	43,000
Canada	558	560	7,000	20,000
Chile	4,900	5,380	140,000	360,000
China	610	620	26,000	63,000
Indonesia	979	860	35,000	38,000
Kazakhstan	485	485	14,000	20,000
Mexico	361	400	27,000	40,000
Peru	831	1,000	30,000	60,000
Poland	495	500	30,000	48,000
Russia	675	675	20,000	30,000
Zambia	330	400	19,000	35,000
Other countries	1,400	1,600	60,000	110,000
World total (rounded)	13,600	14,500	470,000	940,000

World Resources: A recent assessment of U.S. copper resources indicated 550 million tons of copper in identified (260 million tons) and undiscovered resources (290 million tons), more than double the previous estimate.[9] By extension, global land-based resources are expected to be much larger than the previously published estimate of 1.6 billion tons. Resources in deep-sea nodules were estimated to contain 700 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 and drain pipe and plumbing fixtures.

[e]Estimated.
[1]Some electrical components are included in each end use. Distribution by Copper Development Association, 2003.
[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 2000, 2001, 2002, 2003, and 2004, general imports of 1,020,000 tons, 1,200,000 tons, 1,060,000 tons, 687,000 tons, and 730,000 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. Tariffs for other countries for some items may be eliminated under special trade agreements.
[6]International Copper Study Group, 2004, Forecast 2004-2005: Lisbon, Portugal, International Copper Study Group release, September 23, 1 p.
[7]Phelps Dodge Corp., 2004, Phelps Dodge is increasing copper production in 2004, 2005: Phoenix, AZ, Phelps Dodge Corp. news release, January 29, 2 p.
[8]See Appendix C for definitions.
[9]U.S. Geological Survey National Mineral Resource Assessment Team, 2000, 1998 assessment of undiscovered deposits of gold, silver, copper, lead, and zinc in the United States: U.S. Geological Survey Circular 1178, 21 p.

DIAMOND (INDUSTRIAL)

(Data in million carats unless otherwise noted)

Domestic Production and Use: In 2004, domestic production was estimated to be approximately 250 million carats, and the United States remained the world's leading 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 88% 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:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Bort, grit, and dust and powder; natural and synthetic:					
Production:					
Manufactured diamond[e]	182	202	219	236	250
Secondary	10	10	5.7	4.7	4.4
Imports for consumption	291	281	185	250	250
Exports[1]	98	88	82	74	83
Sales from Government stockpile excesses	—	—	—	—	—
Consumption, apparent	385	405	328	417	421
Price, value of imports, dollars per carat	0.39	0.31	0.34	0.26	0.24
Net import reliance[2] as a percentage of apparent consumption	50	48	31	42	40
Stones, natural:					
Production:					
Mine	([3])	([3])	—	—	—
Secondary	([3])	([3])	([3])	([3])	([3])
Imports for consumption[4]	2.5	2.5	2.0	1.8	2.0
Exports[1]	1.6	1.0	1.1	0.3	0.8
Sales from Government stockpile excesses	1.0	0.5	0.4	0.4	0.4
Consumption, apparent	2.2	2.2	1.6	2.1	1.9
Price, value of imports, dollars per carat	5.31	3.54	5.43	3.09	5.84
Net import reliance[2] as a percentage of apparent consumption	86	91	88	91	85

Recycling: In 2004, the amount of diamond bort, grit, and dust and powder recycled was estimated to be 4.4 million carats. Lower prices of newly produced industrial diamond appear to be reducing the number and scale of diamond stone recycling operations. In 2004, it was estimated that 275,000 carats of diamond stone were recycled.

Import Sources (2000-03): Bort, grit, and dust and powder; natural and synthetic: Ireland, 40%; China, 21%; Ukraine, 15%; and other, 24%. Stones, primarily natural: Ireland, 26%; Switzerland, 21%; United Kingdom, 14%; Russia, 12%; and other, 27%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-04**
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—9-30-04[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Industrial stones	0.520	—	0.520	0.600	0.381

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

World demand for diamond grit and powder will continue growing. Demand for synthetic diamond grit and powder is expected to 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 continues increasing.

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

	Mine production		Reserves[7]	Reserve base[7]
	2003	2004[e]		
United States	([3])	([3])	NA	NA
Australia	18.2	19.0	90	230
Botswana	7.6	7.5	130	225
China	1.0	1.0	10	20
Congo (Kinshasa)	21.6	20.0	150	350
Russia	12.0	12.0	40	65
South Africa	7.6	6.0	70	150
Other countries	1.5	4.5	85	210
World total (rounded)	69.5	70.0	580	1,250

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

Substitutes: Materials that can compete with industrial diamond in some applications include manufactured abrasives, such as cubic boron nitride, fused aluminum oxide, and silicon carbide. Synthetic diamond rather than natural diamond is used for about 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]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]Less than ½ unit.
[4]May include synthetic miners' diamond.
[5]See Appendix B for definitions.
[6]Natural industrial diamond only. Note, however, that synthetic diamond production far exceeds natural industrial diamond output. Worldwide production of manufactured industrial diamond totaled at least 614 million carats in 2001; the leading 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 $164 million in 2004. Production was from 7 companies with 12 processing facilities in four States. Nevada and California were the principal producing States and accounted for about 78% of U.S. production in 2004. Estimated end uses of diatomite were filter aids, 68%; absorbents, 14%; fillers, 12%; and other (mostly cement manufacture), 6%.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production[1]	677	644	624	620	635
Imports for consumption	([2])	([2])	([2])	1	1
Exports	131	148	128	136	136
Consumption, apparent	546	546	497	485	500
Price, average value, dollars per ton, f.o.b. plant	256	270	255	258	258
Stocks, producer, yearend[e]	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 (2000-03): France, 61%; Italy, 21%; Mexico, 8%; and other, 10%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Siliceous fossil meals, including diatomite	2512.00.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Alan Founie [(703) 648-7720, afounie@usgs.gov, fax: (703) 648-7975]**

DIATOMITE

Events, Trends, and Issues: The amount of domestically produced diatomite sold or used in 2004 increased 2% compared with that of 2003. Filtration (including the purification of beer, liquors, wine and the cleansing of greases and oils) continued to be the leading end use for diatomite, also known as diatomaceous earth (D.E.). Other applications include the removal of microbial contaminants, such as bacteria, protozoa, and viruses, 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 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]
	2003	2004[e]		
United States[1]	620	635	250,000	500,000
Argentina	25	25	NA	NA
China	380	370	110,000	410,000
Commonwealth of Independent States	80	80	NA	13,000
Czech Republic	30	35	4,500	4,800
Denmark[5] (processed)	232	232	NA	NA
France	75	75	NA	2,000
Japan	180	180	NA	NA
Korea, Republic of	21	21	NA	NA
Mexico	60	65	NA	2,000
Peru	35	35	2,000	5,000
Spain	35	36	NA	NA
Other countries	175	175	550,000	NA
World total (rounded)	1,950	1,960	920,000	Large

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

Substitutes: Many materials can be substituted for diatomite. However, the unique properties of diatomite assure its continuing use in many applications. Expanded perlite and silica sand compete for filtration. Synthetic filters, notably ceramic, polymeric, or carbon membrane filters and filters made with cellulose fibers, are also becoming competitive as filter media. Alternate filler materials include talc, ground silica sand, ground mica, clay, perlite, vermiculite, and ground limestone. For thermal insulation, materials such as various clays, 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 2004 had an estimated value of about $43 million. The three leading producers accounted for about 70% of the production, with six other companies supplying the remainder. Operations in North Carolina provided more than 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 2004 end-use distribution of domestic feldspar was glass, 70%, and pottery and other, 30%.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production, marketable[e]	790	800	790	800	790
Imports for consumption	7	6	5	8	28
Exports	11	5	10	9	8
Consumption, apparent[e]	786	801	785	799	810
Price, average value, marketable production, dollars per ton[e]	56.00	55.00	54.00	54.00	54.00
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	([3])	E	E	2

Recycling: Insignificant.

Import Sources (2000-03): Mexico, 91%; Turkey, 7%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 leading end use of feldspar in the United States. U.S. shipments of glass containers were about 4% higher in the first 8 months of 2004 than in the comparable period of 2003, according to the U.S. Census Bureau.

An active U.S. housing construction market consumed large quantities of tile and vitreous plumbing fixtures and, therefore, feldspar. U.S. housing starts for the first 9 months of 2004 were about 8% higher than in the comparable period of 2003, according to the U.S. Census Bureau. A major portion of U.S. tile consumption in recent years has been supplied by imports.

Turkey has recently become a significant exporter of feldspar to the United States.

Unimin Corp. increased its Minex nepheline syenite functional filler production capacity by 50% at its Blue Mountain, Ontario, Canada, operation. Markets for the company's functional fillers include architectural and industrial paint and coatings applications. The Minex products are said to have environmental and performance properties, including improved weatherability.[4] Other major markets for nepheline syenite are glass and ceramics.

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		Reserves and reserve base[5]
	2003	2004[e]	
United States[e]	800	790	Quantitative estimates of reserves and reserve base are not available.
Argentina	60	60	
Australia	50	50	
Brazil	75	75	
Colombia	100	100	
Czech Republic	350	400	
Egypt	350	350	
France	650	670	
Germany	450	500	
Greece	95	125	
India	150	150	
Iran	190	190	
Italy	2,500	2,500	
Japan	50	50	
Korea, Republic of	400	400	
Mexico	330	330	
Norway	74	74	
Poland	240	250	
Portugal	120	125	
South Africa	57	50	
Spain	450	500	
Thailand	780	780	
Turkey	1,800	1,900	
Venezuela	150	150	
Other countries	529	400	
World total (rounded)	10,800	11,000	

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]Industrial Minerals, 2004, Unimin completes nepheline syenite expansion: Industrial Minerals, no. 444, September, p. 8.
[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 2004. 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 88% 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 12% 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 54,000 tons of fluorosilicic acid (equivalent to 95,000 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:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production:					
Finished, all grades[1]	NA	NA	—	—	—
Fluorspar equivalent from phosphate rock	119	104	92	94	95
Imports for consumption:					
Acid grade	484	495	466	533	540
Metallurgical grade	39	27	28	34	50
Total fluorspar imports	523	522	494	567	590
Fluorspar equivalent from hydrofluoric acid plus cryolite	208	176	182	180	190
Exports[2]	40	21	24	31	22
Shipments from Government stockpile	106	65	23	75	42
Consumption:					
Apparent[3]	601	543	477	589	622
Reported	512	536	588	616	630
Stocks, yearend, consumer and dealer[4]	289	221	245	206	110
Employment, mine and mill, number	5	5	—	—	—
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

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

Import Sources (2000-03): China, 65%; South Africa, 22%; Mexico, 12%; and other, 1%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-04**
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 2004, there were no fluorspar sales from the Defense National Stockpile. Under the proposed fiscal year 2005 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—9-30-04[6]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2004**	**Disposals FY 2004**
Acid grade	4	53	11	11	—
Metallurgical grade	84	—	54	54	—

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

FLUORSPAR

Events, Trends, and Issues: China reduced its announced fluorspar export quota for 2004 to 750,000 tons. This continues the trend of recent years as China attempts to reduce fluorspar exports in order to supply rapidly increasing domestic markets. In 2003, China exported 951,000 tons, which was about 100,000 tons higher than the 2003 quota. The higher figure is explained by the fact that there is usually a carryover of export licenses from the previous year. The average export license fees in 2004 were in the $55 to $60 per metric ton range.

Work continued on mine projects in Australia and Vietnam and on capacity upgrades in Kenya and South Africa. Increased production is expected from Mongolia, which has large reserves but in the past has exported the majority of its material to Russia and Ukraine.

Import prices for acid-grade fluorspar stabilized in 2004 after a dramatic increase in 2003. The reduction in Chinese exports resulted in short supplies and increased prices.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7, 8]	Reserve base[7, 8]
	2003	2004[e]		
United States	—	—	NA	6,000
China	2,650	2,700	21,000	110,000
France	105	105	10,000	14,000
Kenya	100	120	2,000	3,000
Mexico	730	750	32,000	40,000
Mongolia	190	270	12,000	16,000
Morocco	75	80	NA	NA
Namibia	[9]79	[9]81	3,000	5,000
Russia	170	170	Moderate	18,000
South Africa	235	235	41,000	80,000
Spain	130	130	6,000	8,000
Other countries	290	290	110,000	180,000
World total (rounded)	4,750	4,930	230,000	480,000

World Resources: Identified world fluorspar resources were approximately 500 million tons of contained fluorspar. The quantity of fluorine present in phosphate rock deposits is enormous. Current U.S. reserves of phosphate rock are estimated to be 1.0 billion tons, which at 3.5% fluorine would contain 35 million tons of fluorine, equivalent to about 72 million tons of fluorspar. World reserves of phosphate rock are estimated to be 18 billion tons, equivalent to 630 million tons of fluorine and 1.29 billion tons of fluorspar.

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

[e]Estimated. NA Not available. — Zero.
[1]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 leading 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 2004. One company in Utah recovered and refined gallium from scrap and impure gallium metal, and one company in Oklahoma refined gallium from impure metal. Imports of gallium, which supplied most of U.S. gallium consumption, were valued at about $4 million, most of which was low-purity material. Gallium arsenide (GaAs) and gallium nitride (GaN) electronic components represented about 98% of domestic gallium consumption. About 41% of the gallium consumed was used in optoelectronic devices, which include light-emitting diodes (LEDs), laser diodes, photodetectors, and solar cells. Integrated circuits represented 40% of gallium demand. The remaining 19% was used in research and development, specialty alloys, and other applications. Optoelectronic devices were used in areas such as aerospace, consumer goods, industrial equipment, medical equipment, and telecommunications. Integrated circuits were used in defense applications, high-performance computers, and telecommunications.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production, primary	—	—	—	—	—
Imports for consumption	39,400	27,100	13,100	14,300	18,000
Exports	NA	NA	NA	NA	NA
Consumption:					
Reported	39,900	27,700	18,600	20,100	25,000
Apparent	NA	NA	NA	NA	NA
Price, yearend, dollars per kilogram, 99.99999%-pure	640	640	[1]530	[1]411	[1]550
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, refinery, number[e]	20	20	20	20	20
Net import reliance[2] as a percentage of reported consumption[e]	99	99	99	99	99

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

Import Sources (2000-03): France, 40%; China, 27%; Russia, 8%; Kazakhstan, 5%; and other, 20%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: Imports of gallium and GaAs continued to supply almost all U.S. demand for gallium and increased from those in 2003 because of a rebound in the wireless communications industry. Using partial-year data, China and Ukraine were the principal U.S. gallium metal suppliers in 2004.

The owner of the gallium recovery plant in Germany and gallium refinery in France filed for Chapter 11 bankruptcy in March, but still continued to operate both facilities. Also in March, the company announced that it would continue to operate its Stade, Germany, plant at one-third of its rated capacity, which has been the operating rate since 2003. The extraction plant has an estimated capacity of 35 metric tons per year. The Kazakhstan gallium producer also closed its 25-ton-per-year plant in March citing a depressed market as the reason for the closure. In China, however, one of the large gallium producers announced that it would reopen its 20-ton-per-year plant in April, although the plant would operate only at about one-quarter of its capacity. The plant had been closed in mid-2003 because of low gallium prices. A purification plant in China, with a capacity of about 15 tons per year, announced that it was increasing production to between 6 and 7 tons in 2004, about three times production in 2003. The company also has the capacity to produce about 5 tons per year of crude gallium (99.99% pure).

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

GALLIUM

At the beginning of 2004, the price of 99.99%-pure gallium from China was estimated to be about $250 per kilogram, and 99.9999%-pure material was about $350 per kilogram. By the end of the first quarter, the price of 99.99%-pure gallium had increased to $325 per kilogram, but by midyear, this had declined slightly and stabilized at about $300 per kilogram.

Market analysts were divided on their estimates of the world GaAs market in 2004, with estimates that ranged from $2.9 billion to $3.9 billion. They forecast that cellular telephone applications would remain the leading use for GaAs-base components, but applications such as automotive radar would begin to increase; automotive radar could have potential for double-digit annual growth until 2008.

Companies began introducing products for the commercial market that contain GaN-base laser diodes and LEDs. One Japanese electronics manufacturer introduced a range of televisions that feature GaN-base LED backlights for improved color reproduction, and another launched liquid crystal display monitors that were backlit by GaN-base LEDs. In addition, one of the manufacturers of video-game systems announced that it would use GaN-base laser diodes when it begins production of the next generation of the system.

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 2004, world primary production was estimated to be about 69 metric tons, about the same as that in 2003. China, Germany, Japan, Kazakhstan, and Ukraine were the leading producers; countries with smaller output were Hungary, Russia, and Slovakia. Refined gallium production was estimated to be about 86 metric tons; this figure includes some scrap refining. France was the leading 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. World primary gallium production capacity in 2004 was estimated to be 165 metric tons; refinery capacity, 140 tons; and recycling capacity, 68 tons.

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

World Resources:[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 also are working to develop organic-base LEDs that may compete with GaAs in the future. Indium phosphide components can be substituted for GaAs-base infrared laser diodes in some specific-wavelength applications, and GaAs competes with helium-neon lasers in visible laser diode applications. Silicon is the principal competitor for GaAs in solar cell applications. GaAs-base 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 2002-04 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 2004 by three firms, one in Idaho and two in New York. The estimated value of crude garnet production was about $3.21 million, while refined material sold or used had an estimated value of $10.9 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:	2000	2001	2002	2003	2004[e]
Production (crude)	60,200	52,700	38,500	29,200	29,700
Sold by producers	51,900	46,200	37,500	33,100	33,100
Imports for consumption[e]	23,000	23,000	23,000	30,800	27,800
Exports[e]	10,000	10,000	10,400	11,000	10,500
Consumption, apparent[e]	66,300	59,300	56,300	83,200	50,400
Price, range of value, dollars per ton[2]	55-2,000	50-2,000	50-2,000	50-2,000	50-2,000
Stocks, producer[e]	50,100	50,000	43,800	13,600	13,600
Employment, mine and mill, number	220	220	200	180	180
Net import reliance[3] as a percentage of apparent consumption	23	22	33	60	34

Recycling: Small amounts of garnet reportedly are recycled.

Import Sources (2000-03):[e] Australia, 46%; India, 37%; and China, 17%.

Tariff:

Item	Number	Normal Trade Relations 12-31-04
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 2004, U.S. garnet consumption decreased 39%, while domestic production of crude garnet concentrates increased slightly from that of 2003. The high 2003 U.S. consumption was a result of stocks sales from a company that had ceased production in 2002 combined with higher garnet imports in 2003. In 2004, imports were estimated to have decreased almost 10% compared with 2003, and exports were estimated to have decreased about 5% from those of 2003. The 2004 domestic sales of garnet remained at about the same level as sales of 2003. In 2004, the only Montana garnet producer reported no production for the year. In 2004, the United States was a net importer. Garnet imports have displaced U.S. production in the domestic market, with Australia, China, and India being major garnet suppliers.

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]
	2003	2004[e]		
United States	29,200	29,700	5,000,000	25,000,000
Australia	127,000	130,000	1,000,000	7,000,000
China	27,000	28,000	Moderate to Large	Moderate to Large
India	63,000	64,000	90,000	5,400,000
Other countries	30,800	31,500	6,500,000	20,000,000
World total (rounded)	277,000	283,000	Moderate	Large

World Resources: World resources of garnet are large and occur in a wide variety of rocks, particularly gneisses and schists. Garnet also occurs as contact-metamorphic deposits in crystalline limestones, pegmatites, serpentinites, and vein deposits. In addition, alluvial garnet is present in many heavy-mineral sand and gravel deposits throughout the world. Large domestic resources of garnet also are concentrated in coarsely crystalline gneiss near North Creek, NY; other significant domestic resources of garnet occur in Idaho, Maine, Montana, New Hampshire, North Carolina, and Oregon. In addition to 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.
[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 decreased by 24% in 2004 from that of 2003. Production of natural gemstones increased by 3% during 2004. 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, Oregon, Arizona, California, Montana, Nevada, Idaho, and Arkansas produced 83% of U.S. natural gemstones. Production of laboratory-created (synthetic) gemstones decreased by more than 33% during the year, owing to the closure of the only U.S. cubic zirconia producer. Reported output of laboratory-created gemstones was from four firms in North Carolina, Florida, Michigan, and Arizona, in decreasing order of production. Major uses were jewelry, carvings, and gem and mineral collections.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production:[2]					
Natural[3]	17.2	14.9	12.6	12.5	12.9
Laboratory-created (synthetic)	57.1	24.7	18.1	33.4	22.2
Imports for consumption	12,900	11,300	12,900	13,600	15,400
Exports, including reexports[4]	4,330	4,320	4,880	5,490	6,940
Consumption, apparent[5]	8,640	7,020	8,050	8,160	8,500
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 (2000-03 by value): Israel, 44%; India, 20%; Belgium, 19%; and other, 17%. Diamond imports accounted for 94% of the total value of gem imports.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 stones, 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 material that could be used by the gem industry. The U.S. Department of Defense is currently selling some NDS materials that may be near-gem quality.

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

GEMSTONES

Events, Trends, and Issues: In 2004, the U.S. market for unset gem-quality diamonds was estimated to have exceeded $12.9 billion, accounting for more than an estimated 35% of world demand. The domestic market for natural, unset nondiamond gemstones was estimated to be about $816 million. The United States is expected to dominate global gemstone consumption throughout this decade.

The Kimberley Process Certification Scheme for rough diamond shipments, which was mandated by the United Nations, was implemented during 2002. The United States was a full participant in the Kimberley Process in 2003. Thus far the scheme appears to be successful in excluding conflict diamonds from the legitimate supply chain.

Canada's Ekati Mine completed its fifth full year in 2003, with diamond production of 5.57 million carats. The Diavik Diamond Mine came onstream and was up to full operating capacity by February 2003 and produced 3.8 million carats by yearend. Canada's first entirely underground diamond mine, the Snap Lake project, is expected to come onstream in 2006. Canada produced about 15% of the world's diamond in 2003.

World Mine Production,[7] Reserves, and Reserve Base: Mine production in 2004 for Angola, Australia, Canada, Guinea, Namibia, Russia, Sierra Leone, and Tanzania were revised upward, while production for Botswana, Congo (Kinshasa), Ghana, and South Africa were revised downward based on submissions from country sources.

	Mine production		Reserves and reserve base[8]
	2003	2004[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	4,770	5,500	
Australia	14,900	15,000	
Botswana	22,800	22,500	
Brazil	500	500	
Canada	11,200	11,300	
Central African Republic	300	300	
China	235	235	
Congo (Kinshasa)	5,400	5,000	
Ghana	800	750	
Guinea	368	490	
Namibia	1,650	1,700	
Russia	12,000	12,500	
Sierra Leone	214	250	
South Africa	5,070	5,000	
Tanzania	198	310	
Other countries[10]	495	495	
World total (rounded)	80,900	81,800	

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 78% 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 2004 producer price, was $10 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 2004. The domestic industry was based on two zinc mining operations, one in Alaska and the other in Washington State. The germanium-bearing ore was exported to Canada for processing. A Tennessee operation, which closed in mid-2003, was sold to a limestone producer that will not process zinc or the germanium-rich residue.

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 polymerization catalysts, 35%; infrared optics, 25%; fiber-optic systems, 20%; electronics/solar electrical applications, 12%; and other (phosphors, metallurgy, and chemotherapy), 8%. Domestically these end uses varied and were estimated to be fiber-optic systems, 40%; infrared optics, 30%; electronics/solar electrical applications, 20%; and other (phosphors, metallurgy, and chemotherapy), 10%. The main difference is that the United States does not use germanium in polymerization catalysts.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production, refinery[e]	23,000	20,000	15,000	12,000	15,000
Total imports[1]	8,220	8,240	13,100	8,380	10,000
Exports	NA	NA	NA	NA	NA
Consumption, estimated	28,000	28,000	28,000	20,000	25,000
Price, producer, yearend, dollars per kilogram:					
Zone refined	1,250	890	620	380	640
Dioxide, electronic grade	800	575	400	245	410
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant,[2] number[e]	90	90	85	65	65
Net import reliance[3] as a percentage of estimated consumption	NA	NA	NA	NA	NA

Recycling: Worldwide, about 35% of the total germanium consumed is produced from recycled materials. During the manufacture of most electronic and optical devices, more than 60% 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. About 2,000 kilograms of germanium were estimated to be consumed as old scrap in 2004. Because new European directives on Waste Electrical and Electronic Equipment (WEEE) mandate the recycling of electronics, the supply of old scrap within the European Union is expected to increase.

Import Sources (2000-03):[4] Belgium, 31%; China, 29%; Taiwan, 15%; Russia, 10%; and other, 15%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: 14% (Domestic and foreign).

Government Stockpile:

Stockpile Status—9-30-04[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Germanium	34,198	540	34,198	8,000	5,691

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

GERMANIUM

Events, Trends, and Issues: China's production of germanium declined in the early part of 2004 because of power shortages. However, many of the mines and smelters have since increased their output. A new zinc mine in the United States (Washington State) began producing germanium-rich ore, which was processed in Canada. In Mexico, a zinc-germanium mine was in the early developmental stage. Recycling of new scrap continued to grow and remained a significant supply factor, as the primary supply of germanium was well below the level of consumption. Also, there has been some renewed interest in the recovery of germanium from coal fly ash in areas outside of China and Russia.

Demand for germanium increased in 2004 because of increases in infrared applications, especially in automobiles as a safety device; also the potential replacement of gallium arsenide by silicon-germanium (SiGe) in wireless telecommunications devices portends 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. Optical fiber manufacturing increased slightly as compared with that of 2003; however, the telecommunications industry was reluctant to invest a large amount of capital in a fiber-optic program because of the high risk and the long time until revenue generation. Research continued on germanium-on-insulator substrates as a replacement for silicon on miniaturized chips and on germanium-base solid-state light-emitting diodes (LEDs). Germanium consumption as a catalyst for polyethylene terephthalate (PET) production was stable, but as the price of germanium climbs, consumers in China and Japan will probably switch to the cheaper catalysts.

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] 2003	2004	Reserves[6]	Reserve base[6]
United States	12,000	15,000	450,000	500,000
Other countries	32,000	35,000	NA	NA
World total	44,000	50,000	NA	NA

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

Substitutes: 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, it is more reliable than competing materials in many high-frequency and high-power electronics applications and is more economical as a substrate for some LED 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- and titanium-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.
[5]See Appendix B for definitions.
[6]See Appendix C for definitions.

GOLD

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

Domestic Production and Use: Gold was produced at about 50 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 2004, the value of mine production was about $3.2 billion, about the same value as in 2003. Commercial-grade refined gold came from about 2 dozen producers. A few dozen companies, out of several thousand companies and artisans, dominated the fabrication of gold into commercial products. U.S. jewelry manufacturing was heavily concentrated in New York, NY, and Providence, RI; areas with lesser concentrations include California, Florida, and Texas. Estimated uses were jewelry and arts, 92%; electrical and electronics, 4%, dental, 3%; and other, 1%.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production:					
Mine	353	335	298	277	247
Refinery:					
Primary	197	191	196	196	185
Secondary (new and old scrap)	82	83	78	92	95
Imports[2]	223	194	217	249	400
Exports[2]	547	489	257	352	500
Consumption, reported	183	179	163	200	200
Stocks, yearend, Treasury[3]	8,140	8,140	8,140	8,140	8,140
Price, dollars per ounce[4]	280	272	311	365	410
Employment, mine and mill, number[5]	10,400	9,500	7,600	7,300	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 about 50% of reported consumption, was recycled in 2004.

Import Sources (2000-03):[2] Canada, 56%; Brazil, 11%; Colombia, 10%; Peru, 8%; and other, 15%.

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

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

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

Events, Trends, and Issues: Domestic gold mine production in 2004 was estimated to be about 11% less than the level of 2003, but high enough to regain the United States' position as the second largest gold-producing nation, after South Africa. Domestic mine output continued to be dominated by Nevada, where production accounted for more than 85% of the U.S. total. Between July 2003 and August 2004, four gold mines were closed, and one mine was reopened in the United States. During this 12-month period, the average output per mine remained about the same, companies continued to merge, and the size of gold-mining companies increased. Most of the larger companies replaced annual production with new reserves, but smaller companies found this more difficult. Estimates by an industry association indicate that, owing to higher prices, worldwide gold exploration expenditures increased for the first time since 1997. The expenditures of U.S. gold producers for exploration also increased in 2003.

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

GOLD

During the first 9 months of 2004, the Engelhard Corporation's daily price of gold ranged from a low of about $376 per troy ounce in May to a high of about $429 in April. For most of the year, however, this price averaged about $400. The Iraqi War in the Middle East and concerns about terrorism continued to keep gold prices at $400; however, the main U.S. dollar-denominated gold price driver was still the up and down movements in the U.S. dollar. The Central Bank Gold Agreement I (CBGA I) expired in September 2004, with just the Swiss National Bank left to sell less than 60 tons of gold during the fourth quarter of 2004, which would complete its sales plans of 1,300 tons of gold (one-half of its reserves) for the period of the agreement. Other countries of Europe, however, were expected to join CBGA II.

World Mine Production, Reserves, and Reserve Base: Data on reserves and reserve base have been revised downward from those previously published for the United States and upward for Peru based on mine closures in the United States and a report by the Peru Ministry of Energy and Mines.[7] Data for the "Other countries" category excluded some countries for which reliable data were not available.

	Mine production		Reserves[8]	Reserve base[8]
	2003	2004[e]		
United States	277	247	2,700	3,700
Australia	282	242	5,000	6,000
Canada	141	171	1,300	3,500
China	202	210	1,200	4,100
Indonesia	140	120	1,800	2,800
Peru	172	160	3,500	4,100
Russia	170	180	3,000	3,500
South Africa	373	344	6,000	36,000
Other countries	830	800	17,000	26,000
World total (rounded)	2,590	2,470	42,000	90,000

Of the estimated 150,000 tons of all gold ever mined, about 15% is thought to have been lost, used in dissipative industrial uses, or otherwise was unrecoverable or unaccounted for. Of the remaining 128,000 tons, central banks hold an estimated 32,000 tons as official stocks, and about 96,000 tons is privately held as bullion, coin, and jewelry.

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

Substitutes: Base metals clad with gold alloys are widely used in electrical/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: 355.8 (2000), 259.5 (2001), 39.6 (2002), 29.9 (2003), and 3.1 (2004, estimated).

[3]Includes gold in Exchange Stabilization Fund. Stocks were valued at the official price of $42.22 per troy ounce.
[4]Engelhard Corporation's average gold price quotation for the year.
[5]Data from Mine Safety and Health Administration.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]Ministerio de Energia y Minas, 2003, 2002 Anuario de la Mineria del Peru: Lima, Peru, December, p. 32.
[8]See Appendix C for definitions.
[9]U.S. Geological Survey National Mineral Resource Assessment Team, 2000, 1998 assessment of undiscovered deposits of gold, silver, copper, lead, and zinc in the United States: U.S. Geological Survey Circular 1178, 21 p.

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 2004, 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 2004 were refractory applications, 24%; brake linings, 13%; foundry operations, 9%; lubricants, 8%; and other uses (including steelmaking), 46%.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production, mine	—	—	—	—	—
Imports for consumption	61	52	45	52	61
Exports	22	24	22	22	30
Consumption, apparent[1]	39	28	24	30	31
Price, imports (average dollars per ton at foreign ports):					
Flake	615	520	529	622	600
Lump and chip (Sri Lankan)	1,250	1,360	1,220	2,260	2,200
Amorphous	130	131	137	152	150
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 (2000-03): China, 37%; Mexico, 23%; Canada, 19%; Brazil, 6%; Japan, 6%; and other, 9%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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—9-30-04[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Sri Lanka, amorphous lump	—	—	—	1,814	685
Madagascar, crystalline flake	—	813	—	—	311

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 2004. Flake graphite imports were from China and Canada (in descending order of tonnage), imports of graphite lump and chip were from Sri Lanka; and amorphous graphite imports were from China and Mexico (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 also is 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]
	2003	2004[e]		
United States	—	—	—	1,000
Austria	—	12	([5])	([5])
Brazil	61	62	360	1,000
Canada	25	25	([5])	([5])
China	450	450	64,000	220,000
Czech Republic	15	10	11,400	13,000
India	110	120	800	3,800
Korea, North	25	25	([5])	([5])
Madagascar	2	2	940	960
Mexico	15	10	3,100	3,100
Norway	2	2	([5])	([5])
Sri Lanka	4	4	([5])	([5])
Turkey	15	15	([5])	([5])
Ukraine	8	8	([5])	([5])
Zimbabwe	8	8	([5])	([5])
Other countries	2	3	5,100	44,000
World total (rounded)	742	756	86,000	290,000

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.
[5]Reserves and reserve base for this country are included with "Other countries."

GYPSUM

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2004, domestic production of crude gypsum was estimated to be 18.0 million tons with an estimated value of $124 million. The leading crude gypsum producing States were, in descending order, Nevada, Oklahoma, Iowa, Texas, California, Arkansas, and Indiana, which together accounted for 78% of total output. Overall, 22 companies produced gypsum at 45 mines in 17 States, and 8 companies calcined gypsum at 56 plants in 29 States. Almost 88% of domestic consumption, which totaled approximately 39 million tons, was accounted for by manufacturers of wallboard and plaster products. Approximately 4.7 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 2004, the capacity of operating wallboard plants in the United States was about 40 billion square feet[1] per year.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production:					
Crude	19,500	16,300	15,700	16,700	18,000
Synthetic[2]	4,950	6,820	9,380	11,700	11,000
Calcined[3]	21,000	19,100	18,600	20,400	25,500
Wallboard products (million square feet[1])	26,100	29,500	29,900	31,500	34,200
Imports, crude, including anhydrite	9,210	8,270	7,970	8,300	10,400
Exports, crude, not ground or calcined	161	295	341	166	130
Consumption, apparent[4]	33,700	31,100	32,700	36,700	39,300
Price:					
Average crude, f.o.b. mine, dollars per ton	8.44	7.31	6.90	6.83	6.90
Average calcined, f.o.b. plant, dollars per ton	16.81	18.42	20.01	19.64	20.00
Stocks, producer, crude, yearend	1,500	1,500	1,500	1,500	1,500
Employment, mine and calcining plant, number[e]	6,000	5,900	5,900	5,900	5,900
Net import reliance[5] as a percentage of apparent consumption	27	26	23	23	26

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

Import Sources (2000-03): Canada, 68%; Mexico, 22%; Spain, 9%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Gypsum; anhydrite	2520.10.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Alan Founie [(703) 648-7720, afounie@usgs.gov, fax: (703) 648-7975]**

GYPSUM

Events, Trends, and Issues: The U.S. gypsum industry began to stabilize after the period of acquisitions, mergers, and bankruptcy reorganization filings in recent years. Several companies constructed new plants and expanded capacity in existing plants in 2004, which resulted in increased efficiency of gypsum-product manufacturing facilities.

Domestic housing starts and commercial construction were both slightly higher in 2004 compared with 2003. The net result was a small overall gypsum production increase for the year. Increasing 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 large wallboard plants designed to use synthetic gypsum will increase the substitution of synthetic for natural gypsum as the new plants become operational. However, because an increase in the number of powerplants that use high-sulfur coal (currently the principle source of synthetic gypsum) is not anticipated, the substitution of synthetic gypsum for natural gypsum may eventually level out and additional mining may be required to meet rising demand.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	2003	2004[e]		
United States	16,700	18,000	700,000	Large
Australia	4,000	4,000		
Austria	1,000	1,000		
Brazil	1,650	1,650	1,300,000	Large
Canada	9,000	9,000	450,000	Large
China	6,900	6,900		
Egypt	2,000	2,000		
France	3,500	3,500		
India	2,300	2,300		
Iran	11,500	11,500		
Italy	1,200	1,200	Reserves and reserve base are large in major producing countries, but data are not available.	
Japan	5,700	5,700		
Mexico	6,800	6,800		
Poland	1,100	1,100		
Spain	7,500	7,500		
Russia	1,000	2,000		
Thailand	6,500	6,500		
United Kingdom	1,500	1,500		
Uruguay	1,130	1,130		
Other countries	12,500	12,500		
World total (rounded)	104,000	106,000	Large	Large

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

Substitutes: In such applications as stucco and plaster, cement and lime may be substituted; brick, glass, metallic or plastic panels, and wood may be substituted for wallboard. Gypsum has no practical substitute in the manufacturing of portland cement. Synthetic gypsum generated by various industrial processes, including flue gas desulfurization of smokestack emissions, is becoming very important as a substitute for mined gypsum in wallboard manufacturing, cement production, and agricultural applications (in descending tonnage order). In 2004, 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 2004, the estimated value of Grade-A helium (99.995% or better) extracted domestically by private industry was about $280 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 2004 domestic consumption of 77 million cubic meters (2.8 billion cubic feet) was used for cryogenic applications, 28%; for pressurizing and purging, 26%; for welding cover gas, 20%; for controlled atmospheres, 13%; leak detection, 4%; breathing mixtures, 2%; and other, 7%.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Helium extracted from natural gas[2]	98	87	87	87	85
Withdrawn from storage[3]	29	45	40	35	36
Grade-A helium sales	127	132	127	122	121
Imports for consumption	—	—	—	—	—
Exports[4]	37.0	43.0	40.0	41.0	44.0
Consumption, apparent[4]	89.6	88.9	87.6	80.7	77.0
Employment, plant, number[e]	320	325	325	325	325
Net import reliance[5] as a percentage of apparent consumption	E	E	E	E	E

Price: The Government price for crude helium was $1.947 per cubic meter ($54.00 per thousand cubic feet) in fiscal year (FY) 2004. 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.

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 (2000-03): None.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-04**
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 2004, privately owned companies purchased nearly 6.0 million cubic meters (217 million cubic feet) of in-kind crude helium. In addition to this, the privately owned companies also purchased 18.8 million cubic meters (676 million cubic feet) of open market sales helium. During FY 2004, BLM's Amarillo Field Office, Helium Operations (AMFO) accepted about 20.5 million cubic meters (739 million cubic feet) of private helium for storage and redelivered nearly 56.4 million cubic meters (2.032 billion cubic feet). As of September 30, 2004, 56.5 million cubic meters (2.0 billion cubic feet) of helium was owned by private firms.

Stockpile Status—9-30-04[6]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2004**	**Disposals FY 2004**
Helium	753.3	16.6	753.3	63.80	24.80

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 2004, some of the major helium producers again announced helium price increases of 8% to 10%. They stated that helium prices were revised because of the rising costs of raw material, labor, health care, insurance premiums, and fuel and transportation costs. It is anticipated that the cost of helium will continue to rise as U.S. helium reserves are depleted. Helium demand will continue to grow slowly, but not at the 5%-per-year rate that was seen the past 10 years. Based on helium export totals through August 2004, it is anticipated that FY 2004 exports will increase by about 7% more than 2003 exports. AMFO continues work on 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. A second open market helium sale was held in the early part of FY 2004. Sales of helium for the two open market offers totaled 65 million cubic meters (2.342 billion cubic feet). In January 2004, one of two overseas helium projects was shut down because of an explosion. The Skikda, Algeria, helium expansion project was shut down after a faulty boiler exploded in the liquefied natural gas complex portion of the refinery. This helium expansion project was designed to increase helium production capacity by 16.6 million cubic meters (600 million cubic feet) per year and had been scheduled to come onstream by mid-2005. The other overseas helium project is a new helium extraction facility under construction in Qatar that is scheduled to start up in early 2006 and to have a helium production capacity of 8.3 million cubic meters (300 million cubic feet) per year.

World Production, Reserves, and Reserve Base:

	Production		Reserves[8]	Reserve base[8]
	2003	2004[e]		
United States (extracted from natural gas)	87	85	3,700	[9]8,500
United States (from Cliffside Reserve)	35	36	—	—
Algeria	14	14	1,900	8,400
Canada	NA	NA	NA	2,000
China	NA	NA	NA	1,100
Poland	2	2	35	280
Qatar	NA	NA	NA	10,000
Russia	6	6	1,700	6,700
Other countries	NA	NA	NA	2,800
World total (rounded)	144	143	NA	40,000

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

Helium resources of the world exclusive of the United States were estimated to be about 31.4 billion cubic meters (1.132 trillion cubic feet). The locations and volumes of the principal deposits, in billion cubic meters, are Qatar, 10; Algeria, 8; Russia, 7; Canada, 2; China, 1; Poland, 0.3. As of December 31, 2004, AMFO had analyzed more than 21,500 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 2004. 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 leading end use. Indium semiconductor compounds were used in infrared detectors, high-speed transistors, and high-efficiency photovoltaic devices. A major manufacturer is testing indium for a new application as a heat-management material in computers, which could increase consumption by 40 metric tons per year. The estimated distribution of uses in 2004 indicated an increase in the application for coatings and electrical components and semiconductors, which was offset by a reduction in the use for solder and alloys and other purposes. Major uses were coatings, 70%; electrical components and semiconductors, 12%; solders and alloys, 12%; and research and other, 6%. The estimated value of primary indium metal consumed in 2004, based upon the annual average price, was about $54 million.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004**[e]
Production, refinery	—	—	—	—	—
Imports for consumption[1]	69	79	112	118	115
Exports	NA	[e]10	[e]10	NA	NA
Consumption, estimated	55	65	85	90	90
Price, annual average, dollars per kilogram (99.97% indium)	188	120	97	170	600
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: In the United States, only small amounts of indium scrap were recycled in 2004. The reason for the low recycling rate is the lack of infrastructure in the United States for collection of indium-containing products. Recycling of indium could expand significantly in the United States if the current price of indium is sustained or continues to increase. Indium tin oxide (ITO) consumption is highly inefficient, as only about 15% of ITO is consumed to make LCDs; the rest is scrap. The major problem in recycling the ITO scrap is the high cost associated with the process. The process takes about 12 weeks from collection of scrap to fabrication of secondary indium products. A recycler may have millions of dollars worth of indium in the recycling loop at any one time. A large increase in ITO scrap could be difficult for the recycling industry to handle because of large capital costs, environmental restrictions, and storage space.

Japan, however, has an aggressive recycling program that makes up for any shortfalls in domestic production and imports of indium. For example, in 2003, about 50% to 60% of Japanese ITO production was from secondary indium, while 10% was recycled from old LCDs. Japanese ITO producers are considering recycling the remaining 30% to 50% of indium that currently is not captured.

Import Sources (2000-03):[1] China, 49%; Canada, 21%; Japan, 9%; France, 6%; and other, 15%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Unwrought indium, including powder	8112.92.3000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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

INDIUM

Events, Trends, and Issues: Estimated domestic indium consumption remained the same as that for 2003. Continued strong sales of flat panel displays and other LCD products increased consumption of ITO, mostly in Japan, the Philippines, the Republic of Korea, and Taiwan, well beyond the available production capacity. The report of reduced production from mines that produce byproduct indium and the closure of several smelters because of environmental problems created the perception that supplies of indium from China would decrease, which drove world prices to historic highs. The price dropped briefly in July 2004, but then quickly rebounded. Although the short-range outlook for indium demand remains positive, market supply remains questionable because of its heavy dependence on the strength of the zinc market. With the increasing capacity of ITO refineries and LCD plants in Japan, the Philippines, the Republic of Korea, and Taiwan, and with China opening new ITO refineries and LCD plants, the availability of primary indium feedstock will be further reduced. 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]
	2003	2004		
United States	—	—	300	600
Belgium	40	40	([4])	([4])
Canada	50	50	700	2,000
China	100	110	280	1,300
France	65	10	([4])	([4])
Germany	10	10	NA	NA
Japan	70	70	100	150
Peru	5	5	100	150
Russia	15	15	200	300
Other countries	15	15	800	1,500
World total (rounded)	370	325	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 occurs with other base metals—copper, lead, and tin—and to a lesser extent with bismuth, cadmium, and silver, most deposits of these metals are subeconomic for indium.

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

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

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

[1]Imports for consumption are based on U.S. Department of Commerce, U.S. Treasury, and U.S. International Trade Commission data for unwrought indium 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 2004 from three companies operating in Oklahoma accounted for 100% of the elemental iodine value estimated to be about $16 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, 20 plants reported consumption of iodine in 2003. Major consumers were located in the Eastern United States. The average value of iodine imports through August was $12.91 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 25,500 metric tons.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production	1,470	1,290	1,420	1,090	1,340
Imports for consumption, crude content	4,790	5,030	6,200	5,800	5,200
Exports	886	1,460	1,430	1,600	1,330
Shipments from Government stockpile excesses	949	83	25	361	245
Consumption:					
Apparent	5,420	4,730	6,520	5,610	5,210
Reported	3,990	3,560	4,540	3,930	NA
Price, average c.i.f. value, dollars per kilogram, crude	14.59	13.94	12.71	11.87	12.91
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, number	30	30	30	30	30
Net import reliance[1] as a percentage of apparent consumption	77	74	77	81	74

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

Import Sources (2000-03): Chile, 67%; Japan, 22%; Russia, 10%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Iodine, crude	2801.20.0000	Free.
Iodide, calcium or copper	2827.60.1000	Free.
Iodide, potassium	2827.60.2000	2.8% ad val.
Iodides and iodide oxides, other	2827.60.5000	4.2% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: In October, the Defense National Stockpile Center announced the fiscal year 2005 Annual Materials Plan would include sales of 454 tons (1,000,000 pounds) of crude iodine.

Stockpile Status—9-30-04[2]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Stockpile-grade	1,180	—	1,180	454	245

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

IODINE

Events, Trends, and Issues: Chile was the leading producer of iodine in the world. Iodine was a coproduct from surface mineral deposits used to produce nitrate fertilizer. Two of the leading iodine companies in the world are located in Chile. The leading Chilean company announced an expansion of its iodine and potassium nitrate production of about 30% at a cost of $145 million. Japan was the second leading producer, and its production was associated with gas brines.

The Defense National Stockpile Center issued a DLA-IODINE-005 Basic Ordering Agreement (BOA) for crude iodine. The BOA solicits offers for the sale of 454 metric tons (1,000,000 pounds) of crude iodine in fiscal year 2005, with quarterly sales of approximately 113,400 kilograms (250,000 pounds). Awards were subject to the certification of the Drug Enforcement Administration. The iodine offered for sale was located at New Haven, IN, and was of Chilean, Japanese, and unknown origin.

The U.S. Environmental Protection Agency approved a wood preservative that contained iodine. The solution can be airless sprayed, brushed, rolled, dip bathed, or pressure treated. Once dry, the treatment provided the same permanent decay protection as chrome-copper-arsenic treated wood.

A major consumer of iodine as a catalyst to produce acetic acid to supply acetyl raw materials used gasified coal (syngas) as its chemical base. The chemicals are used in the production of cellulosic plastics and fibers that are made into photographic film, tool handles, paints, and cigarette filters. The company, 1 of 13 companies that applied for a U.S. Department of Energy Clean Coal Initiative grant, will use its technology to produce methanol from coal-derived synthetic gas. The methanol unit will use coal-derived syngas from the coal gasification facility.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	2003	2004[e]		
United States	1,090	1,340	250,000	550,000
Azerbaijan	300	300	170,000	340,000
Chile	11,900	16,200	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)	20,900	25,500	15,000,000	27,000,000

World Resources: In addition to 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 remains a large resource.

Substitutes: Bromine and chlorine could be substituted for most of the biocide, colorant, and ink uses of iodine, although they are usually considered less desirable than iodine. Antibiotics and boron are also substitutes for iodine as biocides. Salt crystals and finely divided carbon may be used for cloud seeding. There are no substitutes for iodine in some animal feed, catalytic, nutritional, pharmaceutical, and photographic uses.

[e]Estimated. NA Not available.
[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: In 2004, almost all of the usable ore, having an estimated value of $1.6 billion, was shipped from mines in Michigan and Minnesota. Ten iron ore production complexes with 10 mines, 8 concentration plants, and 8 pelletizing plants were in operation during the year. The mines included 10 open pits and no underground operations. Virtually all ore was concentrated before shipment. Eight mines operated by three companies accounted for 99% of production. The United States produced 4% of the world's iron ore output and consumed about 5%.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production, usable	63.1	46.2	51.6	46.4	54.0
Shipments	61.0	50.6	51.5	44.5	53.2
Imports for consumption	15.7	10.7	12.5	12.6	11.6
Exports	6.1	5.6	6.8	6.8	8.8
Consumption:					
Reported (ore and total agglomerate)[3]	76.5	67.3	59.1	60.6	56.0
Apparent	70.2	62.0	57.9	53.1	58.8
Price,[4] U.S. dollars per metric ton	25.57	23.87	26.04	26.86	31.00
Stocks, mine, dock, and consuming plant, yearend, excluding byproduct ore	28.8	18.0	18.3	17.5	15.5
Employment, mine, concentrating and pelletizing plant, quarterly average, number	6,814	5,017	4,742	4,674	4,800
Net import reliance[5] as a percentage of apparent consumption (iron in ore)	10	26	10	13	8

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

Import Sources (2000-03): Canada, 49%; Brazil, 41%; Australia, 4%; Chile, 3%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: The tremendous increase in iron ore consumption in China during the past decade had little effect on U.S. iron ore production until 2004. In December 2003, a major Chinese steel company purchased a minority interest in a bankrupt iron ore producer in northeastern Minnesota. Pellet production continued throughout 2004 with China accepting trade for their portion of the production from the majority partner's Canadian affiliate. Discussions were underway to increase production levels from the joint-venture operation to meet burgeoning global demand.

A major U.S. steel producer in late 2002 decided to terminate negotiations for the sale of its lone iron ore mine and pelletizing operation and instead negotiated the acquisition of the iron ore assets of a bankrupt steel corporation in mid-2003. This purchase, combined with a new labor agreement with the mine and pelletizing plant's major operating union in 2003, indicated a decision by the company to remain involved in upstream activities and to control more of their feedstock sources. In 2004, this decision was confirmed when production was increased at both of the company's mining and pelletizing operations.

Research and development testing on a value-added iron product was completed in Minnesota in 2004. The Mesabi Nugget project determined that iron ore pellets produced in Minnesota could be converted to iron nuggets of 96% to 98% iron content using noncoking coals with low emissions. This product, which was superior to direct-reduced iron and chemically similar to pig iron, could then be used in steelmaking furnaces in integrated steelworks and minimills. Construction of the first commercial 500,000-ton-per-year-capacity plant was planned for spring 2005 in Minnesota.

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

IRON ORE

China has become the dominant source of iron ore demand growth. About 98% of iron ore is used to produce pig iron, which is, therefore, the best indicator of iron ore consumption worldwide. In 1992, China produced 76 million tons of pig iron, surpassing Japan as the leading producing country in the world. In 2003, China produced more than 200 million tons of pig iron, almost 2½ times the production of the second leading producer, Japan, at 82 million tons. China's pig iron production grew at an average rate of more than 9% per year from 1992 through 2003.

China's astonishing growth affected the large global iron ore producers long before it had an impact on U.S. production. In 2004, the three leading iron-ore-producing companies, located in Brazil and Australia, continued to invest large sums of money to increase production to satisfy Chinese demand. One estimate of output from all iron ore projects planned to start before 2009 indicates a production increase equal to more than one-third of the world's 2004 estimated production.

The future of the global iron ore industry will depend primarily on how long China can continue its extraordinary growth. China is the world's leading producer of iron ore on a gross tonnage basis, but is only a distant third when considered on the basis of iron content. Growth in Chinese iron ore consumption is expected to continue, although not at the extraordinary rate seen between 2000 and 2004. Continued strong growth in Chinese iron ore imports to maintain steel production growth and offset decreased low-grade domestic ore production will be needed to meet China's expected growth in steel consumption. This, along with Brazil's development of downstream steel-producing facilities and India's increased consumption of domestic ores, is expected to increase global demand for iron ore.

World Mine Production, Reserves, and Reserve Base:[6] The iron ore reserves and reserve base estimates for Brazil have been revised based on new information from that country.

	Mine production		Crude ore		Iron content	
	2003	2004[e]	Reserves	Reserve base	Reserves	Reserve base
United States	46	54	6,900	15,000	2,100	4,600
Australia	187	220	18,000	40,000	11,000	25,000
Brazil	212	220	21,000	62,000	14,000	41,000
Canada	31	31	1,700	3,900	1,100	2,500
China	261	280	21,000	46,000	7,000	15,000
India	106	110	6,600	9,800	4,200	6,200
Iran	16	16	1,800	2,500	1,000	1,500
Kazakhstan	17	17	8,300	19,000	3,300	7,400
Mauritania	10	10	700	1,500	400	1,000
Mexico	11	12	700	1,500	400	900
Russia	92	95	25,000	56,000	14,000	31,000
South Africa	38	40	1,000	2,300	650	1,500
Sweden	22	22	3,500	7,800	2,200	5,000
Ukraine	62	66	30,000	68,000	9,000	20,000
Venezuela	18	18	4,000	6,000	2,400	3,600
Other countries	34	40	10,000	30,000	6,200	17,000
World total (rounded)	1,160	1,250	160,000	370,000	80,000	180,000

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

Substitutes: Iron ore, used directly or converted to pellets, briquettes, or concentrates, is the only source of primary iron. In some operations, ferrous scrap constitutes as much as 7% of the blast furnace feedstock. Scrap is extensively used in steelmaking and in iron and steel foundries, but a greater than 200% increase in scrap prices during the past year has made steel production using iron ore more profitable in comparison with steel production using scrap.

[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.
[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 in 2004 valued at an estimated $62 billion. The steel industry consisted of about 79 companies that produced raw steel at about 122 locations, with combined raw steel production capability of about 106 million tons. Indiana accounted for about 24% of total raw steel production, followed by Ohio, 14%, Michigan, 6%, and Pennsylvania, 6%. Pig iron was produced by 9 companies operating integrated steel mills, with about 31 blast furnaces in continuous operation. The distribution of steel shipments was estimated as follows: warehouses and steel service centers, 23%; construction, 14%; transportation (predominantly for automotive production), 12%; cans and containers, 3%; and other, 48%. 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:	2000	2001	2002	2003	2004[e]
Pig iron production[2]	47.9	42.1	40.2	40.6	40.8
Steel production:	102	90.1	91.6	93.7	96.2
Basic oxygen furnaces, percent	53.0	52.6	49.6	49.0	47.0
Electric arc furnaces, percent	47.0	47.4	50.4	51.0	53.0
Continuously cast steel, percent	96.4	97.2	97.2	97.3	97.0
Shipments:					
Steel mill products	99	89.7	90.7	96.1	104
Steel castings[3]	1.0	0.8	0.7	0.7	1.1
Iron castings[3]	9.4	8.3	7.8	7.5	8.3
Imports of steel mill products	34.4	27.3	29.6	21.0	29.1
Exports of steel mill products	5.9	5.6	5.4	2.5	7.3
Apparent steel consumption[4]	120	107	107	107	125
Producer price index for steel mill products (1982=100)[5]	108.4	101.3	104.8	109.5	150.0
Steel mill product stocks at service centers yearend[6]	7.8	7.1	13.7	12.3	10.0
Total employment, average, number[7]					
Blast furnaces and steel mills	151,000	141,000	140,000	140,000	140,000
Iron and steel foundries[e]	125,000	117,000	116,000	116,000	116,000
Net import reliance[8] as a percentage of apparent consumption	18	16	15	10	18

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

Import Sources (2000-03): European Union[9], 18%; Canada, 17%; Mexico, 11%; Republic of Korea, 6%; and other, 48%.

Tariff: Item	Number	Normal Trade Relations 12-31-04	Mexico 12-31-04
Pig iron	7201.10.0000	Free	Free.
Carbon steel:			
Semifinished	7207.12.0050	Free.	Free.
Structural shapes	7216.33.0090	Free.	Free.
Bars, hot-rolled	7213.20.0000	Free.	Free.
Sheets, hot-rolled	7208.39.0030	Free.	Free.
Hot-rolled, pickled	7208.27.0060	Free.	Free.
Cold-rolled	7209.18.2550	Free.	Free.
Galvanized	7210.49.0090	Free.	Free.
Stainless steel:			
Semifinished	7218.91.0015	Free.	Free.
	7218.99.0015	Free.	Free.
Bars, cold-finished	7222.20.0075	Free.	Free.
Pipe and tube	7304.41.3045	Free.	Free.
Cold-rolled sheets	7219.33.0035	Free.	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

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

IRON AND STEEL

Events, Trends, and Issues: During the first 8 months of 2004, monthly pig iron production fluctuated near 3.3 million tons and monthly raw steel production fluctuated near 8.2 million tons. Production totals during these periods increased about 3.5% for pig iron and 7.1% for steel from those of 2003. Steel production was trending upward during the first 8 months of 2004. Shipments of steel mill products for 2004 were up 8.2% compared with those of 2003. Imports of steel mill products increased an estimated 39% compared with those of 2003, and U.S. net import reliance as a percentage of apparent consumption surged to an estimated 18%, the highest level since 2000.

The U.S. International Trade Commission's section 201 investigation under the Trade Act of 1974 led to the imposition in 2002 of 8% to 30% duties on a wide range of steel products. The subsequent World Trade Organization ruling that Section 201 violated global trading rules was followed by the European Union's threat of retaliatory trade sanctions against the United States. Total relief from imports was partially nullified when the U.S. Department of Commerce exempted 727 imported steel products from the tariff. The United States ended tariffs ahead of schedule in late 2003 on the grounds that the steel industry had enough time to restructure to become competitive.

The intense bankruptcy activity in the U.S. steel industry since late-2000 appeared to be at an end with the declaration of bankruptcy by a South Carolina steel company in October 2003, subsequently being purchased by a major international steel company in June 2004, and reopening in August 2004. During this 4-year period, the steel industry experienced restructuring and consolidation that included acquisitions totaling more than $3.6 billion. Consolidations were facilitated by labor agreements that increased worker participation and streamlined the management structure.

The recovery of the global economy that began in late 2003 has been steady and gradual. The International Iron and Steel Institute estimated a gross domestic product growth rate of 3.1% in 2004 and 3.4% in 2005. Growth in the United States was estimated to be 4.7% in 2004 and 3.6% in 2005. World consumption of finished steel products was estimated to increase by 6.2% in 2004 and by 4.5% in 2005. Finished steel product consumption in the United States was expected to rise by 4.6% in the period 2003 to 2005.

World Production:

	Pig iron		Raw steel	
	2003	2004[e]	2003	2004[e]
United States	40.6	40.8	93.7	96.2
Brazil	29.6	34.3	29.6	32.8
China	202	242	220	263
European Union[9]	89.6	111	153	196
India	25.0	25.1	31.8	33.2
Japan	82.1	82.8	111	112
Korea, Republic of	29.5	27.5	46.3	47.2
Russia	48.4	50.2	62.7	64.2
Ukraine	29.6	30.8	36.9	38.6
Other countries	70.6	58.5	177	142
World total (rounded)	647	703	962	1,030

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 Census Bureau.
[4]Defined as steel shipments + imports - exports + adjustments for industry stock changes + adjustment for imports of semifinished steel products.
[5]U.S. Department of Labor, Bureau of Labor Statistics.
[6]Metals Service Center Institute.
[7]U.S. Department of Labor, Bureau of Labor Statistics. Blast furnaces and steel mills: SIC 3312; Iron and steel foundries: NAICS 331511.
[8]Defined as imports - exports + adjustments for Government and industry stock changes.
[9] European Union membership increased from 15 to 25 as of May 1, 2004.

IRON AND STEEL SCRAP[1]

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

Domestic Production and Use: Total value of domestic purchases (receipts of ferrous scrap by all domestic consumers from brokers, dealers, and other outside sources) and exports was estimated to be $12.9 billion in 2004, up about 35% from that of 2003. Manufacturers of pig iron, raw steel, and steel castings accounted for 89% of scrap consumption by the domestic steel industry, using scrap together with pig iron and direct-reduced iron to produce steel products for the construction, transportation, oil and gas, machinery, container, appliance, and various other consumer industries. The ferrous castings industry consumed most of the remaining 11% to produce cast iron and steel products, such as motor blocks, pipe, and machinery parts. Relatively small quantities of scrap were used for producing ferroalloys, for the precipitation of copper, and by the chemical industry; these uses totaled collectively less than 1 million tons.

Raw steel production in 2004 was an estimated 99.2 million tons, almost 6% more than that of 2003; capacity utilization was up by 10% from that of 2003. Net shipments of steelmill products were estimated to be about 104 million tons compared with 96.1 million tons for 2003. The domestic ferrous castings industry shipped 8.3 million tons of all types of iron castings in 2003 and an estimated 1.1 million tons of steel castings, including investment castings, according to the latest available information.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production:					
Home scrap	20	18	17	17	17
Purchased scrap[2]	56	55	56	53	56
Imports for consumption[3]	4	3	3	4	5
Exports[3]	6	7	9	11	12
Consumption, reported	74	71	69	61	64
Price, average, dollars per metric ton delivered, No. 1 Heavy Melting composite price, Iron Age Average, Pittsburgh, Philadelphia, Chicago	92.61	73.84	88.21	108.00	190
Stocks, consumer, yearend	5.3	4.9	5.1	4.3	4.1
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 more than 200 years. The automotive recycling industry alone recycled about 14 million vehicles in 2004 through more than 200 car shredders to supply more than 14.2 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 64 million tons of steel was recycled in steelmills and foundries in 2004. 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 49% post-consumer (old, obsolete) scrap, 26% prompt scrap (produced in steel-product manufacturing plants), and 25% home scrap (recirculating scrap from current operations).

Import Sources (2000-03): Canada, 62%; United Kingdom, 20%; Sweden, 7%; Russia, 3%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 third quarter of 2003 displayed near-record levels of real economic growth, about 8% annualized. Growth continued with strength through 2004. U.S. apparent steel consumption, an indicator of economic growth, remained at about 107 million tons from 2001 through 2003, the lowest amount since 1995, from a peak of 120 million tons in 2000. However, it rose to an estimated 125 million tons in 2004. Scrap prices increased steadily through 2003 and the first quarter of 2004, but moderated in the second and third quarters. Hot-rolled steel prices and the producer price index for steelmill products rose during 2003 and the first three quarters of 2004. Steelmill capacity utilization also increased steadily during 2003 and through 2004 to a peak of 97.3% in September 2004. This record performance supported forecasts of a steadily improving domestic economic recovery.

Ferrous scrap prices were significantly higher, on average, during 2004 than in 2003. 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 $219 per metric ton in 2004. As reported by Iron Age Scrap Price Bulletin, the average price for nickel-bearing stainless steel scrap delivered to purchasers in Pittsburgh was about $1,450 per ton in 2004, which was significantly higher than the 2003 average price of $881 per ton. Exports of ferrous scrap increased from 11 million tons during 2003 to about 12 million tons in 2004. Export scrap value increased from $2.0 billion in 2003 to an estimated $2.8 billion in 2004.

In the United States, the primary source of old steel scrap is the automobile. The recycling rate for automobiles in 2003, the latest year for which statistics were available, was 103%. A recycling rate greater than 100% is a result of the steel industry recycling more steel from automobiles than was used in the domestic production of new vehicles. The recycling rates for appliances and steel cans in 2003 were 90% and 60%, respectively. Recycling rates for construction materials in 2003 were about 96% for plates and beams and 60% 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 2.1 million tons of direct-reduced iron was used in the United States in 2004 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 million metric tons unless otherwise noted)

Domestic Production and Use: Ferrous slags are valuable coproducts of ironmaking and steelmaking. In 2004, about 20 million tons of domestic iron and steel slag, valued at about $310 million[1] (f.o.b.), was consumed. Iron or blast furnace slag accounted for about 60% of the tonnage sold and was worth about $270 million; about 80% of this was granulated slag. Steel slag, produced from basic oxygen and electric arc furnaces[2] accounted for the remainder. There were 25 slag-processing companies servicing iron and/or steel companies or reprocessing old slag piles at about 130 locations: iron slag at about 40 sites in 15 States and steel slag at about 90 sites in 32 States. Included in these data are 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 $63 for some GGBFS. The major uses of air-cooled iron slag and for steel slag were as aggregates for asphaltic paving, fill, and road bases, and as a feed for cement kilns. Air-cooled slag also is used as an aggregate for concrete. In contrast, GGBFS is mainly used as a partial substitute for portland cement in concrete mixes and in blended cements. Owing to their low unit values, most slag types are shipped by truck over short distances only (rail and waterborne transportation can be longer). Because it has a much higher unit value, GGBFS can be shipped over longer distances.

Salient Statistics—United States:	**2000**	**2001**	**2002[3]**	**2003[3]**	**2004[e, 3]**
Production, marketed[1, 4]	16.3	16.9	19.1	19.7	20.0
Imports for consumption	1.2	2.6	1.1	1.1	1.0
Exports	0.02	([5])	0.1	0.1	0.1
Consumption, apparent[6]	20.2	19.5	19.1	19.7	19.9
Price average value, dollars per ton, f.o.b. plant	8.60	8.05	[7]15.50	[7]15.00	[7]15.75
Stocks, yearend	NA	NA	NA	NA	NA
Employment, number[e]	2,750	2,700	2,700	2,700	2,700
Net import reliance[8] as a percentage of apparent consumption	10	8	5	5	5

Recycling: Ferrous slags are useful byproducts of ironmaking and steelmaking. Apart from the large outside markets for slag in the construction sector, some iron and steel slags are returned to the furnaces as ferrous and flux feed. Entrained metal, particularly in steel slag, is routinely recovered during slag processing for return to the furnaces. However, data for such furnace-feed uses are unavailable.

Import Sources (2000-03): Year-to-year import data for ferrous slags show variations in both tonnage and unit value; many past data contain discrepancies. Most of the imported material is unground granulated blast furnace slag. Principal suppliers in recent years have been Brazil, Canada, France, Italy, Japan, South Africa, and Spain. Principal sources, for 2002-03 only, were Canada, 38%, France, 26%; Italy, 24%; Japan, 5%; and other, 7%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-04**
Granulated slag	2618.00.0000	Free.
Basic slag	3103.20.0000	Free.
Slag, dross, scale, from manufacture of iron and steel	2619.00.3000	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

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

IRON AND STEEL SLAG

Events, Trends, and Issues: 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, but slag from electric arc furnaces (largely fed with steel scrap) 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. One new import-based grinding plant for GGBFS came online in 2004. Sales in 2004 of GGBFS were almost 20% of the total slag market by weight and more than 70% of its total value. Additional pelletizers were installed at one integrated iron and steel complex in 2003. Pelletized slag largely feeds the lightweight aggregates market. Overall, most of the demand for slag is in large-scale (mostly public-sector) construction projects and fluctuates with levels of construction spending.

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 natural (rock) raw materials.

[e]Estimated. NA Not available.
[1]The data (obtained from an annual survey of slag processors) pertain to the quantities of processed slag sold rather than that processed or produced during the year. The data exclude any entrained metal that may be recovered during slag processing and returned to iron and, especially, steel furnaces. Data for such recovered metal were unavailable.
[2]There were very minor sales of open hearth furnace steel slag from stockpiles but no domestic production of this slag type in 2004.
[3]Owing to inclusion of more complete information (especially for granulated slag), data in 2002-04 are not strictly comparable to those of recent previous years.
[4]The data include (2000-04) sales of imported granulated blast furnace slag, either after domestic grinding or still unground, and exclude (2003-04) sales of pelletized slag (proprietary but very small). Overall, blast furnace slag production may be estimated as equivalent to 25% to 30% of crude (pig) iron production and steel furnace slag at about 10% to 15% of crude steel output.
[5]Less than ½ unit.
[6]Defined, for 2000-01, as production (sales) + imports – exports and, for 2002-04, as total sales of slag (includes that from imported feed) – exports. Calculation is based on unrounded original data.
[7]The higher price in 2002-04 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 2000-01 and, for 2002-04, as total sales of imported slag – exports of slag. Data are not available to allow adjustments for changes in stocks.

KYANITE AND RELATED MINERALS

(Data in thousand metric tons unless otherwise noted)

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

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production:					
Mine[e]	90	90	90	90	90
Synthetic mullite[e]	40	40	40	40	40
Imports for consumption (andalusite)	6	3	5	4	5
Exports[e]	35	35	35	35	35
Shipments from Government stockpile excesses	—	—	—	—	0.1
Consumption, apparent[e]	101	100	100	99	100
Price, average, dollars per metric ton:					
U.S. kyanite, raw	165	165	165	165	165
U.S. kyanite, calcined	279	279	279	279	279
Andalusite, Transvaal, South Africa	175	186	191	220	238
Stocks, producer	NA	NA	NA	NA	NA
Employment, kyanite mine and plant, number[e]	150	150	150	150	150
Net import reliance[1] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2000-03): South Africa, 100%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Andalusite, kyanite, and sillimanite	2508.50.0000	Free.
Mullite	2508.60.0000	Free.

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

Government Stockpile:

Stockpile Status—9-30-04[2]
(Metric tons)

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Kyanite, lump	1	—	1	50	139

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

KYANITE AND RELATED MINERALS

Events, Trends, and Issues: A new andalusite source in western China came onstream in March 2004. Xinjiang Bazhou Yilong Andalusite Mineral Co. commissioned its 50,000-ton-per-year andalusite plant in Xinjiang Province. Pilot plant production of andalusite at the facility had reached 10,000 tons per year in 2002. Besides export markets, the andalusite will supply the domestic refractories market, which is currently being driven by increasing steel and nonferrous metal production in China.[3]

The leading consumer of refractories has been the steel industry. According to the American Iron and Steel Institute, U.S. steel shipments for the first 7 months of 2004 were about 10% higher than in the same period in 2003. According to the International Iron and Steel Institute, world crude steel production was about 8% higher in the first 8 months of 2004 than in the first 8 months of 2003. However, according to an industry analyst, the refractories industry continued to face a number of issues and concerns, including consolidation and downsizing; government regulations on the environment, health, and safety; intense global and local competition; and resistance to refractory price increases from buyers of refractories.[4]

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	2003	2004[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	21	
South Africa	220	250	
Zimbabwe	4	—	
Other countries	8	5	
World total (rounded)	410	430	

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

[2]See Appendix B for definitions.

[3]Industrial Minerals, 2004, New andalusite source in Xinjiang: Industrial Minerals, no. 439, April, p. 17.

[4]Industrial Minerals, 2004, Refractory industry still in transition: Industrial Minerals, no. 440, May, p. 23-24.

[5]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 2004, based on the average U.S. producer price, was $500 million. Five lead mines in Missouri plus lead-producing mines in Alaska, Idaho, Montana, and Washington yielded most of the total. Primary lead was processed at one smelter-refinery in Missouri. Of the 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. The lead-acid battery industry continued to be the principal user of lead, accounting for 83% of the reported U.S. lead consumption for 2004. Lead-acid batteries were primarily used as starting-lighting-ignition (SLI) batteries for automobiles and trucks. Lead-acid batteries were also used as industrial-type batteries for uninterruptible power-supply equipment for computer and telecommunications networks and hospitals; for load-leveling equipment for commercial electrical power system; and as traction batteries used in airline ground equipment, industrial forklifts, mining vehicles, golf carts, etc. About 11% of lead was used in ammunition; casting material; sheets (including radiation shielding), pipes, traps and extruded products; cable covering, calking lead, and building construction; solder; and oxides for glass, ceramics, pigments, and chemicals. The balance was used in ballast and counter weights, brass and bronze, foil, terne metal, type metal, wire, and other undistributed consumption.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production:					
Mine, lead in concentrates	465	466	451	460	440
Primary refinery	341	290	262	245	W
Secondary refinery, old scrap	1,080	1,040	1,070	1,110	1,170
Imports for consumption, lead in concentrates	31	2	([1])	—	—
Exports, lead in concentrates	117	181	241	253	275
Imports for consumption, refined metal, wrought and unwrought	366	284	218	183	190
Exports, refined metal, wrought and unwrought	49	35	43	123	92
Shipments from Government stockpile excesses, metal	32	41	6	60	44
Consumption:					
Reported	1,720	1,550	1,440	1,390	1,420
Apparent[2]	1,780	1,640	1,450	1,440	1,520
Price, average, cents per pound:					
North American Producer	43.6	43.6	43.6	43.8	53
London Metal Exchange	20.6	21.6	20.5	23.3	39
Stocks, metal, producers, consumers, yearend	124	100	111	107	60
Employment:					
Mine and mill (peak), number[3]	1,100	1,100	930	830	880
Primary smelter, refineries	450	400	320	320	240
Secondary smelters, refineries	1,700	1,600	1,600	1,600	1,600
Net import reliance[4] as a percentage of apparent consumption	13	8	E	E	E

Recycling: About 1.19 million tons of secondary lead was produced, an amount equivalent to 84% of reported domestic lead consumption. Nearly all of it was recovered from old (post-consumer) scrap. About 1.14 million tons (equivalent to 80% of reported domestic lead consumption) was recovered from used batteries alone.

Import Sources (2000-03): Metal, wrought and unwrought: Canada, 70%; China, 16%; Australia, 5%; Mexico, 4%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations[5] 12-31-04
Unwrought (refined)	7801.10.0000	2.5% ad val.

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

Government Stockpile:

Stockpile Status—9-30-04[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Lead	51	16	51	54	56

Prepared by **Peter N. Gabby [(703) 648-4957, pgabby@usgs.gov, fax: (703) 648-7757]**

LEAD

Events, Trends, and Issues: During 2004, the price of refined lead increased in the U.S. and world markets. The average North American Producer and London Metal Exchange prices for the first 8 months of the year were 52.58 cents per pound and 38.70 cents per pound, respectively. These averages represent a 20% and a 66% increase, respectively, from the annual average prices for 2003. Estimated world use of lead rose by between 2% and 3% in 2004. The main driver behind this world growth, as it had been for several years, was higher use in China for vehicle fleet expansion, production of automotive batteries for export, and investment in the telecommunications and information technology. European lead use increased by a modest 1.5%. Despite a projected 6% increase in global mine production, refined lead production was nearly stagnant in 2004. According to a report issued by the International Lead and Zinc Study Group in October, the Western World experienced a significant production deficit for refined lead in 2004, and the production deficit was forecast to continue in 2005.

U.S. lead mine production in 2004 deceased by about 5% compared with production in 2003, owing to the lower lead content of ore milled at the Red Dog Mine in Alaska, and a decrease in mine production in Missouri. Production of secondary refined lead, mostly derived from spent lead-acid batteries, increased by about 3.5%, and U.S. reported consumption of lead increased by about 2%. Early in the year there was a significant increase in shipments of original equipment and replacement SLI batteries. An increase in capital spending resulted in increased demand for industrial type lead-acid batteries.

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 the Battery Council International (BCI) in July 2003. The lead recycling rate ranked higher than that of any other recyclable material. The BCI report tracked lead recycling from spent SLI 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[7]	Reserve base[7]
	2003	2004[e]		
United States	460	440	8,100	20,000
Australia	694	680	15,000	28,000
Canada	150	80	2,000	9,000
China	660	950	11,000	36,000
Kazakhstan	40	44	5,000	7,000
Mexico	140	150	1,500	2,000
Morocco	38	41	500	1,000
Peru	308	300	3,500	4,000
South Africa	40	36	400	700
Sweden	50	61	500	1,000
Other countries	370	370	19,000	30,000
World total (rounded)	2,950	3,150	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 Australia, Canada, China, Ireland, Mexico, Peru, Portugal, and the United States (Alaska). Identified lead resources of the world total more than 1.5 billion tons.

Substitutes: Substitution of plastics has reduced the use of lead in building construction, electrical cable covering, cans, and containers. Aluminum, iron, plastics, and tin compete with lead in other packaging and protective coatings, and tin has replaced lead in solder for new or replacement potable water systems in the United States.

[e]Estimated. E Net exporter. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Less than ½ unit.
[2]Apparent consumption series revised to reflect a total raw material balance. Apparent consumption defined as mine production + secondary refined + imports (concentrates and refined) – exports (concentrates and refined) + adjustments for Government and industry stock changes.
[3]Includes only mines for which lead was the primary product.
[4]Defined as imports – exports + adjustments for Government and industry stock changes. Series revised to include trade in both concentrates and refined lead.
[5]No tariff for Mexico and Canada for item shown.
[6]See Appendix B for definitions.
[7]See Appendix C for definitions.

LIME[1]

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

Domestic Production and Use: In 2004, 20.4 million metric tons (22.5 million short tons) of quicklime and hydrate was produced (excluding commercial hydrators) in 34 States and Puerto Rico. This was an increase of about 1.2 million metric tons compared with that of 2003. Production was valued at about $1.4 billion, an increase of nearly $150 million from 2003 levels. Five companies accounted for more than 70% of the total output. Principal producing States, each with production of more than 1 million tons, were Alabama, Kentucky, Missouri, Nevada, Ohio, Pennsylvania, and Texas. These seven States produced about 13.3 million tons (14.7 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:	2000	2001	2002	2003	2004[e]
Production[3]	19,600	18,900	17,900	19,200	20,400
Imports for consumption	113	115	157	202	211
Exports	73	96	106	98	86
Consumption, apparent	19,600	19,000	17,900	19,300	20,500
Quicklime average value, dollars per ton at plant	57.50	58.10	59.20	61.30	65.00
Hydrate average value, dollars per ton at plant	85.00	80.70	88.50	84.80	90.00
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and plant, number	5,600	5,500	5,400	5,350	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 (2000-03): Canada, 78%; Mexico, 21%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: In 2003, the National Lime Association (NLA) signed an agreement with the U.S. Department of Energy to reduce voluntarily carbon dioxide emissions intensity by 8% between 2002 and 2012. It was understood that the lime industry cannot reduce emissions from the calcination of limestone, so the agreement focused on achieving energy-related reductions in emissions intensity. In response to this agreement, in 2004, NLA members held discussions on a broad array of methods to reduce emissions of carbon dioxide from lime plants, including developing better energy management programs, examining fuel options, and enhancing the efficiency of various operations and equipment, including blasting, fuel grinding, motor/drive use, scrubbers and/or baghouses, and kilns. Presentations also were made to address other methods of reducing emissions (or emissions intensity), such as cogeneration of electrical power, underground injection of carbon dioxide, and collaboration with customers (such as steelmakers) to allow for the sale of lime products that can be manufactured more efficiently.[6, 7]

World Lime Production and Limestone Reserves and Reserve Base:

	Production		Reserves and reserve base[8]
	2003	2004[e]	
United States	19,200	20,400	Adequate for all countries listed.
Austria	2,000	2,000	
Brazil	6,500	6,500	
Canada	2,200	2,250	
China	23,000	23,500	
France	2,500	2,500	
Germany	7,000	6,500	
Iran	2,200	2,000	
Italy[9]	3,000	3,000	
Japan (quicklime only)	7,500	7,400	
Mexico	6,500	6,500	
Poland	1,900	2,000	
Russia	8,000	8,000	
South Africa (sales)	1,600	1,900	
United Kingdom	2,000	2,000	
Other countries	24,900	25,000	
World total (rounded)	120,000	121,000	

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]National Lime Association, 2003, Lime industry commits to 8% reduction in energy-related CO_2 emissions intensity: Limeitems, v. 68, no. 6, May-June, p. 2.
[7]National Lime Association, 2004, Reducing carbon dioxide—Efficiency and beyond: Limelites, v. 71, no. 1, July-September, p. 2.
[8]See Appendix C for definitions.
[9]Includes hydraulic lime.

LITHIUM

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

Domestic Production and Use: Chile was the leading lithium chemical producer in the world; Argentina, China, Russia, and the United States also were major producers. Australia, Canada, and Zimbabwe were major producers of lithium ore concentrates. The United States remained the leading consumer of lithium minerals and compounds and the leading producer of value-added lithium materials. Because only one company produced lithium compounds from domestic resources, reported production and value of production data cannot be published. Estimation of value for the lithium mineral compounds produced in the United States is extremely difficult because of the large number of compounds used in a wide variety of end uses and the great variability of the prices for the different compounds.

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, primary and secondary (rechargeable) batteries, and in the production of synthetic rubber.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production	W	W	W	W	W
Imports for consumption	2,880	1,990	1,920	2,200	2,400
Exports	1,310	1,480	1,620	1,520	1,600
Consumption:					
Apparent	W	W	W	W	W
Estimated	2,800	1,400	1,100	1,400	1,500
Price, yearend, dollars per kilogram:					
Lithium carbonate	4.47	NA	NA	NA	NA
Lithium hydroxide, monohydrate	5.74	NA	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 (2000-03): Chile, 83%; Argentina, 12%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Other alkali metals	2805.19.9000	5.5% ad val.
Lithium oxide and hydroxide	2825.20.0000	3.7% ad val.
Lithium carbonate:		
U.S.P. grade	2836.91.0010	3.7% ad val.
Other	2836.91.0050	3.7% ad val.

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

Government Stockpile: None.

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

LITHIUM

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

Two companies produced a large array of downstream lithium compounds in the United States from domestic or South American lithium carbonate. A U.S. recycling company produced a small quantity of lithium carbonate from solutions recovered during the recycling of lithium batteries.

The market for lithium compounds with the largest potential for growth is batteries, especially rechargeable batteries. Rechargeable lithium batteries were growing in popularity for powering video cameras, portable computers and telephones, and cordless tools. Interest in lithium batteries for hybrid electric vehicles, vehicles with an internal combustion engine and a battery-powered electric motor, continued. Commercially available hybrid vehicles do not use lithium batteries, although future models may. Nonrechargeable lithium batteries were used in calculators, cameras, computers, electronic games, watches, and other devices.

<u>World Mine Production, Reserves, and Reserve Base</u>:

	Mine production		Reserves[2]	Reserve base[2]
	2003	2004[e]		
United States	W	W	38,000	410,000
Argentina[e]	960	1,300	NA	NA
Australia[e]	3,450	3,450	160,000	260,000
Bolivia	—	—	—	5,400,000
Brazil	240	240	190,000	910,000
Canada	710	700	180,000	360,000
Chile	6,580	6,600	3,000,000	3,000,000
China	2,500	2,700	540,000	1,100,000
Portugal	190	190	NA	NA
Zimbabwe	480	360	23,000	27,000
World total (rounded)	[3]15,100	[3]15,500	[4]4,100,000	[4]11,000,000

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

<u>Substitutes</u>: 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 51% of U.S. magnesium compounds production in 2004. Magnesium oxide and other compounds were recovered from seawater by two companies in Delaware and Florida, from well brines by two companies in Michigan, and from lake brines by two companies in Utah. Magnesite was mined by one company in Nevada, brucite was mined by one company in Nevada and one company in Texas, and olivine was mined by two companies in North Carolina and Washington. About 56% of the magnesium compounds consumed in the United States was used for refractories. The remaining 44% was used in agricultural, chemical, construction, environmental, and industrial applications.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production	370	388	312	329	280
Imports for consumption	395	307	337	332	310
Exports	56	62	66	53	50
Consumption, apparent	709	634	583	608	540
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant, number[e]	450	450	450	370	370
Net import reliance[2] as a percentage of apparent consumption	48	39	46	46	48

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

Import Sources (2000-03): China, 68%; Australia, 9%; Canada, 9%; Austria, 2%; and other, 12%.

Tariff:[3] Item	Number	Normal Trade Relations 12-31-04
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: The leading magnesia producer in the United States announced that it would increase capacity at its Manistee, MI, plant for high-surface-area magnesia that is used as a scorch retarder in the rubber and plastics industries. The company developed a lower cost production method for this magnesia, which has resulted in increased sales. The production capacity increase was estimated to be about 1,100 tons per year.

A new magnesia plant opened in Jordan that recovers magnesia from the Dead Sea. The plant's principal product is dead-burned magnesia, with a 50,000-ton-per-year capacity, and it has additional capacity to produce 10,000 tons per year of caustic-calcined magnesia and magnesium hydroxide.

After a failed attempt to build a magnesium metal plant, the magnesia producer in Rockhampton, Queensland, Australia, announced that it would sell its magnesia business to a consortium of two firms—one based in Australia, and the other, in the United States. The plant has the capacity to produce 65,000 tons per year of caustic-calcined magnesia, 110,000 tons per year of dead-burned magnesia, and 25,000 tons per year of fused magnesia.

World Mine Production, Reserves, and Reserve Base:

	Magnesite production		Magnesite reserves and reserve base[4]	
	2003	2004[e]	Reserves	Reserve base
United States	W	W	10,000	15,000
Australia	136	136	100,000	120,000
Austria	202	200	15,000	20,000
Brazil	78	80	45,000	65,000
China	1,070	1,100	380,000	860,000
Greece	144	150	30,000	30,000
India	110	110	14,000	55,000
Korea, North	288	300	450,000	750,000
Russia	346	350	650,000	730,000
Slovakia	274	250	45,000	324,000
Spain	72	80	10,000	30,000
Turkey	576	600	65,000	160,000
Other countries	163	170	390,000	440,000
World total (rounded)	[5]3,460	[5]3,500	2,200,000	3,600,000

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

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

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

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

MAGNESIUM METAL[1]

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2004, magnesium was produced by one company in Utah by an electrolytic process that recovered magnesium from brines from the Great Salt Lake. The leading use for magnesium, which accounted for 43% 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 38% of domestic metal use. Desulfurization of iron and steel accounted for 16% of U.S. consumption of primary metal, and other uses were 3%.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production:					
Primary	W	W	W	W	W
Secondary (new and old scrap)	82	66	74	70	70
Imports for consumption	91	69	88	83	90
Exports	24	20	25	20	15
Consumption:					
Reported, primary	104	96	102	102	100
Apparent[2]	160	120	110	120	110
Price, yearend:					
Metals Week, U.S. spot Western, dollars per pound, average	1.27	1.25	1.16	1.14	1.75
Metal Bulletin, European free market, dollars per metric ton, average	2,000	1,825	1,930	1,900	2,000
Stocks, producer and consumer, yearend	W	W	W	W	W
Employment, number[e]	700	400	400	400	400
Net import reliance[3] as a percentage of apparent consumption	43	44	55	53	68

Recycling: In 2004, about 25,000 tons of the secondary production was recovered from old scrap.

Import Sources (2000-03): Canada, 43%; Russia, 19%; China, 17%; Israel, 9%; and other, 12%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: On February 27, the U.S. magnesium producer filed a petition with the U.S. International Trade Commission (ITC) claiming that imports of alloy magnesium from China and pure and alloy magnesium from Russia were harming the U.S. industry. After a hearing on March 19, the U.S. Department of Commerce, International Trade Administration (ITA) began an investigation into the claims. Although some magnesium from China was already subject to antidumping duties, this investigation included material not included in the first sets of antidumping duties. In 1995, the ITC had determined that imports of pure magnesium from China were injuring the U.S. magnesium industry, and set a duty rate of 108.26% ad valorem for pure magnesium, but no duty was established for alloy magnesium. After a new investigation begun in 2000, the ITC established a duty of 305.56% ad valorem as the China-wide rate (with one exception for a specific company) for granular magnesium, which was not covered by the 1995 determination. In both instances, magnesium from Russia had been investigated along with magnesium from China, but it was determined that imports of pure, alloy, and granular magnesium from Russia did not injure the U.S. industry, so no duty rates were established. In the new investigation, primary and secondary magnesium alloy, which would be classified under Harmonized Tariff Schedule (HTS) numbers 8104.19.00 and 8104.30.00 are the principal materials from China that are under investigation. For Russia, the investigation includes magnesium classified under HTS numbers 8104.11.00, 8104.19.00, 8104.30.00, and 8104.90.00. In September, the ITA announced preliminary antidumping duties for magnesium imports from China and Russia. It established a China-wide rate of 177.62% ad valorem, with slightly lower rates for three specific companies, and 10.62% ad valorem and 21.49% ad valorem for the two principal Russian magnesium producers. Final determinations were due in the first quarter of 2005.

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

MAGNESIUM METAL

In October, the U.S. magnesium producer announced that it would begin construction of a third set of electrolytic cells that would increase its capacity to 51,000 tons per year from the current level of 45,000 tons per year. The company would start bringing the new cells online in June 2005 and reach full capacity in 2006. The company planned an additional expansion to 73,000 tons per year if market conditions warrant.

Prices rose significantly in the first half of 2004. Increased costs for ferrosilicon and freight in China combined with electricity shortages drove prices up. By the end of May, the magnesium price in China had reached $2,300 per metric ton, its highest level ever since this price was first reported in 1999. As ferrosilicon prices began to fall, magnesium metal prices in China fell as well. European magnesium prices fell slightly in the third quarter, and U.S. and Chinese magnesium prices increased. Several factors contributed to the increase in U.S. prices: large aluminum producers began negotiating contracts for their 2005 magnesium needs, anticipation of a decision in the antidumping duty case on imports of magnesium from China and Russia, and the absence of low-cost Chinese magnesium in the U.S. market. Magnesium from China was sold mostly in Europe in the third quarter, and as a result, prices in Europe declined slightly.

Although construction of the proposed Queensland, Australia, magnesium plant was abandoned because of financial difficulties, some other proposed magnesium plants continued to move forward. In Australia, the proposed 100,000-ton-per-year magnesium-from-fly-ash plant was expected to be constructed within 5 years in Victoria, using Russian magnesium extraction technology, if funding is secured. Another Australian firm is investigating three sites—one each in Egypt, Qatar, and the United Arab Emirates—for a proposed 84,000-ton-per-year magnesium plant. In Congo (Brazzaville), development of a proposed 60,000-ton-per-year magnesium extraction plant continued; the plant was scheduled for completion in 2007. China continued to increase ingot and alloy production capacities at many of its plants.

World Primary Production, Reserves, and Reserve Base:

	Primary production	
	2003	2004[e]
United States	W	W
Brazil	6	6
Canada	60	60
China	340	400
Israel	34	34
Kazakhstan	14	16
Russia	52	55
Serbia and Montenegro	2	2
World total[5] (rounded)	508	570

Reserves and reserve base[4]

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

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

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

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]See also Magnesium Compounds.
[2]Rounded to two significant digits to protect proprietary data.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions.
[5]Excludes the United States.

MANGANESE

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

Domestic Production and Use: Manganese ore containing 35% or more manganese was not produced domestically in 2004. 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. 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, although one closed in January. Leading identifiable end uses of manganese were in products for construction, machinery, and transportation, which were estimated to be 33%, 11%, and 13%, 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 $1.29 billion.

Salient Statistics—United States:[1]	2000	2001	2002	2003	2004[e]
Production, mine[2]	—	—	—	—	—
Imports for consumption:					
Manganese ore	447	358	427	347	450
Ferromanganese	312	251	275	238	342
Silicomanganese[3]	378	269	247	267	360
Exports:					
Manganese ore	10	9	15	18	97
Ferromanganese	8	9	9	11	7
Shipments from Government stockpile excesses:[4]					
Manganese ore	63	37	56	74	231
Ferromanganese	33	2	38	38	215
Consumption, reported:[5]					
Manganese ore[6]	486	425	360	398	420
Ferromanganese	300	266	253	248	270
Consumption, apparent, manganese[7]	768	692	696	618	925
Price, average value, 46% to 48% Mn metallurgical ore, dollars per mtu cont. Mn, c.i.f. U.S. ports	2.39	2.44	2.30	2.41	2.79
Stocks, producer and consumer, yearend:					
Manganese ore[6]	226	138	151	156	158
Ferromanganese	31	25	21	20	22
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 (2000-03): Manganese ore: Gabon, 73%; South Africa, 13%; Australia, 8%; Brazil, 3%; and other, 3%. Ferromanganese: South Africa, 51%; France, 16%; Brazil, 7%; Australia, 6%; and other, 20%. Manganese contained in all manganese imports: South Africa, 36%; Gabon, 21%; Australia, 12%; France, 7%; and other, 24%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: 23% (Domestic), 15% (Foreign).

Government Stockpile: In addition to the quantities shown below, the stockpile contained 258,000 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—9-30-04[9]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Battery:					
Natural ore	22	5	22	27	27
Synthetic dioxide	3	—	3	3	—
Chemical ore	68	4	68	36	41
Metallurgical ore	368	101	625	227	244
Ferromanganese, high-carbon	680	—	680	45	51
Electrolytic metal	—	—	—	2	0.5

Events, Trends, and Issues: While the annual growth rate for manganese ferroalloy demand usually falls in the range of 1% to 2% and is tied to steel production, apparent consumption in 2004 was estimated to be about 50% higher than that of 2003, and reached the highest level since 1981. Through the first 9 months of 2004, domestic steel production was 8% higher than that for the same period in 2003. Rising crude steel production in response to economic growth in North America coupled with supply deficits contributed to the unprecedented increase in manganese alloy spot-market prices in late 2003 through September 2004. Prices for high- and medium-carbon ferromanganese and silicomanganese in the United States reached their highest levels in history during the first half of 2004. As a result of the record ferromanganese prices, some steel companies began to place manganese surcharges on their products. Domestic manganese ore prices followed the increase in the international benchmark price for metallurgical-grade ore set between Japan and major suppliers in early 2004.

World Mine Production, Reserves, and Reserve Base (metal content): Data for reserves and reserve base have been revised upward from those previously published for India based on information reported by the Government of India; reserves are based on estimates of proven and probable reserves.

	Mine production 2003	Mine production 2004[e]	Reserves[10]	Reserve base[10]
United States	—	—	—	—
Australia	1,200	3,300	32,000	82,000
Brazil	[e]990	1,000	23,000	51,000
China	[e]800	800	40,000	100,000
Gabon	[e]870	1,300	20,000	160,000
India	[e]620	600	93,000	[11]160,000
Mexico	110	120	4,000	9,000
South Africa	1,600	1,800	32,000	[11]4,000,000
Ukraine	880	880	140,000	520,000
Other countries	1,100	1,300	Small	Small
World total (rounded)	[e]8,200	11,000	380,000	5,100,000

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 about 80% of the world's identified resources, and Ukraine accounts for 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 metric tons, manganese content; based on estimates of average content for all significant components except imports, for which content is reported.
[8]Defined as imports – exports + adjustments for Government and industry stock changes.
[9]See Appendix B for definitions.
[10]See Appendix C for definitions.
[11]Includes inferred resources.

MERCURY

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

Domestic Production and Use: Mercury has not been mined as a primary mineral commodity in the United States since 1992. Byproduct mercury was recovered from gold ore and as calomel from scrubbers at gold smelters, but production data were not reported. Secondary mercury, which has been the principal domestic source of mercury, is recycled from automobile convenience switches, dental amalgam, mercury vapor and fluorescent lamps, and medical equipment; that secondary reservoir, however, is shrinking. Mercury is also used in, and may be recycled from, barometers, computers, gym flooring, manometers, thermometers, and thermostats. Mercury use is declining owing to environmental and human health considerations, and non-mercury-bearing products may be substituted for these devices. The chlorine-caustic soda industry is the leading end user of mercury as an electrolyte to separate chlorine from caustic soda. The mercury is recycled in-plant, but some mercury is lost during the chlorine-caustic soda production process, and replacement mercury is purchased. Mercury use in batteries and paints has been discontinued in the United States. Globally, mercury may also be used in artisanal gold mining, button-type batteries, cleansers, folk medicine, pesticides, and skin-lightening cream and soap.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production:					
Mine	NA	NA	NA	NA	NA
Secondary, industrial	NA	NA	NA	NA	NA
Imports for consumption (gross weight)	103	100	209	46	50
Exports (gross weight)	182	108	201	287	300
Price, average value, dollars per flask, free market	155.00	155.00	155.00	170.00	350.00
Net import reliance[2] as a percentage of apparent consumption[e]	E	E	NA	E	E

Recycling: Recycling from secondary sources (old scrap), as described above, was the principal source of domestic mercury production in 2004. The approximately 3,000 tons of mercury on hand in the chlorine-caustic soda industry are recycled in-plant (home scrap).

Import Sources (2000-03): Australia, 29%; Chile, 25%; Germany, 18%; Peru, 13%; and other, 15%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 prepared a Mercury Management Environmental Impact Statement in 2004 to determine how to manage its elemental mercury inventory. Consolidated storage is the preferred alternative for storage of this inventory. Sales from the National Defense Stockpile remained suspended.

Stockpile Status—9-30-04[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Mercury	4,436	—	4,436	—	—

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

MERCURY

Events, Trends, and Issues: The secondary supply of mercury is in decline owing to declining use of mercury in many products. This is partially offset by increased recycling of existing mercury-bearing products and various wastes to avoid deposition in landfills. The rise in price for a flask of mercury during the past year was caused by a steadily diminishing supply of mercury products that may be recycled, combined with higher gold prices and the consequent increase in demand for mercury use in artisanal gold mining. Federal, State, and local governments are concerned about the toxic effects of mercury. Therefore, legislation such as the Resource Conservation and Recovery Act and the Comprehensive Environmental Response, Compensation, and Liability Act mandate regulation of generation, treatment, and disposal of products that contain mercury. Environmental standards and regulations are likely to continue as major factors in domestic mercury supply and demand. Domestic production is expected to remain limited mainly to byproduct production from gold processing where the mercury is recovered to avoid releases to the environment. Domestic mercury consumption will continue to decline as mercury-containing products are phased out and non-mercury-containing products are substituted.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2003	2004[e]		
United States	NA	NA	—	7,000
Algeria	300	400	2,000	3,000
China	610	650	—	—
Italy	—	—	—	69,000
Kyrgyzstan	300	300	7,500	13,000
Spain	150	200	76,000	90,000
Other countries	170	200	38,000	61,000
World total (rounded)	1,530	1,750	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 to be nearly 600,000 tons, principally in China, 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, lead, and zinc mines worldwide; there are, however, no data on the amount of mercury produced.

Substitutes: Diaphragm and membrane cells are increasingly replacing 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. E Net exporter. NA Not available. — Zero.
[1]Some international data and dealer prices are reported in flasks. One metric ton (1,000 kilograms) = 29.0082 flasks, and 1 flask = 76 pounds, or 34.5 kilograms, or 0.034 ton.
[2]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 76,000 tons in 2004. North Carolina accounted for about 54% 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 2004 scrap mica production was estimated to be $19 million. Ground mica sales in 2003 were valued at about $30 million. There were nine domestic producers of scrap and flake mica.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production:[2, 3]					
Mine	101	98	81	79	76
Ground	112	89	98	94	90
Imports, mica powder and mica waste	29	32	38	35	50
Exports, mica powder and mica waste	10	9	10	10	10
Consumption, apparent[4]	119	121	106	103	117
Price, average, dollars per ton, reported:					
Scrap and flake	136	82	90	213	245
Ground:					
Wet	751	771	960	938	1,080
Dry	169	147	180	205	236
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine, number[5]	NA	NA	NA	NA	NA
Net import reliance[6] as a percentage of apparent consumption	15	19	24	24	35

Recycling: None.

Import Sources (2000-03): Canada, 55%; India, 23%; China, 12%; Finland, 4%; and other, 6%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Mica powder	2525.20.0000	Free.
Mica waste	2525.30.0000	Free.

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

Government Stockpile: None.

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

MICA (NATURAL), SCRAP AND FLAKE

Events, Trends, and Issues: Domestic production of ground mica decreased in 2004. The decrease primarily resulted from lower production in Georgia and New Mexico. Production in North Carolina in 2004 was estimated to be slightly higher than that of 2003. Canada remained the main source of imported phlogopite mica for the United States. 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]
	2003	2004[e]		
United States[2]	79	76	Large	Large
Brazil	5	5	Large	Large
Canada	18	18	Large	Large
France	10	10	Large	Large
India	2	2	Large	Large
Korea, Republic of	40	50	Large	Large
Russia	100	100	Large	Large
Other countries	31	35	Large	Large
World total (rounded)	290	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 2004, 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 2004, an estimated 150 tons of unworked mica split block and mica splittings valued at $153,000 was consumed by five companies in four States, mainly in the East and the Midwest. Most was fabricated into parts for electronic and electrical equipment. An additional estimated 1,360 tons of imported worked mica valued at $13.6 million also was consumed.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production, mine[e]	([2])	([2])	([2])	([2])	([2])
Imports, plates, sheets, strips; worked mica; split block; splittings; other > $1.00/kg	5,430	4,290	1,580	1,140	1,570
Exports, plates, sheets, strips; worked mica; crude and rifted into sheet or splittings > $1.00/kg	1,150	1,160	723	1,030	979
Shipments from Government stockpile excesses	1,230	1,860	894	1,280	1,170
Consumption, apparent	5,500	4,990	1,750	1,390	1,760
Price, average value, dollars per kilogram, muscovite and phlogopite mica, reported:					
Block	23	55	67	67	67
Splittings	1.81	1.67	1.82	1.74	1.80
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 (2000-03): India, 65%; Belgium, 13%; China, 5%; Germany, 4%; and other, 13%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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—9-30-04[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Block:					
Muscovite (stained and better)	0.883	7.20	0.883	([5])	11.2
Film, muscovite	—	—	—	([5])	0.506
Splittings:					
Muscovite	7.13	121	7.13	([5])	1,160
Phlogopite	1.51	17	1.51	([5])	—

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 increased in 2004, following a decline in 2003. The increase in apparent consumption was primarily the result of increased imports of "plates, sheet, and strips of agglomerated or reconstituted mica" and "split block." U.S. imports of mica splittings decreased, partly because of continued shipments from the National Defense Stockpile (NDS). Stocks of phlogopite block in the NDS were depleted by year end 2003. Imports and the NDS remained principal sources 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. 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[e]		Reserves[6]	Reserve base[6]
	2003	2004		
United States	([2])	([2])	Very small	Small
India	3,500	3,500	Very large	Very large
Russia	1,500	1,500	Moderate	Large
Other countries	200	200	Moderate	Large
World total	5,200	5,200	Very large	Very large

World Resources: There has been no formal evaluation of world resources of sheet mica because of the sporadic occurrence of this material. Large deposits of mica-bearing rock are known to exist in countries such as Brazil, India, and Madagascar. Limited resources of sheet mica are available in the United States. These domestic resources are uneconomic because of the high cost of hand labor required to mine and process 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 2,268 metric tons (5,000,000 pounds).
[6]See Appendix C for definitions.

MOLYBDENUM

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

Domestic Production and Use: In 2004, molybdenum, valued at about $1.18 billion (based on average oxide price), was produced by seven mines. Molybdenum ore was produced at three primary molybdenum mines, one each in Colorado, Idaho, and New Mexico, whereas four copper mines (two in Arizona, one each in Montana and Utah) recovered molybdenum as a byproduct. Three 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:	2000	2001	2002	2003	2004[e]
Production, mine	40,900	37,600	32,300	33,600	39,900
Imports for consumption	15,000	12,800	11,500	11,900	15,900
Exports	27,900	31,500	23,800	35,700	54,100
Consumption:					
Reported	18,300	15,800	15,300	15,700	16,800
Apparent	28,600	19,600	20,700	12,800	1,700
Price, average value, dollars per kilogram[1]	5.64	5.20	8.27	11.65	29.67
Stocks, mine and plant concentrates, product, and consumer materials	11,400	10,700	10,000	6,900	6,900
Employment, mine and plant, number	618	518	489	510	568
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

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

Import Sources (2000-03): Ferromolybdenum: China, 78%; United Kingdom, 20%; and other, 2%. Molybdenum ores and concentrates: Mexico, 58%; Canada, 38%; Chile, 2%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 2004 increased about 19% from that of 2003. U.S. imports for consumption increased an estimated 34% from those of 2003, while the U.S. exports increased 51% from those of 2003. The increase in exports reflects the return to full production levels by the end of 2004 by some copper companies after reduced byproduct molybdenum production in 2003. U.S. reported consumption increased 7% from that of 2003. Mine capacity utilization was about 53%.

China continued its high level of steel production and consumption, thus providing a stable demand for molybdenum. Strong copper prices and a deficit of refined copper allowed the Bagdad and Sierrita Mines in Arizona to return to full production capacity, thus increasing byproduct molybdenum production. The Continental Pit operation in Butte, MT, resumed mining activities and was 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 2004, consumers increasingly considered use of duplex stainless steel, with higher molybdenum content.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	2003	2004[e]	(thousand metric tons)	
United States	33,600	39,900	2,700	5,400
Armenia	3,500	3,500	200	400
Canada	7,500	9,700	450	910
Chile	30,000	33,400	1,100	2,500
China	30,600	31,000	3,300	8,300
Iran	1,400	1,400	50	140
Kazakhstan	230	230	130	200
Kyrgyzstan	250	250	100	180
Mexico	3,500	3,500	90	230
Mongolia	1,600	1,700	30	50
Peru	9,600	11,000	140	230
Russia[e]	2,900	2,900	240	360
Uzbekistan[e]	500	500	60	150
World total (rounded)	125,000	139,000	8,600	19,000

World Resources: Identified resources amount to about 5.4 million tons of molybdenum in the United States and about 13 million tons in the rest of the world. Molybdenum occurs as the principal metal sulfide in large low-grade porphyry molybdenum deposits and as an associated metal sulfide in low-grade porphyry copper deposits. Resources of molybdenum are adequate to supply world needs for the foreseeable future.

Substitutes: There is little substitution for molybdenum in its major application as an alloying element in steels and cast irons. In fact, because of the availability and versatility of molybdenum, industry has sought to develop new materials that benefit from the alloying properties of the metal. Potential substitutes for molybdenum include chromium, vanadium, 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]Time-average price per kilogram of molybdenum contained in technical-grade molybdic oxide, as reported by Platts Metals Week.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions.

NICKEL

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

Domestic Production and Use: The United States did not have any active nickel mines in 2004. 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, 124 facilities reported nickel consumption. The principal consuming State was Pennsylvania, followed by Kentucky, West Virginia, and Indiana. Approximately 41% of the primary nickel consumed went into nonferrous alloy and superalloy production, 41% into stainless and alloy steels, 16% 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%; household appliances, 7%; machinery, 6%; petroleum industry, 6%; and other, 7%. Estimated value of apparent primary consumption was $1.74 billion.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production, mine	—	—	—	—	—
Shipments of purchased scrap[1]	123,000	141,000	137,000	129,000	129,000
Imports: Primary	156,000	136,000	121,000	125,000	133,000
Imports: Secondary	10,700	8,760	9,110	11,500	19,300
Exports: Primary	8,150	8,450	6,520	6,330	7,910
Exports: Secondary	49,900	48,600	39,400	47,300	48,000
Consumption: Reported, primary	115,000	98,800	87,400	86,400	92,300
Consumption: Reported, secondary	84,000	102,000	106,000	93,400	100,000
Consumption: Apparent, primary	147,000	129,000	121,000	118,000	126,000
Consumption: Total[2]	231,000	230,000	227,000	211,000	226,000
Price, average annual, London Metal Exchange:					
Cash, dollars per metric ton	8,638	5,945	6,772	9,629	13,843
Cash, dollars per pound	3.918	2.696	3.072	4.368	6.279
Stocks: Consumer, yearend	14,400	14,300	13,700	8,890	8,500
Stocks: Producer, yearend[3]	12,300	12,600	6,150	7,250	7,100
Employment, yearend, number, mine	1	—	—	—	—
Net import reliance[4] as a percentage of apparent consumption	56	46	46	48	49

Recycling: About 100,000 tons of nickel was recovered from purchased scrap in 2004. This represented about 44% of total reported secondary plus apparent primary consumption for the year.

Import Sources (2000-03): Canada, 40%; Russia, 14%; Norway, 11%; Australia, 10%; and other, 25%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 a record high of 1.56 million tons in 2004—13% more than the previous record of 1.37 million tons (revised) set in 2003. U.S. stainless producers continued to struggle against significant import penetration but were helped when demand for specialty steel began to recover in North America during the second half of 2004. World nickel mine production was at an alltime high in 2004. Since 1950, stainless steel production in the Western World has been growing at an average rate of 6.0% per year. Demand for stainless steel in China has been particularly robust since 2000 and is now on a par with that of Japan.

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

NICKEL

Nickel prices were at their highest level since 1989. For the week ending December 3, 2004, the London Metal Exchange cash price for 99.8% pure nickel averaged $13,895 per metric ton ($6.30 per pound). Twelve months earlier, the cash price was $12,578 per ton ($5.71 per pound). High prices have encouraged substitution of duplex or ferritic stainless for some applications where austenitic was being used. For example, type 201 (3.5% to 5.5% nickel) was being substituted for type 304 (8.0% to 10.5% nickel). 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 resumed construction of the Goro laterite mining complex 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 and 1999 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. At least four automobile manufacturers were using nickel-metal hydride (NiMH) batteries to power their gasoline-electric hybrid vehicles for the 2006 and 2007 model years. Demand for gasoline-electric hybrid vehicles has been gradually building up in the United States since their introduction in late 1999 and has accelerated with rising gasoline prices. Seven commercial models were being offered in North America—six of Japanese design. In November 2003, a leading NiMH battery manufacturer began producing battery modules at a new facility in Springboro, OH. Modules were being manufactured for a variety of applications in addition to the transportation market, including stationary backup or uninterruptible power supply systems for telecommunications.

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

	Mine production		Reserves[5]	Reserve base[5]
	2003	2004[e]		
United States	—	—	—	—
Australia	210,000	210,000	22,000,000	27,000,000
Botswana	32,740	37,100	490,000	920,000
Brazil	45,000	45,000	4,500,000	8,300,000
Canada	162,756	180,000	4,800,000	15,000,000
China	60,000	62,000	1,100,000	7,600,000
Colombia	70,844	72,500	830,000	1,100,000
Cuba	74,018	75,000	5,600,000	23,000,000
Dominican Republic	45,400	47,000	720,000	1,000,000
Greece	21,410	22,100	490,000	900,000
Indonesia	143,000	144,000	3,200,000	13,000,000
New Caledonia	111,895	122,000	4,400,000	12,000,000
Philippines	21,150	20,000	940,000	5,200,000
Russia	315,000	315,000	6,600,000	9,200,000
South Africa	40,842	40,700	3,700,000	12,000,000
Venezuela	20,700	22,000	560,000	630,000
Zimbabwe	9,517	9,300	15,000	260,000
Other countries	14,000	14,000	1,300,000	5,100,000
World total (rounded)	1,400,000	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 16 companies at 32 plants in 19 States in the United States during 2004. Fifty-four 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 2004, U.S. producers operated at about 72% 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]	2000	2001	2002	2003	2004[e]
Production[2]	11,800	9,120	10,100	8,770	8,900
Imports for consumption	3,880	4,550	4,670	5,720	5,800
Exports	662	647	437	400	430
Consumption, apparent	14,900	13,200	14,500	14,200	14,200
Stocks, producer, yearend[3]	1,120	916	771	167	197
Price, dollars per ton, average, f.o.b. Gulf Coast[3]	169	183	137	245	275
Employment, plant, number[e]	2,000	1,800	1,700	1,550	1,300
Net import reliance[4] as a percentage of apparent consumption	21	31	30	42	38

Recycling: None.

Import Sources (2000-03): Trinidad and Tobago, 54%; Canada, 18%; Russia, 15%; and other, 13%.

Tariff:

Item	Number	Normal Trade Relations 12-31-04
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: In August, the second largest U.S. ammonia producer agreed to acquire the assets of the sixth largest ammonia producer, who had filed for bankruptcy in 2003. The acquisition, which was expected to be completed by the first quarter of 2005, includes ammonia production facilities in Donaldsonville, LA, and Yazoo City, MS, with a total capacity of 1.5 million tons per year, and one-half ownership of a plant in Trinidad and Tobago with a total capacity of 648,000 tons per year. This acquisition will make the second largest ammonia producer the largest in the United States, with 24% of total U.S. production capacity.

Also in August, a synthesis gas conversion company, based in Denver, CO, entered into an agreement to purchase the East Dubuque, IL, nitrogen-fertilizer complex, which includes a 278,000-ton-per-year ammonia plant, for $63 million. The company intended to continue to operate the plant as a natural-gas-fed nitrogen plant while converting it to a coal-fed gasification process using Illinois coal as the feedstock. The conversion time was estimated to be about 3 years.

Researchers at Iowa State University, in conjunction with one of the U.S. ammonia producers, developed an ammonia additive to help stop the theft of anhydrous ammonia for methamphetamine production, which has become an increasingly frequent event. The product will stain anyone who comes in contact with the treated product a fluorescent pink, and the stain can be detected by ultraviolet light for up to 72 hours. Marketing of the new product, which was estimated to add $9 per ton to the price of ammonia, began in September. Researchers at Iowa State also have identified an additive that makes anhydrous ammonia ineffective for methamphetamine production, although it is not yet in commercial production.

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

NITROGEN (FIXED)—AMMONIA

Three new ammonia plants were opened in 2004—a 697,000-ton-per-year plant in Iran, a 680,000-ton-per-year plant in Qatar, and a 204,000-ton-per-year plant in Turkmenistan. In addition, several companies announced capacity increases in Bolivia, Brazil, China, Egypt, Lithuania, Russia, and Trinidad and Tobago that would add about 2.7 million tons of ammonia production capacity.

According to long-term projections by the U.S. Department of Agriculture (USDA), projected plantings for eight major field crops in the United States were expected to remain relatively stable at about 101 million hectares through the 2004-13 forecast period. Corn, soybeans, and wheat account for about 86% of this acreage. The USDA expected that corn acreage would rise gradually as increasing domestic and export demands lead to rising prices. Feed and residual use of corn is initially unchanged with fewer cattle on feed and lower pork production offsetting increases in poultry output. Feed use then rises as meat production increases. Significant growth in corn production is expected for ethanol use during the next several years as many States ban methyl tertiary butyl ether as a fuel oxygenate. U.S. corn exports are expected to rise faster than global trade, with the United States increasing its market share of exports. Because corn is the most intensive nitrogen-fertilizer-demand crop, increasing corn acreage is expected to lead to increasing nitrogen use in the United States.

According to the U.S. Department of Energy, Energy Information Administration, average natural gas spot prices were not expected to be significantly higher in 2005 than in 2004. Henry Hub prices averaged $5.80 per million cubic feet in 2003 and were expected to average $5.96 in 2004 and $6.16 in 2005.

Nitrogen compounds also are an environmental concern. Overfertilization and the subsequent runoff of excess fertilizer may contribute to nitrogen accumulation in watersheds. Nitrogen in excess fertilizer runoff is suspected to be a cause of the hypoxic zone that takes place 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 2003	Plant production 2004[e]	Reserves and reserve base[5]
United States	8,770	8,900	Available atmospheric nitrogen and sources of natural gas for production of ammonia are considered adequate for all listed countries.
Canada	3,650	3,800	
China	30,200	31,000	
Egypt	1,790	1,600	
Germany	2,800	2,700	
India	9,710	9,400	
Indonesia	4,250	3,900	
Netherlands	1,750	1,900	
Pakistan	2,360	2,400	
Poland	1,910	1,900	
Russia	9,100	9,100	
Saudi Arabia	1,740	1,750	
Trinidad and Tobago	3,570	3,800	
Ukraine	3,900	4,000	
Other countries	23,400	23,000	
World total (rounded)	109,000	109,000	

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]For 2000-03, 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 $18 million in 2004. Peat was harvested and processed by about 52 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 leading producing States, in order of quantity harvested. Reed-sedge peat accounted for approximately 86% of the total volume produced, followed by hypnum moss 6%, and humus and sphagnum moss, each with 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:	2000	2001	2002	2003	2004[e]
Production	792	736	642	634	607
Commercial sales	847	820	728	632	624
Imports for consumption	786	776	763	767	790
Exports	37	31	32	29	30
Consumption, apparent[2]	1,530	1,500	1,420	1,400	1,370
Price, average value, f.o.b. mine, dollars per ton	26.85	25.75	28.85	29.74	29.28
Stocks, producer, yearend	279	257	207	180	175
Employment, mine and plant, number[e]	800	800	750	700	700
Net import reliance[3] as a percentage of apparent consumption	48	47	55	55	56

Recycling: None.

Import Sources (2000-03): Canada, 99%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 gradually declined since 2000 owing to the closure of several large peat harvesting operations in 2001-02. Sales and use of domestic peat also have decreased in response to a reduction in the number of greenhouse and nursery crops, weaker economic conditions, lower demand for ornamental plants, and higher imports of greenhouse products. Imports of high-quality sphagnum peat from Canada increased slightly. Imported peat was used in bulk for custom soil mixes and packaged for consumer usage.

Peat is an important component of growing media and the demand for peat generally follows that of horticultural applications. In the United States, the short-term outlook is for steady to slightly lower production and sales, and imports of peat from Canada accounting for a greater percentage of domestic consumption.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base data have been revised based on information contained in the International Peat Society book on global peat resources. Estimates for countries that reported by volume or area were combined and included with “Other countries.

	Mine production		Reserves[4]	Reserve base[4]
	2003	2004[e]		
United States	634	607	100,000	100,000,000
Belarus	2,100	2,100	400,000	4,000,000
Canada	1,340	1,350	4,000,000	400,000,000
Estonia	1,500	1,000	2,000,000	2,000,000
Finland	7,800	8,200	6,000,000	6,000,000
Germany	2,500	2,500	([5])	([5])
Ireland	3,100	3,100	([5])	([5])
Latvia	560	1,000	([5])	([5])
Lithuania	500	500	190,000	300,000
Moldova	475	475	([5])	([5])
Russia	2,100	2,100	12,000,000	180,000,000
Sweden	1,200	1,200	([5])	([5])
Ukraine	1,000	1,100	([5])	([5])
United Kingdom	250	250	([5])	([5])
Other countries	1,000	1,000	1,000,000	1,300,000,000
World total (rounded)	26,100	26,500	26,000,000	2,000,000,000

World Resources: Many countries evaluate peat resources based on volume or area, because the variations in densities and thickness of peat deposits make it difficult to estimate tonnage. Reserve base data were obtained from the International Peat Society publications and included peat deposits located in protected regions, agricultural areas, and forests. Reserves were estimated based on the percentage of peat resources available for harvesting. More than 50% of the U.S. reserve base is contained in peatlands located in undisturbed areas of Alaska.

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 2004 was $18 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 62 plants in 30 States. The principal end uses were building construction products, 62%; horticultural aggregate, 13%; fillers, 10%; filter aid, 9%; and other, 6%.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production[1]	672	588	521	493	510
Imports for consumption[e]	180	175	224	245	190
Exports[e]	43	43	42	37	40
Consumption, apparent	809	720	703	701	660
Price, average value, dollars per ton, f.o.b. mine	33.78	36.31	36.45	38.20	35.22
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill	150	145	145	135	135
Net import reliance[2] as a percentage of apparent consumption	17	18	26	30	23

Recycling: Not available.

Import Sources (2000-03): Greece, 100%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 of domestic perlite increased about 3% compared with that of 2003. This increase was the first since 1999 after having dropped nearly 27% between 2000 and 2003. Imports decreased about 22% compared with the record-high levels reached in 2003. Domestic apparent consumption dropped about 6% compared to 2003, continuing a trend that began in 2001. Since 2000, domestic apparent consumption has dropped about 18%. Consumption has declined mainly because of a continued decrease in the demand for perlite used in construction-related materials.

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 mineral fines, overburden, and reject ore produced during ore mining and processing are used to reclaim the mined-out areas, and, therefore, little waste remains. Airborne dust is captured by baghouses, and there is practically no runoff that contributes to water pollution.

World Processed Perlite Production, Crude Ore Reserves, and Reserve Base:

	Production		Reserves[3]	Reserve base[3]
	2003	2004[e]		
United States	493	510	50,000	200,000
Greece	360	500	50,000	300,000
Hungary	145	150	3,000	([4])
Japan	250	255	([4])	([4])
Turkey	150	150	([4])	5,700,000
Other countries	240	240	600,000	1,500,000
World total (rounded)	1,600	1,800	700,000	7,700,000

World Resources: Insufficient information is available to make reliable estimates of resources in perlite-producing countries.

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

[e]Estimated. 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 6 firms at 15 mines in 4 States, and upgraded to an estimated 37 million tons of marketable product valued at $1 billion, f.o.b. mine. Florida and North Carolina accounted for more than 85% of total domestic output; the remainder was produced in Idaho and Utah. 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 intermediate feedstocks in the manufacture of granular and liquid ammonium phosphate fertilizers and animal feed supplements. Approximately 45% of the wet-process phosphoric acid produced was exported in the form of upgraded granular diammonium and monoammonium phosphate (DAP and MAP, respectively) fertilizer, merchant-grade phosphoric acid, and triple superphosphate fertilizer. The balance of the phosphate rock mined was for the manufacture elemental phosphorus, which was used to produce phosphorus compounds for a variety of food-additive and industrial applications.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production, marketable	38,600	31,900	36,100	35,000	37,000
Sold or used by producers	37,400	32,800	34,700	36,400	36,300
Imports for consumption	1,930	2,500	2,700	2,400	2,400
Exports	299	9	62	64	40
Consumption[1]	39,000	35,300	37,400	37,400	38,700
Price, average value, dollars per ton, f.o.b. mine[2]	24.14	26.82	27.47	27.01	27.12
Stocks, producer, yearend	8,170	7,510	8,860	7,540	7,600
Employment, mine and beneficiation plant, number[e]	3,500	3,400	3,200	3,200	3,300
Net import reliance[3] as a percentage of apparent consumption	1	9	3	9	6

Recycling: None.

Import Sources (2000-03): Morocco, 99%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: Phosphate rock production and consumption in 2004 increased slightly compared with 2003. One mine in Idaho that has been closed since January 2003 was sold to another phosphate producer in Idaho. The two leading phosphate rock producers in the United States merged to create the second largest fertilizer company in the world, in terms of sales, after a Norwegian company. The merger was announced in late January 2004 and it received approval from the Governments of the United States and Canada in August. The new company will control about 50% of U.S. phosphate rock production capacity and 57% of phosphoric acid production capacity. Worldwide, it will have 13% of phosphate rock capacity and 14.4% of phosphoric acid capacity.

In March 2004, the second largest U.S. phosphate rock producer completed its acquisition of a mine in Manatee County, FL. The mine was reopened in late 2004 after being idle for 5 years. It is the only phosphate rock mine in the United State to use dredge mining. The ore will be processed at the company's plant in Bartow, FL.

U.S. production of phosphate rock is not likely to rise above 40 million tons per year because of the gradual depletion of high-quality deposits in Florida and the subsequent decreases in production capacity. Three new mines are in the development and permitting stages in Florida. These mines will be needed in the next decade to replace existing mines after they are depleted.

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

PHOSPHATE ROCK

The time needed to complete the permitting process has increased significantly because of environmental concern in southwestern Florida. Some are concerned that new mines in DeSoto and Hardee Counties may adversely affect downstream water resources in the Peace River, which is a major source of drinking water.

Combined phosphate rock reserves in Idaho, North Carolina, and Utah are substantial and production rates for mines in those States can be maintained for more than 50 years.

The International Fertilizer Industry Association has predicted that worldwide demand for phosphate fertilizers will grow at a rate of 2.5% per year during the next 5 years. In the United States, phosphate fertilizer production was expected to remain at about 4 million tons per year of phosphorus pentoxide (P_2O_5) nutrient content. The United States is the leading supplier of processed phosphates in the world, accounting for about 45% of world trade. Since 2000, increased exports of MAP, primarily to South America, have helped to offset lower exports of DAP to markets in Asia. Continued growth in world population and the need for dependable food supplies ensures the importance of phosphate fertilizers.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2003	2004[e]		
United States	35,000	37,000	1,400,000	4,000,000
Australia	2,290	2,300	77,000	1,200,000
Brazil	5,600	5,650	260,000	370,000
Canada	1,000	1,100	25,000	200,000
China	24,500	25,000	6,600,000	13,000,000
Egypt	2,140	2,150	100,000	760,000
India	1,180	1,200	90,000	160,000
Israel	3,210	3,000	180,000	800,000
Jordan	6,760	6,800	900,000	1,700,000
Morocco and Western Sahara	23,000	23,000	5,700,000	21,000,000
Russia	11,000	11,000	200,000	1,000,000
Senegal	1,470	2,000	50,000	160,000
South Africa	2,640	2,600	1,500,000	2,500,000
Syria	2,430	2,400	100,000	800,000
Togo	1,480	1,500	30,000	60,000
Tunisia	7,890	8,000	100,000	600,000
Other countries	5,000	3,500	800,000	2,000,000
World total (rounded)	137,000	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. Stillwater milled about 1,000,000 metric tons of ore and recovered more than 18,000 kilograms of palladium and platinum in 2004. 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 leading 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:	2000	2001	2002	2003	2004[e]
Mine production:[1]					
Platinum	3,110	3,610	4,390	4,170	4,200
Palladium	10,300	12,100	14,800	14,000	14,200
Imports for consumption:					
Platinum	93,700	84,200	160,000	88,500	75,000
Palladium	181,000	160,000	117,000	105,000	119,000
Rhodium	18,200	12,400	9,890	12,000	10,000
Ruthenium	20,900	8,170	10,800	15,900	13,000
Iridium	2,700	3,110	2,100	2,200	3,900
Osmium	133	77	36	53	70
Exports:					
Platinum	25,000	31,300	27,800	22,200	16,000
Palladium	57,900	37,000	42,700	22,300	33,000
Rhodium	797	982	348	479	600
Price,[2] dollars per troy ounce:					
Platinum	549.30	533.29	542.56	694.44	852.00
Palladium	691.84	610.71	339.68	203.00	252.00
Rhodium	1,990.00	1,598.67	838.88	530.28	736.00
Ruthenium	129.76	130.67	66.33	35.43	57.00
Employment, mine, number	1,290	1,320	1,420	1,600	1,500
Net import reliance as a percentage of apparent consumption:[e]					
Platinum	78	90	93	92	91
Palladium	84	87	69	81	81

Recycling: An estimated 8,000 kilograms of PGM was recovered from new and old scrap in 2004.

Import Sources (2000-03): Platinum: South Africa, 44%; United Kingdom, 14%; Germany, 13%; Canada, 7%; Russia, 4%; and other, 18%. Palladium: Russia, 40%; South Africa, 18%; United Kingdom, 12%; Belgium, 8%; Germany, 4%; and other, 18%.

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

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

Government Stockpile:

Stockpile Status—9-30-04[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004[4]	Disposals FY 2004
Platinum	649	—	649	778	—
Palladium	756	—	756	6,220	1,070
Iridium	501	21	501	187	108

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

PLATINUM-GROUP METALS

Events, Trends, and Issues: Palladium prices, which declined sharply at the end of 2001 and continued to fall almost unabated through 2003, recovered in 2004 to a high of $273 per ounce and averaged $252 per ounce, up 24% from the full-year 2003 average. Prices increased as consumers returned to the market after drawing down large stocks that were accumulated during 2001 and 2002. Meanwhile, the platinum price averaged $852 per ounce, 23% higher than the 2003 average and 57% higher than the 2002 average.

U.S. palladium producers joined with other palladium producers and processors to form the Palladium Council (PdC). PdC is a nonprofit research foundation organized for the purpose of conducting research and promoting the use of palladium. PdC research and development are intended to cover most major areas of palladium use, including hydrogen generation, purification, sensing and storage, as well as palladium in fuel cells.

The desire to develop an alternative fuel for automobiles is a large public and private effort around the world. In 2004 alone, governments worldwide appropriated funds for research and development in this area exceeding $825 million. Private companies were spending as well, bringing annual investment in fuel-cell technology to more than $1 billion to advance this effort. Platinum is the catalyst used by fuel cells to convert hydrogen and oxygen to electricity. Palladium will likely also play a role in the fuel cell as well.

World Mine Production, Reserves, and Reserve Base:

	Mine production				PGM	
	Platinum		Palladium		Reserves[5]	Reserve base[5]
	2003	2004[e]	2003	2004[e]		
United States	4,170	4,200	14,000	14,200	900,000	2,000,000
Canada	7,400	8,600	11,500	13,400	310,000	390,000
Russia	36,000	36,000	74,000	74,000	6,200,000	6,600,000
South Africa	151,000	163,000	72,800	78,200	63,000,000	70,000,000
Other countries	6,430	6,500	9,700	10,400	800,000	850,000
World total (rounded)	205,000	218,000	182,000	190,000	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 2004, 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 2004, the production value of marketable potash, f.o.b. mine, was about $315 million. Domestic potash was produced in Michigan, New Mexico, and Utah. Most of the production was from southeastern New Mexico, where two companies operated three mines. New Mexico sylvinite and langbeinite ores were beneficiated by flotation, dissolution-recrystallization, heavy-media separations, or combinations of these processes, and provided more than 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 crystallized the sylvinite ore from the brine solution, and a flotation process separated the potassium chloride (muriate of potash or MOP) from byproduct sodium chloride. Two companies processed surface and subsurface brines by solar evaporation and flotation to produce MOP, potassium sulfate (sulfate of potash or SOP) and byproducts. In Michigan, a company used deep-well solution mining and mechanical evaporation for crystallization of MOP and byproduct sodium chloride.

The fertilizer industry used about 85% of U.S. potash sales, and the chemical industry used the remainder. More than 60% of the produced potash was MOP. Potassium magnesium sulfate (sulfate of potash-magnesia or SOPM) and SOP, which are required by certain crops and soils, also were produced.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production, marketable[1]	1,300	1,200	1,200	1,100	1,200
Imports for consumption	4,600	4,540	4,620	4,720	4,900
Exports	367	366	371	329	200
Consumption, apparent[2]	5,600	5,300	5,300	5,400	5,800
Price, dollars per metric ton of K_2O, average, muriate, f.o.b. mine[3]	155	155	155	160	170
Employment, number:					
Mine	610	585	540	520	500
Mill	665	670	645	620	630
Net import reliance[4, 5] as a percentage of apparent consumption	80	80	80	80	70

Recycling: None.

Import Sources (2000-03): Canada, 91%; Belarus, 3%; Russia, 3%; Germany, 1%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 leading potash producers operated up to 40% below capacity for another year to prevent oversupply to the market or excessively large producer stocks, which could result in downward price pressures from the potential buyers. At the end of 2003, North American producer stocks were more than 12% of annual production (1.3 million tons, K_2O equivalent, of 10.4 million tons) resulting in a slow increase in potash prices that started in the fall of 2003.

Domestic producers supplied more than 10% of domestic consumption with MOP sales going mostly to Texas, Illinois, Missouri, Michigan, and New Mexico in 2003. From January through July 2004, accumulated exports of domestic potash declined by about 42%, to an annualized 190,000 tons compared with the same period in 2003. The MOP accumulated exports, for the first 7 months of 2004, declined by about 50% compared with the same period of 2003. SOP accumulated exports on the same basis declined by about 70%, while SOPM accumulated exports on the same basis increased by about 20%.

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

POTASH

In March, 2004, the Denver, CO, owner of the Moab, UT, sylvinite mine purchased the pair of operating underground sylvinite mines and an idle underground mine near Carlsbad, NM, from a company in Chapter 11. Also in March, the Denver, CO, company purchased the Wendover, UT, near-surface brine operation of sylvinite and magnesium chloride production. Later in the year, the Denver company announced intentions to produce langbeinite by modifying the Carlsbad East potash plant to become the second langbeinite producer in the United States.

The other Carlsbad producer ceased SOP production at the Carlsbad site and agreed to merge with the fertilizer (phosphate and nitrogen) portion of a private international provider of food and agricultural products to create a publicly held corporation. The third potash producer was the operator of the Great Salt Lake, UT, SOP site.

According to the U.S. Department of Agriculture, the global production of wheat, coarse grains, and rice for 2003-04 increased to about 1,840 million tons. Global demand for potash increased to about 30 million tons, a level not seen since the peak years of 1987 and 1988. The potash industry needs to start planning for new capacity, even given the 6 million tons of unused capacity in Canada, to prepare for when Russian and Belarus potash is withdrawn from global markets to supply their domestic markets once again.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	2003	2004[e]		
United States	[1]1,100	[1]1,200	90,000	300,000
Belarus	4,200	4,650	750,000	1,000,000
Brazil	340	360	300,000	600,000
Canada	9,200	9,500	4,400,000	9,700,000
Chile	360	400	10,000	50,000
China	500	550	8,000	450,000
Germany	3,600	3,670	710,000	850,000
Israel	1,960	1,940	[7]40,000	[7]580,000
Jordan	1,200	1,130	[7]40,000	[7]580,000
Russia	4,700	5,400	1,800,000	2,200,000
Spain	510	600	20,000	35,000
Ukraine	60	60	25,000	30,000
United Kingdom	620	580	22,000	30,000
Other countries	—	—	50,000	140,000
World total (rounded)	28,400	30,000	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 in central Michigan. Estimated world resources total about 250 billion tons. The potash deposits in Russia and Thailand contain large amounts of carnallite; it is not clear if this can be mined profitably in a free market economy.

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

[e]Estimated. — Zero.
[1]Rounded to within 0.1 million ton to avoid disclosing company proprietary data.
[2]Rounded to within 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 2004 was about $26 million. Domestic output came from 16 producers at 17 mines in 6 States. Pumice and pumicite was mined in Arizona, Oregon, New Mexico, California, Idaho, Nevada, and Kansas, in descending order of significance. About 76% of production came from Arizona, Oregon, and New Mexico. 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:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production, mine[1]	1,050	920	956	870	1,070
Imports for consumption	385	379	360	366	405
Exports[e]	27	27	30	25	25
Consumption, apparent	1,410	1,270	1,320	1,210	1,450
Price, average value, dollars per ton, f.o.b. mine or mill	24.27	21.42	20.69	25.19	24.12
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number	105	100	100	100	100
Net import reliance[2] as a percentage of apparent consumption	25	28	25	28	26

Recycling: Not available.

Import Sources (2000-03): Greece, 80%; Italy, 14%; Turkey, 5%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Crude or in irregular pieces, including crushed pumice	2513.11.0000	Free.
Other	2513.19.0000	0.2¢/kg.

Depletion Allowance: 5% (Domestic and foreign).

Government Stockpile: None.

Prepared by **Alan Founie [(703) 648-7720, afounie@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 2004 increased 23% compared with that of 2003. Imports increased about 11% compared with those of 2003 as more Greek and Italian pumice was brought into eastern U.S. ports to supply markets primarily in the Eastern United States and Gulf Coast.

Total apparent consumption in 2004 rose about 20% compared with that of 2003. This increase in apparent consumption was due to a greater demand for lightweight building materials associated with the overall increase in building in the Western United States.

In 2005, domestic mine production of pumice and pumicite is expected to increase slightly to about 1.1 million tons, with U.S. apparent consumption rising to 1.5 million tons. Although pumice and pumicite is plentiful in the Western United States, changes in laws and public land designations could decrease access to many deposits. Pumice and pumicite is sensitive to mining and transportation 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 2004 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]
	2003	2004[e]		
United States[1]	870	1,070	Large	Large
Algeria	400	500	NA	NA
Chile	830	850	NA	NA
Ecuador	90	90	NA	NA
France	450	450	NA	NA
Germany	500	500	NA	NA
Greece	1,600	1,700	NA	NA
Guadeloupe	210	210	NA	NA
Guatemala	270	260	NA	NA
Iran	1,200	1,100	NA	NA
Italy	4,600	4,500	NA	NA
Spain	600	600	NA	NA
Turkey	800	800	NA	NA
Other countries	1,900	1,800	NA	NA
World total (rounded)	14,300	14,400	NA	NA

World Resources: The identified U.S. domestic resources of pumice and pumicite in the West are estimated to be more than 25 million tons. The estimated total resources (identified and undiscovered) in the Western and Great Plains States are at least 250 million tons and may total more than 1 billion tons.

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

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

QUARTZ CRYSTAL (INDUSTRIAL)

(Data in metric tons unless otherwise noted)

Domestic Production and Use: Lascas[1] mining and processing in Arkansas was stopped at the end of 1997, and in 2004, no U.S. firms reported the production of cultured quartz crystals. Cultured quartz crystal production capacity still exists in the United States using imported and stockpiled lascas as feed material. In the past several years, cultured quartz crystal was increasingly produced overseas, primarily in Asia. Electronic applications accounted for most industrial uses of quartz crystal; other uses included special optical applications.

Virtually all quartz crystal used for electronics was cultured rather than natural crystal. Electronic-grade quartz crystal was essential for making filters, frequency controls, and timers in electronic circuits employed for a wide range of products, such as communications equipment, computers, and many consumer goods, such as electronic games and television receivers.

Salient Statistics—United States: Production statistics for cultured quartz crystals were withheld to avoid disclosing company proprietary data. 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 (excluding mounted quartz crystals) totaled about 92 tons, and imports (excluding mounted quartz crystals) totaled about 3 tons in 2004. The average value of exports and imports was $133,000 per ton and $1.3 million per ton[2], respectively. Other salient statistics were not available.

Recycling: None.

Import Sources (2000-03): 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 12-31-04
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—9-30-04[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Quartz crystal	7	43	7	68	54

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 global 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.

[1]Lascas is a nonelectronic-grade quartz used as a feedstock for growing cultured quartz crystal and for production of fused quartz.
[2]The quartz crystal import value in the Mineral Commodity Summaries 2004, $208,000, was based on U.S. Census Bureau data that include zirconia.
[3]See Appendix B for definitions.

RARE EARTHS[1]

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

Domestic Production and Use: Rare earths were not mined domestically in 2004. Bastnäsite, a rare-earth fluocarbonate mineral, was previously mined and processed as a primary product at Mountain Pass, CA. Rare-earth concentrates, intermediate compounds, and individual oxides were available from stocks. The United States continued to be a major exporter and consumer of rare-earth products in 2004. The estimated value of refined rare earths consumed in the United States was more than $1 billion. Based on final 2003 reported data, the estimated 2004 distribution of rare earths by end use was as follows: automotive catalytic converters, 46%; glass polishing and ceramics, 14%; metallurgical additives and alloys, 13%; petroleum refining catalysts, 7%; rare-earth phosphors for lighting, televisions, computer monitors, radar, and X-ray intensifying film, 5%; permanent magnets, 3%; and other, 12%.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production, bastnäsite concentrates[e]	5,000	5,000	5,000	—	—
Imports:[2]					
Thorium ore (monazite)	—	—	—	—	—
Rare-earth metals, alloy	2,470	1,420	1,450	1,130	790
Cerium compounds	4,310	3,850	2,540	2,630	1,980
Mixed REOs	2,190	2,040	1,040	2,150	1,540
Rare-earth chlorides	1,330	2,590	1,800	1,890	1,520
Rare-earth oxides, compounds	11,200	9,150	7,260	10,900	12,400
Ferrocerium, alloys	118	118	89	111	109
Exports:[2]					
Rare-earth metals, alloys	1,650	884	1,300	1,190	1,240
Cerium compounds	4,050	4,110	2,740	1,940	2,000
Other rare-earth compounds	1,650	1,600	1,340	1,450	4,590
Ferrocerium, alloys	2,250	2,500	2,830	2,800	3,910
Consumption, apparent	12,100	15,100	11,000	9,340	6,670
Price, dollars per kilogram, yearend:					
Bastnäsite concentrate, REO basis[e]	4.08	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	5-6	5-6	5-6
Stocks, producer and processor, yearend	W	W	W	W	W
Employment, mine and mill, number	78	90	95	90	NA
Net import reliance[4] as a percentage of apparent consumption	71	67	54	100	100

Recycling: Small quantities, mostly permanent magnet scrap.

Import Sources (2000-03): Rare-earth metals, compounds, etc.: China, 67%; France, 17%; Japan, 4%; Estonia, 4%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Rare-earth metals, whether or not intermixed or interalloyed	2805.30.0000	5.0% ad val.
Cerium compounds	2846.10.0000	5.5% ad val.
Mixtures of REOs except cerium oxide	2846.90.2010	Free.
Mixtures of rare-earth chlorides except cerium chloride	2846.90.2050	Free.
Rare-earth compounds, individual REOs (excludes cerium compounds)	2846.90.8000	3.7% ad val.
Ferrocerium and other pyrophoric alloys	3606.90.3000	5.9% ad val.

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

Government Stockpile: None.

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

RARE EARTHS

Events, Trends, and Issues: Domestic demand for rare earths in 2004 was higher overall because of increased demand for rare-earth oxides and other refined rare-earth compounds used in automotive catalytic converters, fiber optics, lasers, oxygen sensors, phosphors for fluorescent lighting, color television, electronic thermometers, and X-ray intensifying screens, pigments, superconductors, and other applications. U.S. demand, however, was lower for cerium compounds used in glass polishing and glass additives, rare-earth chlorides used in the production of fluid cracking catalysts, rare-earth metals and alloys used in metallurgical applications and permanent magnets, and mixed-rare-earth oxides used in a variety of applications. U.S. imports of rare earths decreased in most trade categories. Although the rare-earth separation plant at Mountain Pass, CA, is still closed, it is expected to resume operations. Bastnäsite concentrates and other rare-earth intermediates and refined products continued to be sold from the mine stocks at Mountain Pass. The trend is for a continued increase in the use of rare earths in many applications, especially automotive catalytic converters, permanent magnets, and rechargeable batteries.

The international conferences that are planned are the 35ièmes Journées des Actinides—2005, April 23-26 in Baden/Wien, Austria; the 24th Rare Earth Research Conference, June 26-30, 2005, in Keystone, CO, United States; and the Sixth International Conference on f-Elements (ICFE-6), 2006, in Wroclaw, Poland. The 2005 Intermag Conference is planned for April 5-8, 2005, in Nagoya, Japan, and the 50th Conference on Magnetism and Magnetic Materials is scheduled for October 30 to November 3, 2005, in San Jose, CA, United States. The Rare Earths ’04 was held November 7-12, 2004, in Nara, Japan, and the Rare Earth Metals 2004 was held October 24-26, 2004, in Hong Kong.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e]		Reserves[5]	Reserve base[5]
	2003	2004		
United States	—	—	13,000,000	14,000,000
Australia	—	—	5,200,000	5,800,000
China	92,000	95,000	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	250	250	30,000	35,000
Thailand	2,200	2,000	NA	NA
Other countries	—	—	22,000,000	23,000,000
World total (rounded)	99,100	102,000	88,000,000	150,000,000

World Resources: Rare earths are relatively abundant in the Earth’s crust, but discovered minable concentrations are less common than for most other ores. U.S. and world resources are contained primarily in bastnäsite and monazite. Bastnäsite deposits in China and the United States constitute the learget 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.

Substitutes: Substitutes are available for many applications, but generally are less effective.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Data 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 2004, ores containing rhenium were mined by four operations (two in Arizona, one each in Utah and Montana). Rhenium compounds are included in molybdenum concentrates derived from porphyry copper deposits, and rhenium is recovered as a byproduct from roasting such molybdenum concentrates. Rhenium-containing products included ammonium perrhenate, perrhenic acid, and metal powder. The major uses of rhenium were in petroleum-reforming catalysts and in 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 (1,000º C) strength properties of some nickel-base superalloys. Rhenium alloys were used in crucibles, electrical contacts, electromagnets, electron tubes and targets, heating elements, ionization gauges, mass spectrographs, metallic coatings, semiconductors, temperature controls, thermocouples, vacuum tubes, and other applications. The estimated value of rhenium consumed in 2004 was about $14 million.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production[1]	7,100	5,500	4,000	3,900	4,200
Imports for consumption	16,400	23,400	16,600	14,500	15,700
Exports	NA	NA	NA	NA	NA
Consumption, apparent	23,500	28,900	20,600	18,400	19,900
Price,[2] average value, dollars per kilogram, gross weight:					
Metal powder, 99.99% pure	940	910	1,030	1,090	985
Ammonium perrhenate	510	790	810	790	840
Stocks, yearend, consumer, producer, dealer	NA	NA	NA	NA	NA
Employment, number	Small	Small	Small	Small	Small
Net import reliance[3] as a percentage of apparent consumption	70	81	81	79	79

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

Import Sources (2000-03): Rhenium metal: Chile, 88%; Kazakhstan, 4%; Mexico, 3%; and other, 5%. Ammonium perrhenate: Kazakhstan, 65%; Germany, 11%; United Kingdom, 6%; Estonia, 6%; and other, 12%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 2004, average rhenium metal price was about $985 per kilogram, about 10% lower than that of 2003. Rhenium imports increased by about 8% owing to improved demand in the superalloy and catalyst markets. Rhenium recovery in the United States increased by 8% due to increased production of byproduct molybdenum concentrates from porphyry copper deposits. Copper production from these deposits was reduced in 2002 and 2003 to stabilize copper prices. The United States relied on imports for much of its supply of rhenium. Chile and Kazakhstan 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:

	Mine production[4]		Reserves[5]	Reserve base[5]
	2003	2004		
United States	3,900	4,200	390,000	4,500,000
Armenia	1,000	1,000	95,000	120,000
Canada	1,700	1,700	—	1,500,000
Chile	15,600	15,600	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	1,400	310,000	400,000
Other countries	1,000	1,000	91,000	360,000
World total (rounded)	32,000	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 5 million kilograms, and the identified resources of the rest of the world are approximately 6 million kilograms. In Kazakhstan, rhenium also exists in sedimentary copper deposits.

Substitutes: Substitutes for rhenium in platinum-rhenium catalysts are being evaluated continually. Iridium and tin have achieved commercial success in one such application. Other metals being evaluated for catalytic use include gallium, germanium, indium, selenium, silicon, tungsten, and vanadium. The use of these and other metals in bimetallic catalysts 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]Average price per kilogram of rhenium in pellets or ammonium perrhenate, based on U.S. Census Bureau customs value.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]Estimated amount of rhenium extracted in association with copper and molybdenum production.
[5]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. On a global scale, rubidium may occur with lithium or cesium minerals in pegmatites or evaporite minerals. There are only a small number of U.S. companies that process imported rubidium ore. Rubidium and rubidium compounds, in limited amounts, may be used for DNA separation, fiber optics, inorganic chemicals, lamps, night vision devices, and as standards for atomic absorption analysis. Both rubidium and cesium are used in atomic clocks. Rubidium-82, a decay product of strontium-82, is used in imaging technology in the diagnosis of heart conditions, and the isotopic decay of rubidium-87 to strontium-87 is an important tool in geochronology.

Salient Statistics—United States: One mine in Canada is the major source of U.S. supplies of rubidium, and its production data 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. However, unlisted prices for rubidium and rubidium compounds are known to have remained relatively stable. In 2004, 1-gram ampoules of 99.75%-grade rubidium (metal) were offered at $56.50 each, and the price for 100 grams of the same material was $1,085.20.

Recycling: None.

Import Sources (2000-03): 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 12-31-04
Alkali metals, other	2805.19.9000	5.5% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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

RUBIDIUM

Events, Trends, and Issues: Consumption and use of rubidium and its compounds are not commercially significant, and there are no environmental or human health issues associated with its use or processing. No change in use patterns is predicted, and current technology does not indicate a new rubidium market.

World Mine Production, Reserves, and Reserve Base: Rubidium is found in trace amounts in some potassium-bearing minerals such as feldspar and mica that formed during the crystallization of pegmatites. These exceptionally coarse-grained rocks form late in the crystallization of granitic magma and may have concentrations of unusual and rare minerals such as lepidolite, a lithium-bearing mica. This mineral is the principal ore mineral of rubidium and may contain up to 3.15% 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 no minerals in which rubidium is the predominant metallic element. Canada is the world's leading producer of rubidium (pegmatite). Rubidium occurrences have also been reported in brines in northern Chile and in China and also in salt beds in France, Germany, and New Mexico.

World Resources: Rubidium is present in minor amounts in lepidolite in pegmatites in Maine and South Dakota. 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, Peru, Zambia, and other countries. World resources of rubidium are unknown, but supplies of rubidium-bearing lepidolite are adequate for current use patterns.

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

SALT

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Domestic production of salt increased an estimated 3% in 2004. The total value was estimated to be $1.2 billion. Twenty-nine companies operated 64 plants in 15 States. The estimated percentage of salt sold or used, by type, was salt in brine, 45%; rock salt, 39%; vacuum pan, 9%; and solar salt, 7%.

The chemical industry consumed nearly 40% of total salt sales, with salt in brine representing about 89% of the type of salt used for feedstock. The chlorine and caustic soda manufacturing sector was the main consumer within the chemical industry. Salt for highway deicing accounted for 37% of U.S. demand. The remaining markets for salt, in declining order, were distributors, 8%; industrial, 6%; food, 4%; agricultural, 3%; water treatment, 2%; and other combined with exports, less than 1%.

Salient Statistics—United States:[1]	2000	2001	2002	2003	2004[e]
Production	45,600	44,800	40,300	43,700	45,100
Sold or used by producers	43,300	42,200	37,700	41,100	42,900
Imports for consumption	8,960	12,900	8,160	12,900	11,000
Exports	642	1,120	689	718	800
Consumption:					
Reported	54,000	48,700	43,600	50,200	53,900
Apparent	51,600	54,000	45,100	53,200	53,900
Price, average value of bulk, pellets and packaged salt, dollars per ton, f.o.b. mine and plant:					
Vacuum and open pan salt	113.95	120.02	120.02	124.24	122.00
Solar salt	50.46	52.33	53.93	53.42	55.00
Rock salt	20.67	21.84	21.62	23.11	24.00
Salt in brine	5.70	6.26	5.89	7.21	7.00
Stocks, producer, yearend[e, 2]	2,300	NA	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	16	22	17	23	20

Recycling: None.

Import Sources (2000-03): Canada, 44%; Chile, 20%; Mexico, 10%; The Bahamas, 9%; and other, 17%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: High sodium and chloride levels in water supplies have affected various parts of the country. In Massachusetts, the State Highway Department announced that it would reduce the quantity of salt applied to several of the roads during the winter. Liquid calcium chloride will be applied to road surfaces before a storm arrives to prevent snow from adhering to the pavement, thereby reducing the need to apply salt later. A mixture of salt and sand, instead of 100% salt, would be used in heavy storms.

Although China has abundant resources of salt, there was a shortage of salt supplies in the country that caused imports of salt to increase. A surge in industrial projects in China caused the demand for salt to grow greater than the domestic supply could accommodate. This increase in demand prompted plans to construct a new solar salt operation in Western Australia, which if constructed, could satisfy some of the salt shortages in China.

Domestic consumption of salt in 2005 is expected to be lower than that of 2004. The proposed closure of some solar salt capacity in California will reduce domestic production, 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]
	2003	2004[e]	
United States[1]	43,700	45,100	Large. Economic and subeconomic deposits of salt are substantial in principal salt-producing countries. The oceans contain an inexhaustible supply of salt.
Australia	9,800	10,000	
Brazil	6,100	6,100	
Canada	13,300	13,300	
China	32,400	34,000	
France	7,000	7,000	
Germany	15,700	16,000	
India	15,000	15,000	
Italy	3,600	3,600	
Mexico	8,000	8,000	
Poland	1,500	2,000	
Russia	2,800	3,000	
Spain	3,200	3,200	
Ukraine	2,300	2,500	
United Kingdom	5,800	5,800	
Other countries	39,800	40,000	
World total (rounded)	210,000	215,000	

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 $6.3 billion was produced by an estimated 4,000 companies from about 6,500 operations in 50 States. Leading States, in order of decreasing tonnage, were California, Texas, Michigan, Arizona, Minnesota, Ohio, Colorado, Wisconsin, Washington, and Nevada, which together accounted for about 54% of the total output. It is estimated that about 52% of the 1.19 billion tons of construction sand and gravel produced in 2004 was for unspecified uses. Of the remaining total, about 44% was used as concrete aggregates; 22% for road base and coverings and road stabilization; 15% as construction fill; 13% as asphaltic concrete aggregates and other bituminous mixtures; 2% for concrete products, such as blocks, bricks, pipes, etc.; 2% for plaster and gunite sands; and the remaining 2% 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 2004, was about 943 million tons, a 7.4% increase from the revised total for the same period of 2003. 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:	2000	2001	2002	2003	2004[e]
Production	1,120	1,130	1,130	1,160	1,190
Imports for consumption	3	4	4	4	4
Exports	2	3	3	1	2
Consumption, apparent	1,120	1,130	1,130	1,160	1,190
Price, average value, dollars per ton	4.81	5.02	5.07	5.16	5.28
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mines, mills, and shops, number	37,837	37,508	37,055	36,540	37,000
Net import reliance[3] as a percentage of apparent consumption	([4])	([4])	([4])	([4])	([4])

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

Import Sources (2000-03): Canada, 78%; Mexico, 13%; The Bahamas, 2%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 increased to approximately 1.19 billion tons, about 3% more than that of 2003. It is estimated that 2005 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 a growing economy and outlays for road and other construction. Most areas of the country will likely experience increased sales and consumption of sand and gravel. Crushed stone, the other major construction aggregate, has been replacing natural sand and gravel, especially in more densely populated areas of the Eastern United States.

The construction sand and gravel industry continues to be concerned with safety, health, and environmental regulations. Movement of sand and gravel operations away from densely 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]
	2003	2004[e]	
United States	1,160	1,190	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. Use of offshore deposits in the United States is mostly restricted to beach erosion control and replenishment. Other countries routinely mine offshore deposits of aggregates for onshore construction projects.

Substitutes: Crushed stone remains the predominant choice for construction aggregate use. Increasingly, recycled asphalt and portland cement concretes are being substituted for virgin aggregate although the percentage of total aggregate supplied by recycled materials remained very small in 2004.

[e]Estimated. NA Not available.
[1]See also Sand and Gravel (Industrial).
[2]See Appendix A for conversion to short tons.
[3]Defined as imports – exports + adjustments for Government and industry stock changes; changes in stocks are not available and assumed to be zero.
[4]Less than ½ unit.
[5]See Appendix C for definitions.
[6]No reliable production information for other countries is available, owing to the 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 $646 million was produced by 65 companies from 153 operations in 35 States. Leading States, in order of tonnage, were Illinois, Texas, Michigan, Wisconsin, North Carolina, California, New Jersey, and Oklahoma. Combined production from these States represented 61% of the domestic total. About 39% of the U.S. tonnage was used as glassmaking sand, 19% as foundry sand, 10% as building products, 8% as hydraulic fracturing sand, 3% as abrasive sand, and 21% was for other uses.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production	28,400	27,900	27,300	27,500	29,000
Imports for consumption	247	172	250	440	485
Exports	1,660	1,540	1,410	2,620	2,600
Consumption, apparent	27,400	26,500	26,100	25,300	26,900
Price, average value, dollars per ton	19.58	20.64	20.98	22.14	22.28
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 (2000-03): Canada, 52%; Mexico, 37%, and other, 11%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 2004 increased by about 6% compared with those of 2003, owing to a robust construction sector of the U.S. economy. U.S. apparent consumption was 26.9 million tons in 2004, a 6% increase during the previous year. Imports of industrial sand and gravel in 2004 increased slightly from those of 2003. Mexico's share of imports decreased, and Canada's share increased. Imports of silica are generally of two types: small shipments of very-high-purity silica or a few large shipments of lower grade silica shipped only under special circumstances (e.g., very low freight rates).

The United States was the world's leading producer and consumer of industrial sand and gravel based on estimated world production figures. It was difficult to collect definitive 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.

The industrial sand and gravel industry continued to be concerned with safety and health regulations, environmental restrictions, and in some cases, litigation in 2004. 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] 2003	Mine production[e] 2004[e]	Reserves and reserve base[2]
United States	27,500	29,000	
Australia	4,500	5,000	Large. Industrial sand and gravel deposits are widespread. Calculation of the reserves and reserve base is determined mainly by the location of population centers.
Austria	6,800	6,800	
Belgium	1,800	1,800	
Brazil	1,600	1,600	
Canada	1,600	1,600	
France	6,500	6,500	
Germany	8,500	8,500	
India	1,500	1,500	
Iran	1,700	1,700	
Italy	3,000	3,000	
Japan	4,700	4,800	
Mexico	1,700	1,700	
Norway	1,500	1,600	
Poland	1,500	1,500	
South Africa	2,500	2,240	
Spain	6,500	6,500	
Turkey	1,300	1,300	
United Kingdom	4,500	4,000	
Other countries	21,000	20,000	
World total (rounded)	110,000	111,000	

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: Alternative materials that can be used for glassmaking and for foundry and molding sands are chromite, olivine, staurolite, and zircon sands.

[e]Estimated. E Net exporter. 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 2004. Although scandium was not mined domestically in 2004, 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 2004 were aluminum alloys for sporting equipment (baseball and softball bats, bicycle frames, golf clubs, gun frames, lacrosse shafts, and tent poles), metallurgical research, high-intensity metal halide lamps, analytical standards, electronics, oil well tracers, and lasers.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Price, yearend, dollars:					
Per kilogram, oxide, 99.0% purity	700	700	700	500	500
Per kilogram, oxide, 99.9% purity	2,000	2,300	2,000	1,300	1,300
Per kilogram, oxide, 99.99% purity	3,000	2,700	2,500	2,500	2,500
Per kilogram, oxide, 99.999% purity	6,000	4,100	3,200	3,200	3,200
Per gram, dendritic, metal[2]	270.00	279.00	178.00	185.00	193.60
Per gram, metal, ingot[3]	175.00	198.00	198.00	119.00	124.00
Per gram, scandium bromide, 99.99% purity[4]	91.80	94.60	94.60	98.40	NA
Per gram, scandium chloride, 99.9% purity[4]	39.60	40.80	40.80	42.40	44.30
Per gram, scandium fluoride, 99.9% purity[4]	80.10	173.00	173.00	180.00	188.20
Per gram, scandium iodide, 99.999% purity[4]	151.00	156.00	156.00	162.00	169.00
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2000-03): Not available.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 2004, the total market remained very small. Domestic increases in demand were primarily from recently developed applications in welding wire, scandium-aluminum baseball and softball bats, scandium-aluminum bicycle frames, and high-strength, lightweight handgun frames and cylinders. New demand is expected to come from future fuel-cell markets and aerospace applications.

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

SCANDIUM

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

World Mine Production, Reserves, and Reserve Base:[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 2004. 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 more than 100 minerals. In the Earth's crust, scandium is primarily a trace constituent of ferromagnesium minerals. Concentrations in these minerals (amphibole-hornblende, biotite, and pyroxene) typically range from 5 to 100 parts per million equivalent Sc_2O_3. Ferromagnesium minerals commonly occur in the igneous rocks, basalt and gabbro. Enrichment of scandium also occurs in aluminum phosphate minerals, beryl, cassiterite, columbite, garnet, muscovite, rare-earth minerals, and wolframite. Recent domestic production has primarily been from the scandium-yttrium silicate mineral, thortveitite, and from byproduct leach solutions from uranium operations. One of the principal domestic scandium resources is the fluorite tailings from the mined-out Crystal Mountain deposit near Darby, MT. Tailings from the mined-out fluorite operations, which were generated from 1952 to 1971, contain thortveitite and associated scandium-enriched minerals. Resources also are contained in the tantalum residues previously processed at Muskogee, OK. Smaller resources are associated with molybdenum, titanium-tungsten, and tungsten minerals from the Climax molybdenum deposit in Colorado and in crandallite, kolbeckite, and 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. NA Not available.
[1]See also Rare Earths.
[2]Scandium pieces, 99.9% purity, distilled dendritic, 2000-04 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, 2000. Metal ingot pieces 99.9% purity 2001-04.
[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, 37%; chemicals and pigments, 20%; electronics, 10%; 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 leading agricultural uses are as a dietary supplement for livestock and as a fertilizer additive to enrich selenium-poor soils. It is used as a metallurgical additive to improve machinability of copper, lead, and steel alloys. 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. A new use for selenium was in amorphous selenium (aSe) detector technology. The aSe detector enables the direct conversion of X-ray to digital information.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production, refinery	W	W	W	W	W
Imports for consumption, metal and dioxide	476	483	422	367	390
Exports, metal, waste and scrap	82	41	85	243	90
Consumption, apparent[1]	W	W	W	W	W
Price, dealers, average, dollars per pound, 100-pound lots, refined	3.84	3.80	4.27	5.68	27.00
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. However, as electronic recycling continues to increase, a small amount of selenium could become available.

Import Sources (2000-03): Canada, 49%; Philippines, 21%; Belgium, 10%; Germany, 6%; and other, 14%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-04**
Selenium metal	2804.90.0000	Free.
Selenium dioxide	2811.29.2000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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

SELENIUM

Events, Trends, and Issues: The supply of selenium is directly affected by the supply of the materials from which it is a byproduct, copper and to a lesser extent nickel and cobalt. The annual global consumption of selenium in 2004 was estimated to have been about 2,700 tons. Production of selenium increased in 2004 as worldwide copper production increased. With much of the world's production committed to long-term contracts, selenium was not available on the spot market. This resulted in some concern about the selenium supply and caused the price of selenium to increase from $9.00-$10.50 per pound in January 2004 to $28.00-$30.00 by the beginning of the fourth quarter of 2004.

Domestic selenium exports returned to normal levels in 2004. An overstock of selenium materials, caused by continued low prices, was sold off in 2003 because of the large increase in price. Much of the selenium was exported to the Philippines for further processing and finally sold to China. Exports to the Philippines increased 243% in 2003 as compared with those of 2002.

The use of selenium in China rose with continued interest in selenium as a fertilizer supplement, as an ingredient in glassmaking, and as selenium dioxide substituting for sulfur dioxide in the manganese smelting process.

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. Although small amounts of selenium in the soil are considered beneficial, it can be hazardous in larger quantities.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[3]	Reserve base[3]
	2003	2004[e]		
United States	W	W	10,000	19,000
Belgium	200	200	—	—
Canada	230	250	6,400	10,000
Chile	40	40	16,000	37,000
Finland	40	50	—	—
Germany	100	100	—	—
India	12	12	—	—
Japan	715	750	—	—
Peru	16	20	5,000	8,000
Philippines	40	40	2,000	3,000
Serbia and Montenegro	20	20	1,000	2,000
Sweden	20	20	—	—
Other countries[4]	NA	NA	42,000	90,000
World total (rounded)	[5]1,430	[5]1,500	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 C for definitions.
[4]In addition to the countries listed, Australia, China, Kazakhstan, Russia, and the United Kingdom are known to produce refined selenium, but output is not reported and information is inadequate for formulation of reliable production estimates.
[5]Excludes U.S. production.

SILICON

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

Domestic Production and Use: Estimated value of silicon metal and alloys (excluding semiconductor-grade silicon) produced in the United States in 2004 was about $440 million. Ferrosilicon was produced by four companies in five plants, and silicon metal was produced by three companies in five plants. Two of the five 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 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:	2000	2001	2002	2003	2004[e]
Production	367	282	261	248	240
Imports for consumption	361	231	285	315	330
Exports	41	23	22	26	23
Consumption, apparent	689	502	540	543	560
Price,[1] average, cents per pound Si:					
Ferrosilicon, 50% Si	45.0	42.8	41.1	47.7	59
Ferrosilicon, 75% Si	35.4	31.9	32.8	45.3	57
Silicon metal	54.8	50.5	53.2	61.3	81
Stocks, producer, yearend	52	40	25	28	21
Net import reliance[2] as a percentage of apparent consumption	47	44	52	54	56

Recycling: Insignificant.

Import Sources (2000-03): South Africa, 15%; Norway, 12%, Brazil, 12%; Russia, 10%; and other, 51%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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, 15% (Domestic and foreign); gravel, 5% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Domestic apparent consumption of silicon for 2004 is projected to be slightly more than that of 2003. Of the 2004 total, the share accounted for by ferrosilicon is estimated to have decreased to 50% from 52% in 2003, while that for silicon metal increased to 50% from 48%. The annual growth rate for ferrosilicon demand usually falls in the range of 1% to 2%, in line with long-term trends in steel production, but through the first 9 months of 2004, domestic steel production was 8% higher than that for the same period in 2003. Domestic shipments of silicon metal through the first 8 months in 2004 were about 4% higher than those of the same period in 2003. Demand for silicon metal comes primarily from the aluminum and chemical industries. In 2004, the demand increase in domestic specialty chemicals, which include silicones, was expected to be about 7% compared with that of 2003. Domestic primary aluminum production was projected to decrease in 2004 by about 8% from that of 2003. Global primary aluminum production in 2004 was 4% higher than that of 2003. Through the first 9 months in 2004, domestic secondary aluminum production was about 3% higher than that during the same period in 2003. World secondary aluminum production decreased by 3% through the first 6 months in 2004 compared with that during the same period in 2003.

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

SILICON

Domestic production in 2004, expressed in terms of contained silicon, was projected to decline slightly. For all silicon materials combined, the overall decline was 3% to the lowest level since 1961. As in 2003, production continued to be curtailed or stopped at some plants.

Through the first 9 months of 2004, prices trended upward in the U.S. market for silicon materials. Compared with those at the beginning of the year, weekly average prices as of the end of September were higher for 50% ferrosilicon (9%), 75% ferrosilicon (13%), and silicon metal (30%). Year-average prices were projected to be higher for 50% ferrosilicon, 75% ferrosilicon, and silicon metal than those for 2003. At the end of September, the range in dealer import price, in cents per pound of contained silicon, was 50 to 54 for 50% ferrosilicon, 50 to 52 for 75% ferrosilicon, and 85 to 87 for silicon metal.

U.S. imports and exports of silicon materials in 2004, projected on the basis of data for the first 7 months of the year, were 5% more and 12% less, respectively, than those in 2003. The smallest overall percentage rise was for imports of silicon metal. Net import reliance as a percentage of apparent consumption rose in comparison with that for recent years owing to increases in silicon material imports.

World Production, Reserves, and Reserve Base:

	Production[e] 2003	Production[e] 2004	Reserves and reserve base[3]
United States	248	240	The reserves and reserve base in most major producing countries are ample in relation to demand. Quantitative estimates are not available.
Brazil	214	230	
Canada	66	66	
China	1,970	2,200	
France	139	150	
Iceland	75	79	
India	35	35	
Kazakhstan	83	88	
Norway	326	330	
Poland	35	37	
Russia	538	530	
Slovakia	33	34	
South Africa	138	140	
Spain	55	59	
Ukraine	163	180	
Venezuela	59	62	
Other countries	210	210	
World total (rounded)	4,390	4,700	

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, in descending order of production, were China, Russia, Norway, Ukraine, and Brazil, and for silicon metal China, the United States, Brazil, Norway, and France. China was by far the leading producer of both ferrosilicon and silicon metal. An estimated 700,000 tons of silicon metal is included in China's total silicon production for 2004.

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 2004, U.S. mine production of silver was about 1,200 tons, with an estimated value of $184 million. Alaska replaced Nevada as the leading U.S. silver producer. Precious-metal ores accounted for less than 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 3,100 tons. About 30 fabricators accounted for more than 90% of the silver used in arts and industry. The remainder was used 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:	2000	2001	2002	2003	2004[e]
Production:					
Mine	1,860	1,740	1,420	1,240	1,200
Refinery:					
Primary	2,780	2,640	2,580	1,410	1,400
Secondary	1,680	1,060	1,030	1,600	1,700
Imports for consumption[2]	3,810	3,310	4,600	4,510	3,700
Exports[2]	279	963	624	181	340
Consumption, apparent[e]	6,300	5,800	7,700	5,430	6,200
Price, dollars per troy ounce[3]	5.00	4.39	4.62	4.91	6.46
Stocks, yearend:					
Treasury Department[4]	220	220	220	220	220
COMEX, CBT[5]	2,920	3,340	3,290	3,260	3,200
National Defense Stockpile	458	200	—	—	—
Employment, mine and mill,[6] number	1,500	1,100	1,000	980	900
Net import reliance[7] as a percentage of apparent consumption[e]	43	44	68	56	54

Recycling: About 1,700 tons of silver was recovered from old and new scrap in 2004.

Import Sources (2000-03):[2] Mexico, 44%; Canada, 34%; United Kingdom 11; Peru, 7%; 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 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. The transfer marked the end of silver requirements for the National Defense Stockpile.

Stockpile Status—9-30-04[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Silver	—	—	—	—	—

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 fifth successive year. The decline exceeded that of the 2 previous years combined by more than 4%. In 2004, estimated sales of digital cameras could increase 31% to reach 23 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 should accelerate.

In 2004, silver prices averaged $6.46 per troy ounce, up about 30% year-on-year. Prices were driven by increased investor interest and higher fabrication demand.

The deficit between world silver fabrication demand and world silver supply (mine production and scrap) remained large in 2004 at about 1,700 tons.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[8]	Reserve base[8]
	2003	2004[e]		
United States	1,240	1,200	25,000	80,000
Australia	1,872	2,230	31,000	37,000
Canada	1,309	1,300	16,000	35,000
Chile	1,250	1,300	NA	NA
China	2,500	2,600	26,000	120,000
Mexico	2,569	2,850	37,000	40,000
Peru	2,774	2,800	36,000	37,000
Poland	1,200	1,200	51,000	140,000
Other countries	4,100	4,000	50,000	80,000
World total (rounded)	18,800	19,500	270,000	570,000

World Resources: More than two-thirds of U.S. and world resources of silver are associated with copper, lead, and zinc deposits, often at great depths. The remaining reserves are in vein deposits in which gold is the most valuable metallic component. Although most recent discoveries have been primarily gold 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: U.S. Department of Labor, Mine Safety and Health Administration.
[7]Defined as imports – exports + adjustments for Government and industry stock changes.
[8]Includes silver recoverable from base-metal ores. See Appendix C for definitions.

SODA ASH

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: The total value of domestic soda ash (sodium carbonate) produced in 2004 was estimated to be about $820 million[1]. The U.S. soda ash industry 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 mothballed plant in Colorado that owns one of the Wyoming plants. The five producers have a combined annual nameplate capacity of 14.5 million tons. Sodium bicarbonate, sodium sulfate, potassium chloride, potassium sulfate, borax, and other minerals were produced as coproducts of sodium carbonate production in California. Sodium bicarbonate, sodium sulfite, and chemical caustic soda were manufactured as coproducts at several of the Wyoming soda ash plants. Sodium bicarbonate was produced at the Colorado operation.

Based on final 2003 reported data, the estimated 2004 distribution of soda ash by end use was glass, 49%; chemicals, 28%; soap and detergents, 11%; distributors, 4%; miscellaneous uses, 3%; flue gas desulfurization, 2%; pulp and paper, 2%; and water treatment, 1%.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production[2]	10,200	10,300	10,500	10,600	10,800
Imports for consumption	75	33	9	5	5
Exports	3,900	4,090	4,250	4,450	4,700
Consumption:					
Reported	6,390	6,380	6,430	6,270	6,200
Apparent	6,430	6,310	6,250	6,090	6,300
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	66.23	67.79	68.00	65.31	69
Stocks, producer, yearend	245	226	222	330	200
Employment, mine and plant, number	2,600	2,700	2,600	2,600	2,500
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: There is no recycling of soda ash by producers; however, glass container producers are using cullet glass, thereby reducing soda ash consumption.

Import Sources (2000-03): Canada, 99%; and other, 1%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-04**
Disodium carbonate	2836.20.0000	1.2% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: The soda ash plant in Colorado that came onstream in late 2000 was mothballed in September 2004; however, the sodium bicarbonate part of the operation will continue but will use soda ash feedstock shipped from the company's Wyoming facility. The Colorado facility continued to produce soda ash from underground nahcolite ore through August. The same company also merged its chemical businesses with its mineral operations and renamed the company. In addition, the company formed a joint venture with a major Chinese soda ash manufacturer that has a plant in Lianyungang.

The United States had been the world's leader in soda ash production for nearly 100 years until China, a major world producer of synthetic soda ash, surpassed the United States in 2003 by producing 11.1 million tons. By midyear 2004, China was on pace to produce 12 million tons of soda ash.

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

SODA ASH

Although the domestic and export markets improved in 2004, approximately 2.8 million tons of nameplate capacity remained mothballed in the United States. This surplus capacity adversely affected the U.S. soda ash industry's efforts to increase prices in the past couple of years. The industry announced price increases of $22 per short ton in the third quarter 2004 to offset higher energy and transportation costs. It was uncertain by yearend how much of the increase will be realized for the following year, but industry sources were optimistic that most of the proposed price increase would be accepted by consumers.

A new soda ash project was proposed in Kazakhstan in the Zhambul region by a large detergent company in conjunction with a Turkish investor. The synthetic soda ash plant would have an annual capacity of 200,000 tons. There are more than 35 different companies in Kazakhstan that presently use soda ash in varying quantities.

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 may be slightly higher in 2005.

World Production, Reserves, and Reserve Base:

	Production		Reserves[4, 5]	Reserve base[5]
Natural:	2003	2004[e]		
United States	10,600	10,800	* [6]23,000,000	* [6]39,000,000
Botswana	285	280	400,000	NA
Kenya	350	350	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)	11,200	11,400	24,000,000	40,000,000
World total, synthetic (rounded)	26,800	27,600	XX	XX
World total (rounded)	38,000	39,000	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. *Corrected on November 30, 2005.
[1]Does not include values for soda liquors and mine waters.
[2]Natural only.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]The reported quantities are sodium carbonate only. About 1.8 tons of trona yields 1 ton of sodium carbonate.
[5]See Appendix C for definitions.
[6]From trona, nahcolite, and dawsonite sources.

SODIUM SULFATE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: The domestic natural sodium sulfate industry consisted of two producers operating two plants, one each in California and Texas. Fourteen companies operating 17 plants in 14 States recovered byproduct sodium sulfate from various manufacturing processes or products, including ascorbic acid, battery reclamation, cellulose, rayon, and silica pigments. About one-half of the total output in 2004 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:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production, total (natural and synthetic)[1]	462	512	500	472	425
Imports for consumption	73	34	51	45	45
Exports	165	191	139	154	140
Consumption, apparent (natural and synthetic)	370	355	412	363	330
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 (2000-03): Canada, 90%; Mexico, 6%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: Although there was an oversupply of sodium sulfate in the North American markets in the past several years, the closure of nearly 300,000 tons of capacity in Canada has helped balance the domestic market for sodium sulfate.

The majority of the uses of sodium sulfate have shown flat or negative growth. 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 2005 is expected to be comparable with that of 2004, with detergents remaining the leading sodium-sulfate-consuming sector. If the winter of 2004-05 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 $9.7 billion was produced by 1,200 companies operating 3,200 active quarries and 180 sale/distribution yards in 49 States. Leading States, in order of production, were Texas, Pennsylvania, Florida, Georgia, Illinois, Missouri, Ohio, Virginia, North Carolina, and Tennessee, together accounting for 53.1% of the total output. Of the total crushed stone produced in 2004, about 70% was limestone and dolomite; 16%, granite; 8%, traprock; and the remaining 6% was shared, in descending order of quantity, by sandstone and quartzite, miscellaneous stone, marble, calcareous marl, slate, shell, and volcanic cinder and scoria. It is estimated that of the 1.6 billion tons of crushed stone consumed in 2004, 33% was for unspecified uses, and 15% was estimated for nonrespondents to the U.S. Geological Survey (USGS) canvasses. Of the remaining 806 million tons reported by uses, 82% was used as construction aggregates mostly for highway and road construction and maintenance; 15% for chemical and metallurgical uses, including cement and lime manufacture; 2% for agricultural uses; and 1% for special and miscellaneous uses and products. To provide a more accurate estimate of the consumption patterns for crushed stone, the "unspecified uses—reported and estimated" as defined in the USGS Minerals Yearbook, are not included in the above percentages.

The estimated output of crushed stone in the 48 conterminous States shipped for consumption in the first 9 months of 2004 was 1.21 billion tons, a 7.7% increase compared with the same period of 2003. The third quarter shipments for consumption increased by 5.6% compared with the same period of 2003. 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:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production	1,550	1,590	1,510	1,530	1,600
Imports for consumption	13	14	14	15	15
Exports	4	4	3	1	2
Consumption, apparent[3]	1,560	1,600	1,530	1,540	1,610
Price, average value, dollars per metric ton	5.39	5.57	5.71	5.98	6.08
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e, 4]	78,800	79,200	79,000	78,500	78,700
Net import reliance[5] as a percentage of apparent consumption	([6])	([6])	([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 (2000-03): Canada, 45%; Mexico, 40%; The Bahamas, 13%; and other, 2%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12-31-04**
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 increased 4.6% in 2004 to 1.6 billion tons compared with 2003. It is estimated that in 2005, domestic production and apparent consumption will be about 1.65 billion tons, a 3.1% increase. Gradual increases in demand for construction aggregates are anticipated after 2005 based on the expected volume of work on the infrastructure and an expanding U.S. economy. 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 health and environmental regulations. Shortages in some urban and industrialized areas are expected to continue to increase, owing to local zoning regulations and land-development alternatives. These issues are expected to continue and to cause crushed stone quarries to relocate away from large-population centers.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[7]
	2003	2004[e]	
United States	1,530	1,600	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 1.30 million tons of dimension stone, valued at $257 million, was sold or used in 2004. 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 Texas. These five States accounted for about 50% of the production. Leading producer States, in descending order by value, were Indiana, Vermont, Texas, Georgia, and South Dakota. These States contributed about 49% of the value of domestic production. Approximately 35%, by tonnage, of dimension stone sold or used was granite, followed by limestone (28%), miscellaneous stone (18%), sandstone (13%), marble (5%), and slate (1%). By value, the leading sales or uses were for granite (42%), followed by limestone (28%), miscellaneous stone (10%), sandstone (9%), marble (7%), and slate (4%). Rough block represented 55% of the tonnage and 42% of the value of all the dimension stone sold or used by domestic producers, including exports. The leading uses of rough block, by tonnage, were in construction (41%) and monumental stone (25%) applications. Dressed stone mainly was sold for flagging (25%), ashlars and partially squared pieces (24%), and curbing (22%), by tonnage.

Salient Statistics—United States:[2]	2000	2001	2002	2003	2004[e]
Production:					
Tonnage	1,320	1,220	1,260	1,340	1,300
Value, million dollars	235	263	254	268	257
Imports for consumption, value, million dollars	986	1,070	1,190	1,390	1,490
Exports, value, million dollars	60	74	64	64	64
Consumption, apparent, value, million dollars	1,160	1,260	1,380	1,590	1,680
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)	78	79	82	83	85
Granite only:					
Production	415	408	431	463	452
Imports for consumption	NA	NA	NA	NA	NA
Exports (rough and finished)	116	141	140	144	144
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 (2000-03 by value): Dimension stone: Italy, 40%; Canada, 14%; India, 11%; Spain, 9%; and other, 26%. Granite only: Italy, 41%; Brazil, 18%; India, 12%; Canada, 11%; and other, 18%.

Tariff: Dimension stone tariffs ranged from free to 6.5% ad valorem, according to type, degree of preparation, shape, and size, for countries with normal trade relations in 2004. 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 decreased to about 1.30 million tons, with value decreasing to $257 million in 2004. Imports of dimension stone continued to increase. Imports increased by 7% in value to about $1.50 billion. Dimension stone exports remained steady at about $64 million. Apparent consumption, by value, was $1.70 billion in 2004—an $89 million increase from 2003. Dimension stone is being used more commonly in residential markets. 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 the demand for dimension stone will continue to increase during the next 5 years.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	2003	2004[e]	
United States	1,340	1,300	Adequate except for certain
Other countries	NA	NA	special types and local
World total	NA	NA	shortages.

World Resources: Dimension stone resources of the world are sufficient. Resources can be limited on a local level or occasionally on a regional level by the lack of a particular kind of stone that is suitable for dimension purposes.

Substitutes: 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:	2000	2001	2002	2003	2004[e]
Production	—	—	—	—	—
Imports for consumption:					
Strontium minerals	7,460	5,640	1,150	1,020	2,500
Strontium compounds	29,900	26,500	25,400	23,300	16,000
Exports, compounds	4,520	929	340	693	310
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent, celestite and compounds	32,800	31,200	26,500	23,600	18,000
Price, average value of mineral imports at port of exportation, dollars per ton	62	63	60	58	54
Net import reliance[2] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (2000-03): 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 12-31-04
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: About 11,600 tons of nonstockpile-grade celestite containing about 5,100 tons of strontium is in the National Defense Stockpile. 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 2004 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: China has become the world's leading producer of strontium carbonate with the plant capacity to produce 200,000 tons per year, followed by Germany and Mexico with 95,000 and 103,000 tons per year, respectively. China uses domestic and imported celestite to supply its plants, the German producer uses imported celestite, and Mexican producers use domestic ore to supply their plants. 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, but appears to be decreasing as the popularity of flat panel television monitors grows. Domestic consumption of strontium carbonate decreased in the past 4 years as a result of a shift in production facilities for color televisions to other countries. China, Europe, and North America are the most important markets for televisions. Southeast Asia and Latin America have higher growth rates, potentially representing huge markets for television manufacturers and thus the strontium carbonate industry. Flat screen technology, which does not require strontium carbonate, likely will continue to 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]
	2003	2004[e]		
United States	—	—	—	1,400,000
Argentina	3,320	3,300	All other:	All other:
China[e]	100,000	150,000	6,800,000	11,000,000
Iran	2,000	2,000		
Mexico	127,000	130,000		
Morocco	2,700	3,000		
Pakistan	2,000	2,000		
Spain	160,000	150,000		
Tajikistan	NA	NA		
Turkey	70,000	70,000		
World total (rounded)	[5]470,000	[5]510,000	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 2004, elemental sulfur and byproduct sulfuric acid were produced at 114 operations in 30 States and the U.S. Virgin Islands. Total shipments were valued at about $300 million. Elemental sulfur production was 9.3 million tons; Louisiana and Texas accounted for about 46% of domestic production. Elemental sulfur was recovered at petroleum refineries, natural-gas-processing plants, and coking plants by 38 companies at 108 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 about 7% of production of sulfur in all forms, was recovered at six nonferrous smelters in six States by six companies. Domestic elemental sulfur provided 70% of domestic consumption, and byproduct acid accounted for 6%. The remaining 24% 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 60% of reported sulfur demand; petroleum refining, 25%; and metal mining, 3%. Other uses, accounting for 12% of demand, were widespread because a multitude of industrial products required sulfur in one form or another during some stage of their manufacture.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production:					
Frasch[e]	900	—	—	—	—
Recovered elemental	8,590	8,490	8,500	8,920	9,300
Other forms	1,030	982	772	683	700
Total (may be rounded)	[e]10,500	9,470	9,270	9,600	10,000
Shipments, all forms	10,700	9,450	9,260	9,600	10,000
Imports for consumption:					
Recovered, elemental	2,330	1,730	2,560	2,870	2,800
Sulfuric acid, sulfur content	463	462	346	297	300
Exports:					
Recovered, elemental	762	675	687	742	620
Sulfuric acid, sulfur content	62	69	48	67	55
Consumption, apparent, all forms	12,700	10,900	11,400	12,000	12,400
Price, reported average value, dollars per ton of elemental sulfur, f.o.b., mine and/or plant	24.73	10.01	11.84	28.71	28.00
Stocks, producer, yearend	208	232	181	206	200
Employment, mine and/or plant, number	3,000	2,700	2,700	2,700	2,700
Net import reliance[1] as a percentage of apparent consumption	18	13	19	20	20

Recycling: Between 3 million and 5 million tons of spent sulfuric acid was reclaimed from petroleum refining and chemical processes.

Import Sources (2000-03): Elemental: Canada, 73%; Mexico, 19%; Venezuela, 6%; and other, 2%. Sulfuric acid: Canada, 49%; Mexico, 22%; Germany, 5%; Japan, 3%; and other, 21%. Total sulfur imports: Canada, 70%; Mexico, 19%; Venezuela, 5%; and other, 6%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 2004 than it was in 2003 because sulfur recovered at natural-gas-processing facilities and oil refineries increased. 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 is expected 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 decreased significantly since 2000 because four U.S. copper smelters have closed since then. It is unlikely that any of these will reopen. World sulfur production increased slightly because recovered sulfur production increased at natural-gas-processing plants, oil refineries, and nonferrous smelters in many countries.

Domestic phosphate rock consumption was slightly higher in 2004 than in 2003, with a slight increase in demand for sulfur to process the phosphate rock into phosphate fertilizers, although severe weather in late summer negatively affected the sulfur industry around the Gulf of Mexico. Increased worldwide sulfur demand drove prices higher, which encouraged expansion in world trade. Canadian sulfur stocks were remelted to meet increased demand for overseas trade.

World Production, Reserves, and Reserve Base:

	Production—All forms	
	2003	2004[e]
United States	9,600	10,000
Australia	923	900
Canada	9,030	8,500
Chile	1,300	1,300
China	6,090	6,100
Finland	706	710
France	1,000	1,000
Germany	2,360	2,400
India	1,020	1,100
Iran	1,360	1,400
Italy	684	700
Japan	3,310	3,500
Kazakhstan	1,930	2,500
Korea, Republic of	1,300	1,300
Kuwait	714	720
Mexico	1,610	1,650
Netherlands	527	550
Poland	1,180	1,100
Russia	6,600	6,800
Saudi Arabia	2,400	2,400
Spain	706	700
United Arab Emirates	1,900	1,900
Other countries	5,550	5,500
World total (rounded)	61,800	63,000

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 2004 domestic talc production was $25 million. There were 10 talc-producing mines in 5 States in 2004. Companies in Montana, New York, Texas, and Vermont accounted for most of the domestic production. Domestically produced ground talc was used in ceramics, 32%; paint, 19%; paper, 16%; roofing, 6%; plastics, 4%; rubber, 2%; cosmetics, 2%; and other, 19%. One company in California and two companies in North Carolina mined pyrophyllite. Production of pyrophyllite declined slightly from that of 2003. Consumption was, in decreasing order by tonnage, in refractory products, ceramics, and paint.

Salient Statistics—United States:[1]	2000	2001	2002	2003	2004[e]
Production, mine	851	863	828	869	911
Sold by producers	821	784	793	875	872
Imports for consumption	270	180	232	237	220
Exports	154	137	166	192	210
Shipments from Government stockpile excesses	—	—	—	([2])	([2])
Consumption, apparent	967	906	894	914	921
Price, average, processed dollars per ton	116	108	99	90	112
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill	640	520	510	460	450
Net import reliance[3] as a percentage of apparent consumption	12	5	7	5	1

Recycling: Insignificant.

Import Sources (2000-03): China, 46%; Canada, 23%; France, 5%; Japan, 3%; and other, 23%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: 23% (Domestic), 15% (Foreign). Other: 15% (Domestic and foreign).

Government Stockpile:

Stockpile Status—9-30-04[4]
(Metric tons)

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Talc, block and lump	867	—	867	[5]907	—
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 2003. Apparent consumption increased slightly. Exports increased by 9% compared with those of 2003. Canada remained the major destination for U.S. talc exports, accounting for about 33% of the tonnage. U.S. imports of talc decreased by 7% compared with those of 2003. In 2004, Canada and China supplied approximately 97% of the imported talc.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	2003	2004[e]		
United States[1]	869	911	140,000	540,000
Brazil	400	500	180,000	250,000
China	3,600	2,700	Large	Large
India	555	560	4,000	9,000
Japan	640	600	100,000	160,000
Korea, Republic of	940	950	14,000	18,000
Other countries	1,920	1,900	Large	Large
World total (rounded)	8,920	8,120	Large	Large

World Resources: The United States is self-sufficient in most grades of talc and related minerals. Domestic and world resources are estimated to be approximately five times the quantity of reserves.

Substitutes: 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 2004 was estimated at about $180 million.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production, mine	—	—	—	—	—
Imports for consumption:					
Mineral concentrates[e]	650	690	710	490	450
Tantalum metal and tantalum-bearing alloys[e]	251	316	266	249	450
Exports, concentrate, metal, alloys, waste, scrap[e]	530	600	490	570	650
Government stockpile releases[e, 1]	242	(53)	16	335	66
Consumption, apparent	650	550	500	500	520
Price, tantalite, dollars per pound[2]	220.00	37.00	31.00	28.00	30.80
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 (2000-03): Australia, 57%; Kazakhstan, 9%; Canada, 8%; China, 6%; and other, 20%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 2004, the Defense National Stockpile Center (DNSC), Defense Logistics Agency, sold about 18 tons of tantalum capacitor-grade metal powder, about 11 tons of tantalum metal ingots, about 317 tons of tantalum contained in tantalum-columbium minerals, and about 5 tons of tantalum contained in tantalum oxide from the National Defense Stockpile. There were no sales of tantalum carbide powder in fiscal year 2004. The DNSC announced maximum disposal limits in fiscal year 2005 of about 2 tons[4] of tantalum contained in tantalum carbide powder, about 18 tons[5] of tantalum contained in tantalum metal ingots, about 18 tons[4] of tantalum contained in tantalum metal powder, about 227 tons[4] of tantalum contained in tantalum minerals, and about 9 tons[4] of tantalum contained in tantalum oxide.

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

TANTALUM

Stockpile Status—9-30-04[6]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2004**	**Disposals FY 2004**
Tantalum:					
Carbide powder	6	—	6	[5]2	—
Metal:					
Powder	16	—	16	[5]18	18
Ingots	9	—	9	[5]18	11
Minerals	508	20	508	227	317
Oxide	23	—	23	9	5

Events, Trends, and Issues: Apparent consumption of tantalum in 2004 rose slightly owing to increased demand from the electronics sector. Overall tantalum imports increased. However, imports for consumption of tantalum mineral concentrates were down, with Australia supplying about 75% of the quantity and about 90% of the value. Exports increased; Brazil, China, Germany, Israel, Japan, Thailand, and the United Kingdom were the major recipients of the tantalum materials. The price for tantalum is affected most by events in the supply of and demand for tantalum minerals. In September, quoted spot price ranges for tantalum minerals (per pound tantalum pentoxide content), in three published sources, were \$20 to \$30, \$25 to \$30, and \$30 to \$40. Public information on current prices for tantalum products was not available. According to industry sources, the pricing for tantalum products is mostly established by negotiation between buyer and seller; product specifications, volume, and processing requirements influence the negotiated price.

World Mine Production, Reserves, and Reserve Base:

	Mine production[7] **2003**	**2004**[e]	**Reserves**[8]	**Reserve base**[8]
United States	—	—	—	Negligible
Australia	765	800	40,000	80,000
Brazil	200	200	NA	73,000
Burundi	14	15	NA	NA
Canada	55	55	3,000	NA
Congo (Kinshasa)	15	20	NA	NA
Ethiopia	35	35	NA	NA
Mozambique	75	75	NA	NA
Namibia	11	30	NA	NA
Nigeria	23	25	NA	NA
Rwanda	14	15	NA	NA
Uganda	2	2	NA	NA
Zimbabwe	1	1	NA	NA
Other countries[9]	—	—	NA	NA
World total (rounded)	1,210	1,270	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 2004 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; additional legislative authority is required.
[5]Actual quantity limited to remaining sales authority or inventory.
[6]See Appendix B for definitions.
[7]Excludes production of tantalum contained in tin slags.
[8]See Appendix C for definitions.
[9]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 alloys, to improve machinability without reducing conductivity; in lead alloys, to improve resistance to vibration and fatigue; in cast iron, to help control the depth of chill; and in malleable iron, as a carbide stabilizer. It is used in the chemical industry as a vulcanizing agent and accelerator in the processing of rubber and as a component of catalysts for synthetic fiber production. Tellurium'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 2004, 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:	2000	2001	2002	2003	2004[e]
Production, refinery	W	W	W	W	W
Imports for consumption, unwrought, waste and scrap	52	28	28	48	70
Exports	7	7	2	10	10
Consumption, apparent	W	W	W	W	W
Price, dollars per pound, 99.95% minimum[1]	5	7	7	10	12
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 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 (2000-03): Philippines, 31%; Belgium, 21%; Germany; 18%; United Kingdom, 13%; and other, 17%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Tellurium	2804.50.0020	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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

TELLURIUM

Events, Trends, and Issues: Estimated domestic tellurium production decreased in 2004 as compared with that of 2003, and the domestic consumption was estimated to have increased during the same period. World tellurium consumption was also estimated to have increased slightly in 2004. World production of tellurium, a byproduct of copper refining, increased owing to an increase in world copper production. Russian tellurium production reportedly was significantly higher than that of 2003. 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 United States. In the short term, significant increases are not anticipated in either consumption or production, although increases in copper production may increase 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 was increasing in thermal elements for small ice packs and refrigerators.

Tellurium alloyed with germanium and antimony used in digital video discs (DVDs) consumes only small amounts of tellurium and will, therefore, have minimal impact on tellurium demand. However, new developments in bismuth-coupling material, which consists of bismuth, germanium, and tellurium and enables DVDs to be rewritable at high and low recording speeds, could have an impact on world demand.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[3]	Reserve base[3]
	2003	2004[e]		
United States	W	W	3,000	6,000
Canada	45	40	650	1,500
Japan	28	35	—	—
Peru	20	20	1,600	2,800
Other countries[4]	NA	NA	16,000	37,000
World total (rounded)	[5]93	[5]95	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 wide use 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]Average yearend price published by Mining Journal for United Kingdom lump and powder, 99.95% tellurium.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions. Estimates include tellurium contained in copper resources only.
[4]In addition to the countries listed, Australia, Belgium, China, Germany, Kazakhstan, the Philippines, and Russia produce refined tellurium, but output is not reported, and available information is inadequate for formulation of reliable production estimates.
[5]Excludes refinery production from the United States.

THALLIUM

(Data in kilograms of thallium content unless otherwise noted)

Domestic Production and Use: Thallium is a byproduct metal recovered in some countries from flue dusts and residues collected in the smelting of copper, zinc, and lead ores. Although thallium was contained in ores mined or processed in the United States, it has not been recovered domestically since 1981. Consumption of thallium metal and thallium compounds continued for most of its established end uses. These included the use of radioactive thallium isotope 201 for medical purposes in cardiovascular imaging; thallium as an activator (sodium iodide crystal doped with thallium) in gamma radiation detection equipment (scintillometer); thallium-barium-calcium-copper oxide high-temperature superconductor (HTS) used in filters for wireless communications; thallium in lenses, prisms and windows for infrared detection and transmission equipment; thallium-arsenic-selenium crystal filters for light diffraction in acousto-optical measuring devices; and thallium as an alloying component with mercury for low-temperature measurements. Other uses included an additive in glass to increase its refractive index and density, a catalyst or intermediate in the synthesis of organic compounds, and a component in high-density liquids for sink-float separation of minerals.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004**[e]
Production, mine	([1])	([1])	([1])	([1])	([1])
Imports for consumption[2]					
Unwrought powders	NA	NA	49	36	150
Formed and articles	NA	NA	258	45	70
Waste and scrap	NA	NA	—	—	110
Total	100	2,110	307	81	330
Exports[3]					
Unwrought powders	NA	NA	—	490	250
Formed and articles	NA	NA	463	1,557	1,250
Waste and scrap	NA	NA	188	39	—
Total	NA	NA	651	2,086	1,500
Consumption[4]	300	800	500	NA	NA
Price, metal, dollars per kilogram[5]	1,295	1,295	1,250	1,300	1,300
Net import reliance[6]	100	100	100	100	100

Recycling: None.

Import Sources (2000-03): Belgium, 93%; France, 4%; Russia, 3%; and United Kingdom, less than 1%.

Tariff: Item	**Number**	**Normal Trade Relations**[7] **12-31-04**
Unwrought and powders	8112.51.0000	4.0% ad val.
Waste and scrap	8112.52.0000	Free.
Other	8112.59.0000	4.0% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Research and development activities of both a basic and applied nature were conducted during 2004 that could improve and expand the use of thallium. These activities included the development of HTS materials for such applications as magnetic resonance imaging, storage of magnetic energy, magnetic propulsion, more efficient electrical motors, and electric power generation and transmission. Materials are considered HTS if they have a critical transition (to superconductivity) temperature (Tc) above 77 K, the boiling temperature of liquid nitrogen. Presently, the HTS material attaining the highest Tc, 138 K, is a mercury-thallium-barium-calcium-copper oxide mix. Improved methods for manufacturing high-temperature superconductor tapes and films, such as thallium-barium-calcium-copper oxides with a Tc of 133 K were under development. These tapes and films could be significant energy savers if used in ultra-fast computers and power transmission systems.

A broad range of commercial applications would become available if HTS materials can be fabricated on a large scale into wires having a certain degree of flexibility and strength. Currently, HTS materials are relatively brittle metal-oxide ceramics. There are now more than 50 known HTS materials, but only two (two different formulations of bismuth-strontium-calcium-copper oxides) have been used successfully to form long-length wires.

Prepared by **Peter N. Gabby [(703) 648-4957, pgabby@usgs.gov, fax: (703) 648-7757]**

THALLIUM

In medical applications, dipyridamole-thallium imaging continued to be a useful preoperative procedure for assessing long-term cardiac risks in patients with coronary artery disease or diabetes who are undergoing peripheral vascular surgery. Further use of radioactive thallium in clinical diagnostic applications, including cardiovascular and oncological imaging, was studied during 2004.

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 2004, the U.S. Environmental Protection Agency (EPA) continued health assessments on thallium and thallium compounds 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 readsorption in the intestine by fixing the metal through ion exchange with the drug.

World Mine Production, Reserves, and Reserve Base:[8]

	Mine production		Reserves[9]	Reserve base[9]
	2003	2004		
United States	([1])	([1])	32,000	120,000
Other countries	15,000	15,000	350,000	530,000
World total (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 to be 0.7 part per million.

Substitutes: The apparent leading potential new demand for thallium could be in the area of HTS materials; but demand will be based on which HTS formulation has a combination of favorable electric and physical qualities, and is best suited for fabrication. A firm presently using a thallium HTS material in filters for wireless communications is considering using a non-thallium HTS material next year (2005). While research in HTS continues, and thallium is part of that research effort, it is not guaranteed HTS products will be a large user of thallium in the future.

While other materials and formulations can substitute for thallium in gamma radiation detection equipment, and optics used for infrared detection and transmission, these thallium materials are presently superior and more cost effective for theses very specialized uses.

Thallium in the past was used as semiconductor material for selenium rectifiers. In the United States, selenium rectifiers are sold to a small market of hobbyist collectors of vintage radios and televisions, and even in this market, there are better and safer substitute materials.

While thallium is still used in high-density liquids for sink-float separation of minerals, nonpoisonous substitutes like tungsten compounds are being marketed.

[e]Estimated. NA Not available. — Zero.
[1]No reported mine production; flue dust and residues from base-metal smelters, from which thallium metal and compounds may be recovered, are being exported to Canada, France, the United Kingdom, and other countries.
[2]Reported only as total unwrought, powders, and waste and scrap prior to 2002.
[3]Export data not available prior to 2002.
[4]Based on reported imports and estimated drawdown of private stocks.
[5]Estimated price of 99.999%-pure granules in 100-gram lots.
[6]Defined as imports – exports + adjustments for Government and industry stock changes. Since thallium has not been produced domestically since 1981, it was assumed that consumption and exports of unwrought thallium were from imported material or from a drawdown in unreported inventories.
[7]Under the North American Free Trade Agreement, there is no tariff for Canada or Mexico.
[8]Estimates are based on thallium content of zinc ores.
[9]See Appendix C for definitions.

THORIUM

(Data in metric tons of thorium oxide (ThO_2) equivalent unless otherwise noted)

Domestic Production and Use: The primary source of the world's thorium is the rare-earth and thorium phosphate mineral, monazite. In the United States, thorium has been a byproduct of refining monazite for its rare-earth content. Monazite itself is recovered as a byproduct of processing heavy-mineral sands for titanium and zirconium minerals. In 2004, 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 decreased to about $160,000.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[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	11.10	1.85	0.65	4.14	4.68
Thorium compounds (oxide, nitrate, etc.), ThO_2 content	8.20	1.37	0.48	3.06	3.47
Exports:					
Thorium ore and concentrates (monazite), gross weight	—	—	—	—	—
Thorium ore and concentrates (monazite), ThO_2 content	—	—	—	—	—
Thorium compounds (oxide, nitrate, etc.), gross weight	4.64	7.30	0.88	0.59	0.30
Thorium compounds (oxide, nitrate, etc.), ThO_2 content	3.43	5.40	0.65	0.44	0.22
Shipments from Government stockpile excesses ($ThNO_3$)	—	—	—	—	—
Consumption:					
Reported, (ThO_2 content[e])	6.0	—	NA	NA	NA
Apparent	7.7	NA	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	100	100	100

Recycling: None.

Import Sources (2000-03): Monazite: None. Thorium compounds: France, 99.6%; and other, 0.4%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-04**
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—9-30-04[6]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2004**	**Disposals FY 2004**
Thorium nitrate (gross weight)	3,219	—	3,219	3,221	—

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 2004. 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 2004, according to the U.S. Geological Survey's canvass of mines and processors. In 2004, consumption was believed to be primarily by catalyst manufacturers and was estimated to have increased. On the basis of data through August 2004, the average value of imported thorium compounds decreased to $33.50 per kilogram from the 2003 average of $35.95 per kilogram (gross weight). The average value of exported thorium compounds was $819.69 per kilogram based on data through August 2004. 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]
	2003	2004		
United States	—	—	160,000	300,000
Australia	—	—	300,000	340,000
Brazil	NA	NA	16,000	18,000
Canada	NA	NA	100,000	100,000
India	NA	NA	290,000	300,000
Malaysia	—	—	4,500	4,500
Norway	—	—	170,000	180,000
South Africa	—	—	35,000	39,000
Other countries	NA	NA	90,000	100,000
World total	NA	NA	1,200,000	1,400,000

Reserves and reserve base are contained primarily in the rare-earth ore mineral, monazite. Without demand for the rare earths, monazite would probably not be recovered for its thorium content. Other ore minerals with higher thorium contents, such as thorite, would be more likely sources if demand significantly increased. No new demand, however, is expected. Reserves exist primarily in recent and ancient placer deposits. Lesser quantities of thorium-bearing monazite reserves occur in vein deposits and carbonatites.

World Resources: Thorium resources occur in geologic provinces similar to those that contain reserves. The leading share is contained in placer deposits. Resources of more than 500,000 tons are contained in placer, vein, and carbonatite deposits. Disseminated deposits in various other alkaline igneous rocks contain additional resources of more than 2 million tons. Large thorium resources are found in Australia, Brazil, Canada, Greenland, India, South Africa, and the United States.

Substitutes: Nonradioactive substitutes have been developed for many applications of thorium. Yttrium compounds have replaced thorium compounds in incandescent lamp mantles. A magnesium alloy containing lanthanides, zirconium, and yttrium can substitute for magnesium-thorium alloys in aerospace applications.

[e]Estimated. NA Not available. — Zero.
[1]All domestically consumed thorium was derived from imported materials.
[2]Source: U.S. Department of Defense, Defense Logistics Agency. Based on sales from the National Defense Stockpile.
[3]Source: Rhodia Canada, Inc., and Rhodia Electronics and Catalysis, Inc., f.o.b. port of entry, duty paid, ThO_2 basis.
[4]Source: Rhodia Electronics and Catalysis, Inc., 1-950 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 80% of the primary tin consumed domestically in 2004. 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, $468 million; imports for consumption, refined tin, $567 million; and secondary production (old scrap), $85 million.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production:					
Secondary (old scrap)	6,560	6,700	[1]6,760	[1]5,420	6,000
Secondary (new scrap)	9,140	7,200	[1]3,790	[1]2,460	3,000
Imports for consumption, refined tin	44,900	37,500	42,200	37,100	40,000
Exports, refined tin	6,640	4,350	2,940	3,690	4,600
Shipments from Government stockpile excesses	12,000	12,000	8,960	8,880	9,000
Consumption, reported:					
Primary	38,100	34,200	34,000	32,900	33,000
Secondary	8,940	7,630	5,830	4,490	5,000
Consumption, apparent	57,200	48,300	[1]55,700	[1]48,700	50,400
Price, average, cents per pound:					
New York market	255	211	195	232	412
New York composite	370	315	292	340	643
London	246	203	184	222	422
Kuala Lumpur	244	201	184	222	386
Stocks, consumer and dealer, yearend	10,400	9,620	8,910	7,950	8,000
Net import reliance[2] as a percentage of apparent consumption	88	86	[1]88	[1]89	88

Recycling: About 9,000 tons of tin from old and new scrap was recycled in 2004. Of this, about 6,000 tons was recovered from old scrap at 3 detinning plants and 77 secondary nonferrous metal processing plants.

Import Sources (2000-03): Peru, 41%; China, 18%; Bolivia, 15%; Brazil, 12%; and other, 14%.

Tariff: Most major imports of tin, including unwrought metal, waste and scrap, and unwrought tin alloys, enters the United States duty free.

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

Government Stockpile: The Defense National Stockpile Center (DNSC) continued its long-term tin sales program. The DNSC Annual Materials Plan for tin sales for fiscal year 2004 (October 1, 2003, through September 30, 2004) 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 DNSC 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 2004, DNSC had only one long-term sale, and that was in July. Tin is held in Federal depots at three locations: Hammond, IN; New Haven, IN; and Point Pleasant, WV.

Stockpile Status—9-30-04[3]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2004**	**Disposals FY 2004**
Pig tin	25,100	9,760	25,100	12,000	8,880

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 60% in 2003 compared with 59% in 2002. Tin, as well as steel, is recovered in can recycling.

The price of tin experienced a fairly steady rise throughout 2004. Industry observers believed that the world tin supply-demand relationship was in a net supply deficit.

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 future domestic tinplate sources.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2003	2004[e]		
United States	—	—	20,000	40,000
Australia	6,500	1,200	110,000	300,000
Bolivia	15,000	16,900	450,000	900,000
Brazil	14,200	14,000	540,000	2,500,000
China	50,000	100,000	1,700,000	3,500,000
Indonesia	70,000	70,000	800,000	900,000
Malaysia	3,400	3,500	1,000,000	1,200,000
Peru	38,000	40,200	710,000	1,000,000
Portugal	1,000	500	70,000	80,000
Russia	2,000	2,500	300,000	350,000
Thailand	800	800	170,000	200,000
Vietnam	4,600	NA	NA	NA
Other countries	1,000	1,000	180,000	200,000
World total (rounded)	207,000	250,000	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]Production data for old and new scrap for 2002 and 2003 were reversed in the 2004 Mineral Commodity Summaries and are correctly shown here; revised entries for apparent consumption and net import reliance reflect this.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.
[4]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, Georgia, and Virginia. The value of titanium mineral concentrates consumed in the United States in 2004 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:	2000	2001	2002	2003	2004[e]
Production[2] (ilmenite and rutile, rounded)	300	300	300	300	300
Imports for consumption:					
Ilmenite and slag	647	737	599	569	560
Rutile, natural and synthetic	413	303	368	397	320
Exports,[e] all forms	2	5	2	7	4
Consumption, reported:					
Ilmenite and slag[3]	919	856	951	959	955
Rutile, natural and synthetic	497	448	452	453	400
Price, dollars per metric ton, yearend:					
Ilmenite, bulk, 54% TiO_2, f.o.b. Australian ports	94	100	93	90	90
Rutile, yearend, bulk, f.o.b. Australian ports	485	475	450	430	430
Slag:[e]					
80%-95% TiO_2, f.o.b. Sorel, Quebec	362-547	335-518	340-527	444-471	321-464
85% TiO_2, f.o.b. Richards Bay, South Africa	425	419	445	409	398
Stocks, mine, consumer, yearend:					
Ilmenite	262	221	197	200	200
Rutile	101	118	75	74	75
Employment, mine and mill, number[e]	360	360	366	269	323
Net import reliance[4] as a percentage of reported consumption	79	78	74	68	65

Recycling: None.

Import Sources (2000-03): South Africa, 43%; Australia, 36%; Canada, 13%; Ukraine, 5%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 production and consumption of titanium mineral concentrates was estimated to have decreased slightly in 2004 compared with that of 2003. Owing in part to the closure of a domestic titanium dioxide pigment plant, domestic consumption of titanium mineral concentrates decreased 4% compared with that of the previous year.

A heavy-mineral mining operation was commissioned in Lulaton, GA. The operation included a wet concentrator with a capacity to process 1,000 tons per hour of ore. Heavy-mineral concentrate from Lulaton was shipped to the Green Cove Springs, FL, mining operation for dry separation. Dredging operations at Green Cove Springs were idled while dry mining capacity was expanded.

International exploration and development for new sources of titanium minerals was underway in Australia (Coburn, Douglas, Lodlow, Poonscarie, Mindarie, Wemen), Canada (Athabasca oil sands, Truro), Madagascar (Fort-Dauphin), Mozambique (Corridor Sands, Moebase, Moma), India (Tamil Nadu), Kenya (Kwale), and South Africa (Xolobeni). In India, capacity to produce synthetic rutile was being increased by 9,000 tons per year. In Canada, plans were underway to increase capacity to upgrade sulfate-grade slag to chloride-grade slag by 95,000 tons per year. An extended shutdown was planned at the Tyssedal slag plant in Norway.

World Mine Production, Reserves, and Reserve Base: The reserves and reserve base estimates for Brazil, China, India, Norway, and Vietnam have been revised based on new information from those countries.

	Mine production		Reserves[5]	Reserve base[5]
	2003	2004[e]		
Ilmenite:				
United States[2]	[6]300	[6]300	6,000	59,000
Australia	1,170	1,090	200,000	250,000
Brazil	82	82	12,000	12,000
Canada[7]	765	720	31,000	36,000
China	400	410	200,000	350,000
India	270	250	85,000	210,000
Norway[7]	360	350	37,000	60,000
South Africa[7]	1,080	1,130	63,000	220,000
Ukraine	290	290	5,900	13,000
Vietnam	97	100	2,400	5,900
Other countries	91	90	21,000	78,000
World total (ilmenite, rounded)	4,900	4,800	660,000	1,300,000
Rutile:				
United States	([8])	([8])	400	1,800
Australia	164	160	22,000	34,000
Brazil	2	2	3,500	3,500
India	17	15	7,400	20,000
South Africa	143	152	8,300	24,000
Ukraine	57	67	2,500	2,500
Other countries	—	—	9,500	45,000
World total (rutile, rounded)	[9]380	[9]400	54,000	130,000
World total (ilmenite and rutile, rounded)	5,300	5,200	720,000	1,400,000

World Resources: Ilmenite supplies about 90% of the world's demand for titanium minerals. World resources of anatase, rutile, and ilmenite total more than 2 billion tons.

Substitutes: Ilmenite, leucoxene, rutile, slag, and synthetic rutile compete as feedstock sources for producing TiO_2 pigment, titanium metal, and welding rod coatings.

[e]Estimated. — Zero.
[1]See also Titanium and Titanium Dioxide.
[2]Rounded to nearest 0.1 million ton to avoid disclosing company 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.
[7]Mine production is primarily used to produce titaniferous slag.
[8]Included with ilmenite to avoid disclosing company proprietary data.
[9]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 2004, an estimated 60% of the titanium metal was used in aerospace applications. The remaining 40% was used in armor, chemical processing, marine, medical, power generation, sporting goods, and other nonaerospace applications. The value of sponge metal consumed was about $190 million, assuming an average selling price of $8.50 per kilogram.

In 2004, titanium dioxide (TiO_2) pigment, valued at about $2.9 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) 56%; plastic and rubber, 23%; paper, 16%; 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:	2000	2001	2002	2003	2004[e]
Titanium sponge metal:					
Production	W	W	W	W	W
Imports for consumption	7,240	13,300	10,700	9,590	12,300
Exports	1,930	2,170	2,810	5,000	2,500
Shipments from Government stockpile excesses	4,900	7,640	5,400	6,820	5,060
Consumption, reported	18,200	26,200	17,300	16,800	22,400
Price, dollars per kilogram, yearend	9.37	7.89	8.02	6.50	8.50
Stocks, industry yearend[e]	5,010	6,340	11,700	8,180	4,000
Employment, number[e]	300	300	300	300	300
Net import reliance[2] as a percentage of reported consumption	72	67	46	89	85
Titanium dioxide:					
Production	1,400,000	1,330,000	1,410,000	1,420,000	1,430,000
Imports for consumption	218,000	209,000	231,000	240,000	265,000
Exports	464,000	415,000	540,000	584,000	590,000
Consumption, apparent	1,150,000	1,100,000	1,120,000	1,060,000	1,120,000
Price, rutile, list, dollars per pound, yearend	1.01	1.05	0.90	0.88	0.93
Stocks, producer, yearend	141,000	159,000	145,000	156,000	146,000
Employment, number[e]	4,600	4,600	4,500	4,500	4,400
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: New scrap metal recycled by the titanium industry totaled about 17,000 tons in 2004. Estimated use of titanium as scrap and ferrotitanium by the steel industry was about 7,000 tons; by the superalloy industry, 1,200 tons; and, in other industries, 800 tons. Old scrap reclaimed totaled about 500 tons.

Import Sources (2000-03): Sponge metal: Kazakhstan, 46%; Japan, 42%; Russia, 10%; and other, 2%. Titanium dioxide pigment: Canada, 29%; Germany, 12%; France, 8%; China, 7%; and other, 44%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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 continued the sale of titanium sponge held in the Government stockpile. For fiscal year 2005, the remaining inventory of sponge is planned for disposal.

Stockpile Status—9-30-04[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Titanium sponge	2,520	1,870	2,520	6,350	5,570

Events, Trends, and Issues: Domestic production of TiO_2 pigment was 1.43 million tons, a slight increase compared with that of 2003. Global production of TiO_2 was an estimated 4.50 million tons, a 3% increase compared with that of 2003. Owing to poor demand for anatase-grade pigment, the sulfate-process TiO_2 pigment plant at Savannah, GA, was idled. At the same facility, the chloride-process capacity was being increased through process improvements.

Driven by soaring demand from commercial aircraft and military markets, domestic consumption of titanium sponge metal in 2004 increased an estimated 33% compared with that of 2004. Imports of titanium sponge metal increased by an estimated 28%. Published prices for titanium sponge, ingot, and mill products increased significantly. Efforts to develop a low-cost method for producing titanium metal were ongoing.

In China, plans were underway to increase both TiO_2 pigment and titanium metal production capacity. At yearend, construction was completed to raise sponge capacity at the Zunyi facility to 5,000 tons per year. China's total sponge capacity was expected to reach 10,000 tons per year by 2010.

World Sponge Metal Production and Sponge and Pigment Capacity:

	Sponge production		Capacity 2004[4]	
	2003	2004[e]	Sponge	Pigment
United States	W	W	8,940	1,520,000
Australia	—	—	—	213,000
Belgium	—	—	—	100,000
Canada	—	—	—	81,000
China[e]	4,100	4,400	7,200	500,000
Finland	—	—	—	120,000
France	—	—	—	225,000
Germany	—	—	—	413,000
Italy	—	—	—	80,000
Japan	18,900	23,500	31,000	317,000
Kazakhstan[e]	12,500	16,500	22,000	1,000
Mexico	—	—	—	120,000
Russia[e]	23,000	26,000	26,000	20,000
Spain	—	—	—	80,000
Ukraine[e]	6,750	7,150	8,000	120,000
United Kingdom	—	—	—	330,000
Other countries	—	—	—	641,000
World total (rounded)	[5]65,300	[5]78,000	100,000	5,000,000

World Resources:[6] Resources and reserves of titanium minerals are discussed in Titanium Mineral Concentrates. The commercial feedstock sources for titanium are ilmenite, leucoxene, rutile, slag, and synthetic rutile.

Substitutes: There are few materials that possess titanium metal's strength to weight ratio and corrosion resistance. In high-strength applications, titanium competes with aluminum, composites, intermetallics, steel, and superalloys. For applications that require corrosion resistance, aluminum, nickel, specialty steels, and zirconium alloys may be substituted for titanium. 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 2004, 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 65 industrial consumers were surveyed on a monthly or annual basis. Data reported by these consumers indicate that more than one-half of the tungsten consumed in the United States was used in cemented carbide parts for cutting and wear-resistant materials primarily in the metalworking, mining, oil- and gas-drilling, and construction industries. The remaining tungsten was consumed to make heavy metal alloys for applications requiring high density; electrodes, filaments, wires, and other components for electrical, electronic, heating, lighting, and welding applications; steels, superalloys, and wear-resistant alloys; and chemicals for various applications. The total estimated value of tungsten consumed in 2004 was $200 million.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production:					
Mine	—	—	—	—	—
Secondary	5,210	5,390	4,380	4,110	3,600
Imports for consumption:					
Concentrate	2,370	2,680	4,090	4,690	2,200
Other forms	7,810	8,150	6,510	7,620	8,400
Exports:					
Concentrate	70	220	94	20	40
Other forms	2,800	4,860	3,220	5,070	4,300
Government stockpile shipments:					
Concentrate	1,240	2,200	1,140	710	979
Other forms	591	986	177	182	70
Consumption:					
Reported, concentrate	W	W	W	W	W
Apparent,[1] all forms	14,400	14,500	11,900	10,100	11,800
Price, concentrate, dollars per mtu WO_3,[2] average:					
U.S. spot market, Platts Metals Week	47	64	55	50	47
European market, Metal Bulletin	45	65	38	45	55
Stocks, industry, yearend:					
Concentrate	W	W	W	W	W
Other forms	2,280	2,110	1,610	1,830	1,900
Net import reliance[3] as a percentage of apparent consumption	66	64	69	63	73

Recycling: In 2004, the tungsten content of scrap consumed by processors and end users represented approximately 30% of apparent consumption of tungsten in all forms.

Import Sources (2000-03): Tungsten content of ores and concentrates, intermediate and primary products, wrought and unwrought tungsten, and waste and scrap: China, 47%; Canada, 18%; and other, 35%.

Tariff: Item	Number	Normal Trade Relations[4] 12-31-04
Ore	2611.00.3000	Free.
Concentrate	2611.00.6000	37.5 ¢/kg W cont.
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	5.5% ad val.
Tungsten oxide	2825.90.3000	5.5% ad val.

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

Government Stockpile: Sales of National Defense Stockpile tungsten began in 1999. Included in the data listed in the following table, as of September 30, 2004, are 6,070 tons of tungsten contained in uncommitted nonstockpile-grade ores and concentrates authorized for disposal.

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

TUNGSTEN

Stockpile Status—9-30-04[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Ferrotungsten	233	3	233	136	—
Metal powder	463	—	463	136	—
Ores and concentrates	28,400	—	28,400	1,810	312

Events, Trends, and Issues: World tungsten supply continued to be dominated by Chinese production and exports. Beginning in 1999 and continuing into 2004, 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 large 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.

In late 2003, the sole Canadian tungsten mine suddenly suspended operations, and owners placed the mine on care-and-maintenance status after being notified by their two customers that they were terminating their purchase agreement and issuing a demand with respect to their loan obligation.

Health, safety, and environmental issues are becoming increasingly significant to metals such as tungsten. Several U.S. Government agencies were studying the health or environmental effects of exposure to various tungsten compounds. Cemented carbides were classified as carcinogens by three separate international organizations. The European Commission's new chemicals policy, if implemented as proposed, would affect all suppliers of tungsten materials to the European market by requiring them to collect and submit risk assessment data on each material produced in or imported into the European Union.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	2003	2004[e]		
United States	—	—	140,000	200,000
Austria	1,400	1,400	10,000	15,000
Bolivia	442	450	53,000	100,000
Canada	2,750	—	260,000	490,000
China	52,000	53,000	1,800,000	4,200,000
Korea, North	600	600	NA	35,000
Portugal	700	700	25,000	25,000
Russia	3,900	3,500	250,000	420,000
Other countries	290	300	360,000	700,000
World total (rounded)	62,100	60,000	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 used as substitutes to meet the changing needs of the world market. Tungsten remained the preferred material for electrodes or filaments in fluorescent, gas discharge halogen, and incandescent lighting applications. Researchers recently developed a bulb that uses a carbon nanotube filament, however, and a nontungsten electrodeless lamp based on induction technology is available 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 effect on tungsten consumption will depend on whether tungsten-copper heat sinks are used to dissipate heat from the LED devices. Depleted uranium is a substitute for tungsten alloys or tungsten carbide in armor-piercing projectiles.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]The sum of U.S. secondary production, as estimated from scrap consumption, and net import reliance.
[2]A metric ton unit (mtu) of tungsten trioxide (WO_3) contains 7.93 kilograms of tungsten.
[3]Defined as imports – exports + adjustments for Government and industry stock changes.
[4]Special tariff rates apply for Canada and Mexico.
[5]See Appendix B for definitions.
[6]See Appendix C for definitions.

VANADIUM

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

Domestic Production and Use: Eight U.S. firms that make up the vanadium industry produced ferrovanadium, vanadium pentoxide, vanadium metal, and vanadium-bearing chemicals or specialty alloys by processing materials such as petroleum residues, spent catalysts, utility ash, and vanadium-bearing iron slag. Metallurgical use, primarily as an alloying agent for iron and steel, accounted 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:	2000	2001	2002	2003	2004[e]
Production, mine, mill[1]	—	—	—	—	—
Imports for consumption:					
Ash, ore, residues, slag	1,890	1,670	990	1,630	1,830
Vanadium pentoxide, anhydride	902	600	406	474	1,230
Oxides and hydroxides, other	14	1,080	42	39	193
Aluminum-vanadium master alloys (gross weight)	16	10	98	232	33
Ferrovanadium	2,510	2,550	2,520	1,360	3,260
Exports:					
Vanadium pentoxide, anhydride	653	71	91	185	376
Oxides and hydroxides, other	100	63	203	284	709
Aluminum-vanadium master alloys (gross weight)	677	363	529	671	807
Ferrovanadium	172	70	142	397	214
Consumption, reported	3,520	3,210	3,080	2,960	3,350
Price, average, dollars per pound V_2O_5	1.82	1.37	1.34	2.21	5.28
Stocks, consumer, yearend	303	251	221	220	219
Employment, mine and mill, number[1]	—	—	—	—	—
Net import reliance[2] as a percentage of reported consumption	100	100	100	100	100

Recycling: Some tool steel scrap was recycled primarily for its vanadium content, and vanadium was recycled from spent chemical process catalysts, but these two sources together accounted for only a very small percentage of total vanadium used. The vanadium content of other recycled steels was lost to slag during processing and was not recovered.

Import Sources (2000-03): Ferrovanadium: Czech Republic, 25%; South Africa, 20%; Canada, 17%; China, 14%; and other, 24%. Vanadium pentoxide: South Africa, 95%; Mexico, 2%; and other, 3%.

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

Item	**Number**	**Normal Trade Relations 12-31-04**
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 2004 increased about 13% from that of the previous year. Among the major uses for vanadium, production of high-strength low-alloy, full-alloy, and carbon steels accounted for 34%, 30%, and 29% of domestic consumption, respectively. Steel production in 2004 was expected to be 2% to 3% higher than that of 2003.

Both ferrovanadium and vanadium pentoxide prices increased significantly during 2004. Industry publications attributed the price rise primarily to a reduction in supply of material in the market and steady demand in the steel and aerospace industries. The oversupply on the world market in 2003 was reduced by the closure of the Windimurra Mine in Australia, the Vantec Mine in South Africa, and reduced production from the Tulachermet plant in Russia. High stock levels related to overproduction from 1999 to 2003 were gradually reduced during 2003, leading to balanced supply and demand in 2004.

World Mine Production, Reserves, and Reserve Base: Production data for China were revised downward to reflect lower estimated vanadium recovery from vanadiferous slags.

	Mine production		Reserves[3]	Reserve base[3]
	2003	2004[e]		
United States	—	—	45,000	4,000,000
China	13,200	13,200	5,000,000	14,000,000
Russia	8,500	10,000	5,000,000	7,000,000
South Africa	18,000	20,000	3,000,000	12,000,000
Other countries	1,000	1,000	NA	1,000,000
World total (rounded)	41,000	44,000	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 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. — Zero.
[1]Domestic vanadium mine production stopped in 1999.
[2]Defined as imports – exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions.

VERMICULITE

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: Two companies with mining and processing facilities in South Carolina and Virginia produced vermiculite concentrate. Most of the vermiculite concentrate was shipped to 19 exfoliating plants in 11 States. The end uses for exfoliated vermiculite were estimated to be agricultural, insulation, and other, 74%; and lightweight concrete aggregates (including cement premixes, concrete, and plaster), 26%.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production[1]	[e, 2]150	NA	NA	NA	NA
Imports for consumption[e]	59	65	56	37	57
Exports[e]	5	7	10	15	10
Consumption, apparent, concentrate	[e]204	NA	NA	NA	NA
Consumption, exfoliated[e]	165	140	115	95	120
Price, base value, concentrate, dollars per ton, ex-plant	143	143	143	143	[3]143
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number[e]	120	100	90	90	[4]100
Net import reliance[5] as a percentage of apparent consumption	[e]26	NA	NA	NA	NA

Recycling: Insignificant.

Import Sources (2000-03): South Africa, 71%; China, 26%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
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: IBI Corp., through its subsidiary, North American Vermiculite, Inc., signed an option agreement to acquire the Mica Peak vermiculite claims in Clarke County, Nevada. The company already operates a vermiculite plant in Uganda, which came onstream in 2002. In Canada, Regis Resources, Inc. began producing vermiculite in June 2004 from a mine in Cavendish Township in southern Ontario. The mine produces grades of vermiculite such as fine, super fine, and micron. Product is destined for mostly North American markets.[6]

Although U.S. output of vermiculite decreased during the past few years, an increase in both U.S. imports and apparent consumption is projected for 2004. Although official data are not available, vermiculite production in China is reported to be growing and gaining worldwide market share.[7]

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[8]	Reserve base[8]
	2003	2004[e]		
United States	NA	NA	25,000	100,000
Brazil	23	25	NA	NA
China	50	70	NA	NA
Russia	25	25	NA	NA
South Africa	183	187	14,000	80,000
Zimbabwe	20	16	NA	NA
Other countries	46	47	NA	NA
World total (rounded)[9]	347	370	NA	NA

World Resources: Marginal reserves of vermiculite that occur in Colorado, Nevada, North Carolina, Texas, and Wyoming are estimated to be 2 million to 3 million tons. Reserves have been reported in Australia, Brazil, China, Russia, South Africa, Uganda, the United States, Zimbabwe, and some other countries. However, reserve information comes from many sources, and in most cases it is not clear whether the numbers refer to vermiculite alone or vermiculite plus host rock and/or overburden.[10]

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., 2001, Vermiculite: Mining Engineering, v. 53, no. 6, June, p. 65.
[3]Industrial Minerals, 2004, Prices: Industrial Minerals, no. 442, July, p. 64-65.
[4]Mine, mill, and office.
[5]Defined as imports – exports + adjustments for Government and industry stock changes.
[6]Burke, Alison, 2004, Leading lites–Vermiculite and perlite reviewed: Industrial Minerals, no. 443, August, p. 46-51.
[7]Moeller, Eric, 2004, Vermiculite: Mining Engineering, v. 56, no. 6, June, p. 52.
[8]See Appendix C for definitions.
[9]Excludes U.S. production.
[10]Roskill Information Services Ltd., 2004, The economics of vermiculite (8th ed.): London, United Kingdom, Roskill Information Services Ltd., 126 p. plus appendices.

YTTRIUM[1]

(Data in metric tons of yttrium oxide (Y_2O_3) content unless otherwise noted)

Domestic Production and Use: The rare-earth element yttrium was not mined in the United States in 2004. 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 2003 by end use was as follows: lamp and cathode-ray-tube phosphors, 77%; alloys, 5%; and miscellaneous, 18%.

Salient Statistics—United States:	2000	2001	2002	2003	2004[e]
Production, mine	—	—	—	—	—
Imports for consumption:					
In monazite	—	—	—	—	—
Yttrium, alloys, compounds, and metal[e, 2]	450	470	330	380	400
Exports, in ore and concentrate	NA	NA	NA	NA	NA
Consumption, estimated[3]	450	470	330	380	400
Price, dollars:					
Monazite concentrate, per metric ton[4]	400	400	400	400	400
Yttrium oxide, per kilogram, 99.0% to 99.99% purity[5]	25-200	22-88	22-88	22-88	52
Yttrium metal, per kilogram, 99.0% to 99.9% purity[5]	95-115	95-115	95-115	95-115	96
Stocks, processor, yearend	NA	NA	NA	NA	NA
Net import reliance[e, 6] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Small quantities, primarily from laser crystals and synthetic garnets.

Import Sources (2000-03):[e] Yttrium compounds, >19% to < 85% weight percent yttrium oxide equivalent: China, 71%; Japan, 12%; France, 11%; Austria, 2%; and other, 4%. Import sources based on Journal of Commerce data (year 2003 only): China, 88%; Japan, 6%; Austria, 4%; Netherlands, 1%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12-31-04
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed	2805.30.0000	5.0% ad val.
Yttrium-bearing materials and compounds containing by weight >19% to < 85% Y_2O_3	2846.90.4000	Free.
Other rare-earth compounds, including yttrium oxide $\geq$ 85% Y_2O_3, yttrium nitrate, and other individual compounds	2846.90.8000	3.7% ad val.

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

Government Stockpile: None.

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

YTTRIUM

Events, Trends, and Issues: Yttrium demand in the United States increased in 2003 and again in 2004 as the U.S. economy experienced growth towards yearend. Yttrium production and marketing within China continued to be competitive keeping international prices low, 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, 7]		Reserves[8]	Reserve base[8]
	2003	2004		
United States	—	—	120,000	130,000
Australia	—	—	100,000	110,000
Brazil	4	4	2,200	6,200
China	2,300	2,300	220,000	240,000
India	55	55	72,000	80,000
Malaysia	5	5	13,000	21,000
Sri Lanka	—	—	240	260
Other	26	26	17,000	20,000
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]Imports based on data from the Port Import/Export Reporting Service (PIERS).
[3]Essentially all yttrium consumed domestically was imported or refined from imported ores and concentrates.
[4]Monazite concentrate prices derived from U.S. Census Bureau data.
[5]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, and Hefa Rare Earth Canada Co., Ltd., Vancouver, Canada.
[6]Defined as imports – exports + adjustments for Government and industry stock changes.
[7]Includes yttrium contained in rare-earth ores.
[8]See Appendix C for definitions.

ZINC

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

Domestic Production and Use: The value of zinc mined in 2004, based on contained zinc recoverable from concentrate, was about $885 million. It was produced in 5 States by 10 mines operated by 6 companies. Alaska, Missouri, and Montana accounted for 99% of domestic mine output; the Red Dog Mine in Alaska alone accounted for about 90% of total U.S. production. Two primary and 12 large- and medium-sized secondary smelters refined zinc metal of commercial grade in 2004. 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:	2000	2001	2002	2003	2004[e]
Production:					
Mine, zinc in ore[1]	852	842	780	738	770
Primary slab zinc	228	203	182	187	230
Secondary slab zinc	143	108	113	116	130
Imports for consumption:					
Ore and concentrate	53	84	122	164	220
Refined zinc	915	813	874	758	785
Exports:					
Ore and concentrate	523	696	822	841	850
Refined zinc	3	1	1	2	3
Shipments from Government stockpile	39	24	5	14	40
Consumption:					
Apparent, refined zinc	1,330	1,150	1,170	1,080	1,200
Apparent, all forms	1,630	1,420	1,420	1,340	1,470
Price, average, cents per pound:					
Domestic producers[2]	55.6	44.0	38.6	40.6	53.0
London Metal Exchange, cash	51.2	40.2	35.3	37.5	50.0
Stocks, slab zinc, yearend	77	75	78	73	55
Employment:					
Mine and mill, number[e]	2,600	2,400	1,500	1,000	1,200
Smelter primary, number[e]	1,000	900	600	600	600
Net import reliance[3] as a percentage of apparent consumption:					
Refined zinc	72	73	75	72	70
All forms of zinc	60	59	61	58	56

Recycling: In 2004, an estimated 400,000 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, 345,000 tons was derived from new scrap and 55,000 tons was derived from old scrap. About 35,000 tons of scrap was exported, mainly to China, and 10,000 tons was imported, most of which came from Canada.

Import Sources (2000-03): Ore and concentrate: Peru, 49%; Australia, 29%; Ireland, 10%; and other, 12%. Metal: Canada, 61%; Mexico, 16%; Kazakhstan, 8%; and other, 15%. Combined total: Canada, 55%; Mexico, 15%; Peru, 10%; and other, 20%.

Tariff: Item	Number	Normal Trade Relations[4] 12-31-04
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—9-30-04[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2004	Disposals FY 2004
Zinc	65	13	65	45	40

Events, Trends, and Issues: The zinc industry worldwide was beginning to recover from lows reached in 2002, when the price of zinc on the London Metal Exchange (LME) reached its lowest level in 15 years and stocks were reaching 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 losses and were forced to either temporarily suspend production or close their operations entirely. Larger companies with ample financial resources and diversified production were in a better position to withstand the problems facing the zinc industry. Some companies even increased production in order to take advantage of economies of scale to ensure lower unit costs. As zinc prices began to improve in 2003 and 2004, several mines that were put on care and maintenance reopened, and some new mines came onstream.

The United States remained one of the leading 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] 2003	Mine production[6] 2004[e]	Reserves[7]	Reserve base[7]
United States	738	770	30,000	90,000
Australia	1,480	1,300	33,000	80,000
Canada	1,000	1,000	11,000	31,000
China	1,650	2,000	33,000	92,000
Kazakhstan	395	400	30,000	35,000
Mexico	460	420	8,000	25,000
Peru	1,250	1,400	16,000	20,000
Other countries	2,040	1,810	59,000	87,000
World total (rounded)	9,010	9,100	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, one mine in Georgia, and two mines in Virginia. A new mine that began operating in Georgia in 2004 produced a mixed heavy-mineral sands concentrate that will be trucked to a dry mill in Florida for separation. Zirconium and hafnium metals 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 leading end uses for zirconium. Other end uses of zirconium include abrasives, chemicals, metal alloys, welding rod coatings, and sandblasting. The leading market for hafnium metal is as an addition in superalloys.

Salient Statistics—United States:	**2000**	**2001**	**2002**	**2003**	**2004[e]**
Production, zircon (ZrO_2 content)	W	W	W	W	W
Imports:					
Zirconium, ores and concentrates (ZrO_2 content)	42,400	39,400	22,900	24,300	20,300
Zirconium, alloys, waste and scrap, and powder (ZrO_2 content)	1,400	850	750	308	278
Zirconium, waste and scrap, other	628	772	533	631	714
Zirconium oxide (ZrO_2 content)[1]	3,950	2,950	2,900	2,350	4,180
Hafnium, unwrought, waste and scrap	11	5	5	5	3
Exports:					
Zirconium ores and concentrates (ZrO_2 content)	47,400	43,500	30,600	45,900	41,000
Zirconium, alloys, waste and scrap, and powder (ZrO_2 content)	243	251	281	276	373
Zirconium, waste and scrap, other	1,410	1,660	1,940	2,010	1,940
Zirconium oxide (ZrO_2 content)[1]	1,680	2,100	2,400	1,520	1,600
Consumption, zirconium ores and concentrates, apparent (ZrO_2 content)	W	W	W	W	W
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic[2]	340	340	350	360	400
Imported, f.o.b.[3]	396	356	397	396	440
Zirconium sponge, dollars per kilogram[4]	20-26	20-31	20-31	20-31	30-66
Hafnium sponge, dollars per kilogram[4]	165-209	119-141	119-141	119-141	326
Net import reliance[5] 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 (2000-03):[6] Zirconium ores and concentrates: Australia, 46%; South Africa, 38%; and other, 16%. Zirconium, unwrought, powder: Germany, 58%; Canada, 22%; Argentina, 3%; China, 3%; and other, 14%. Hafnium, unwrought, including powder: France, 50%; Canada, 30%; China, 10%; and Japan, 10%.

Tariff: Item	**Number**	**Normal Trade Relations 12-31-04**
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 demand for zirconium mineral concentrates was higher than the supply in 2004. The cause of the shortage was the result of several issues including increased demand, the closure of several zircon-producing mines, reduced zircon grades at a few mines, and the transfer of mining equipment from mined-out sites to new mining locations. Higher zircon output is expected in 2005, especially in the United States and South Africa. In 2004, U.S. imports of zirconium ores and concentrates (mostly zircon) decreased about 16%, while exports decreased 11%. The main ore body at Green Cove Springs, FL, was mined out, and satellite mining methods were instituted to recover remaining isolated pockets of heavy-mineral sands in the surrounding area. A new heavy-mineral sands mine began operating at Lulaton, GA, that will replace the production lost from the Green Cove Springs, FL, location. In Virginia, an expansion of processing facilities and the addition of a new mine, the Concord, adjacent to the Old Hickory Mine, was completed. The availability of hafnium, produced as a byproduct during zirconium metal processing, continued to exceed demand. Russia was the sole producer of baddeleyite in 2004.

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] (million metric tons, ZrO_2)	Reserve base[7] (million metric tons, ZrO_2)	Reserves[7] (thousand metric tons, HfO_2)	Reserve base[7] (thousand metric tons, HfO_2)
	2003	2004[e]				
United States[1]	W	W	3.4	5.3	68	97
Australia	462	450	9.1	30	180	600
Brazil	21	22	2.2	4.6	44	91
China	15	15	0.5	3.7	NA	NA
India	20	20	3.4	3.8	42	46
South Africa	300	302	14	14	280	290
Ukraine	35	35	4.0	6.0	NA	NA
Other countries	11	11	0.9	4.1	NA	NA
World total (rounded)	860	860	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]Includes germanium oxides and zirconium oxides.
[2]E.I. du Pont de Nemours & Co. and Iluka Resources, Inc., average price.
[3]U.S. Census Bureau trade data.
[4]American Metal Market, daily, Miscellaneous prices. Converted from pounds.
[5]Defined as imports – exports.
[6]Data for the new trade categories “Zirconium, unwrought, powder” and “Hafnium, unwrought, including powder” are based on 2002-03 only.
[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 2004) or in prior years, but not yet removed from stockpile facilities as of September 30, 2004.

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 2004 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 2004 is the period October 1, 2003, through September 30, 2004. 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 2004 refers to material sold or traded from the stockpile in fiscal year 2004.

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*

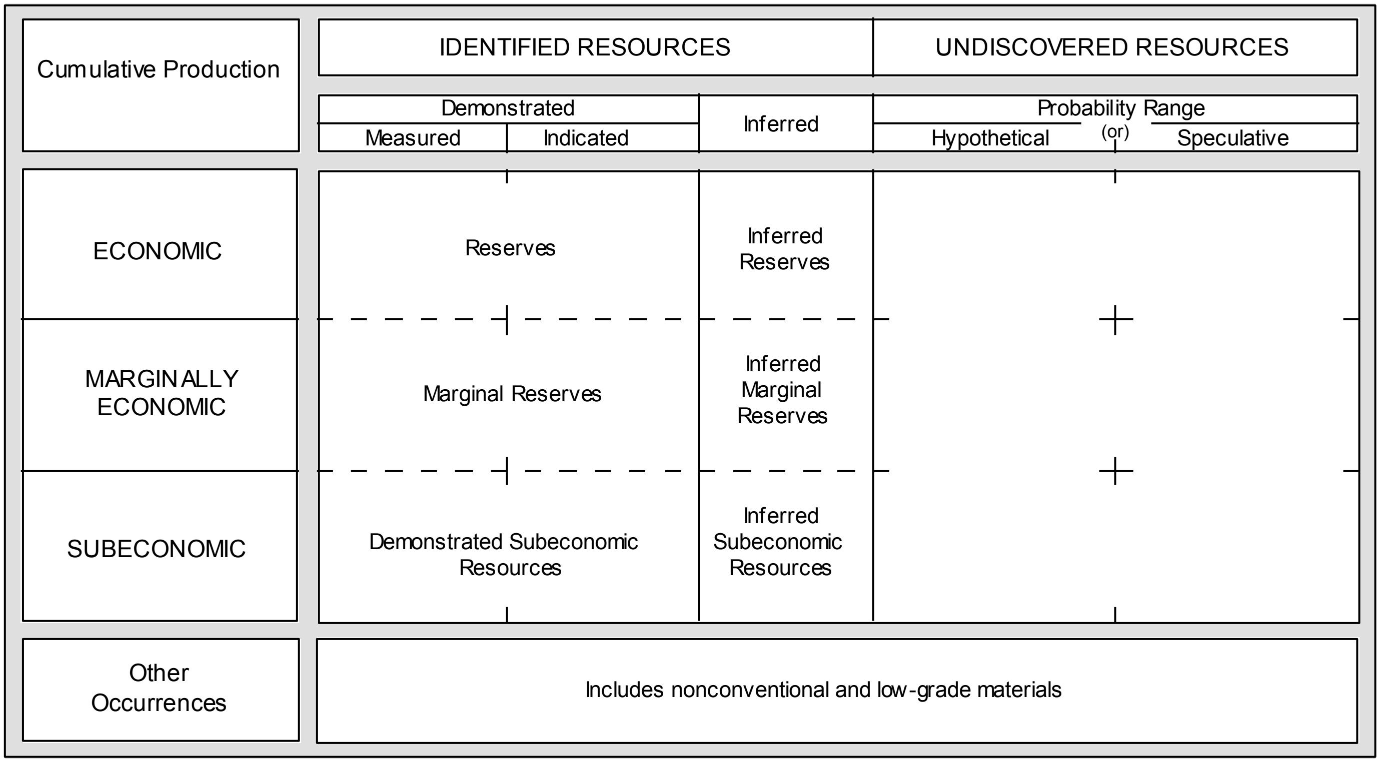
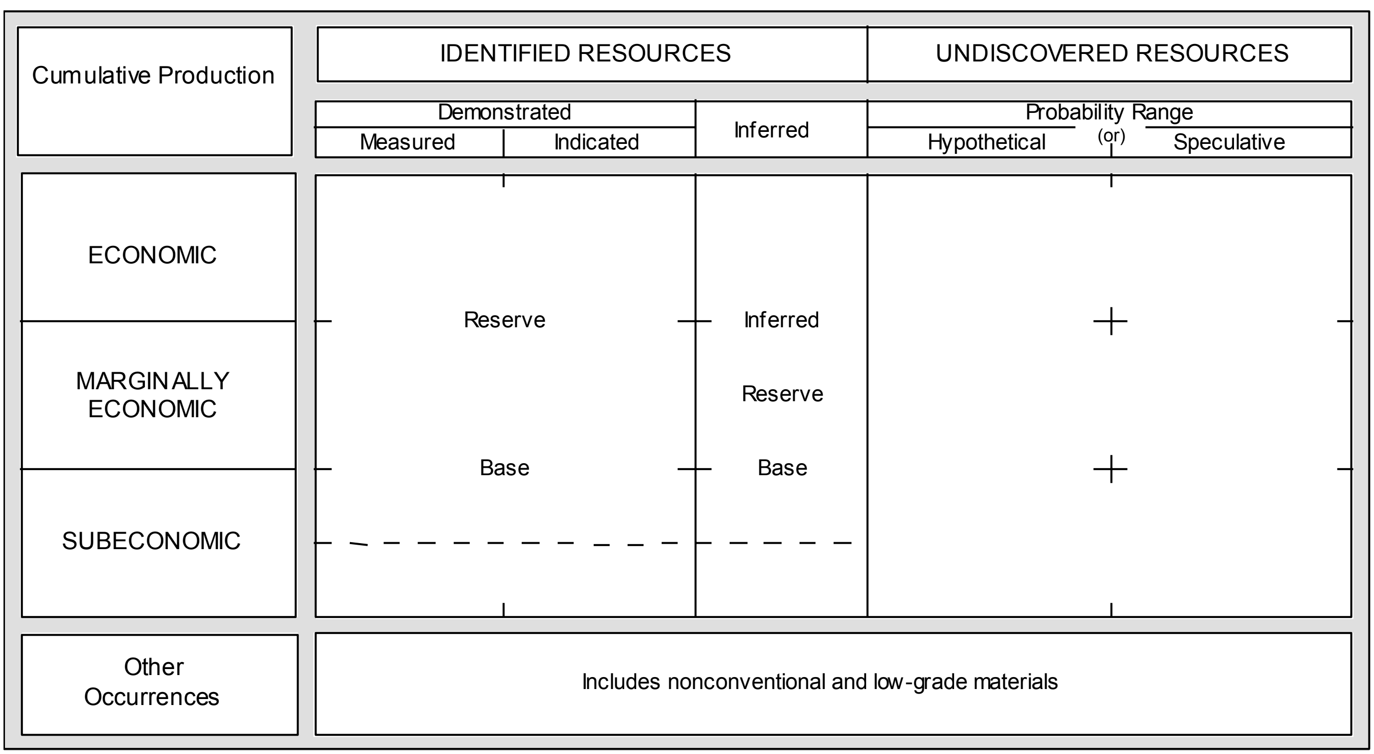


FIGURE 2.—*Reserve Base* and *Inferred Reserve Base* Classification Categories



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	Omayra Bermúdez-Lugo
Botswana	George J. Coakley
Burkina Faso	Omayra Bermúdez-Lugo
Burundi	Thomas R. Yager
Cameroon	Omayra Bermúdez-Lugo
Cape Verde	Omayra Bermúdez-Lugo
Central African Republic	Omayra Bermúdez-Lugo
Chad	Philip M. Mobbs
Comoros	Thomas R. Yager
Congo (Brazzaville)	George J. Coakley
Congo (Kinshasa)	George J. Coakley
Côte d'Ivoire	Omayra Bermúdez-Lugo
Cyprus	Philip M. Mobbs
Djibouti	Thomas R. Yager
Egypt	Harold R. Newman
Equatorial Guinea	Philip M. Mobbs
Eritrea	Thomas R. Yager
Ethiopia	Thomas R. Yager
Gabon	Omayra Bermúdez-Lugo
The Gambia	Omayra Bermúdez-Lugo
Ghana	George J. Coakley
Guinea	Omayra Bermúdez-Lugo
Guinea-Bissau	Omayra Bermúdez-Lugo
Iran	Philip M. Mobbs
Iraq	Philip M. Mobbs
Israel	Thomas R. Yager
Jordan	Thomas R. Yager
Kenya	Thomas R. Yager
Kuwait	Philip M. Mobbs
Lebanon	Thomas R. Yager
Lesotho	George J. Coakley
Liberia	Omayra Bermúdez-Lugo
Libya	Philip M. Mobbs
Madagascar	Thomas R. Yager
Malawi	Thomas R. Yager
Mali	Omayra Bermúdez-Lugo
Mauritania	Omayra Bermúdez-Lugo
Mauritius	Thomas R. Yager
Morocco & Western Sahara	Omayra Bermúdez-Lugo
Mozambique	Thomas R. Yager
Namibia	George J. Coakley
Niger	Omayra Bermúdez-Lugo
Nigeria	Philip M. Mobbs
Oman	Philip M. Mobbs
Qatar	Philip M. Mobbs
Reunion	Thomas R. Yager
Rwanda	Thomas R. Yager
São Tomé & Principe	Omayra Bermúdez-Lugo
Saudi Arabia	Philip M. Mobbs
Senegal	Omayra Bermúdez-Lugo
Seychelles	Thomas R. Yager
Sierra Leone	Omayra Bermúdez-Lugo
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	Omayra Bermúdez-Lugo
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	Pui-Kwan Tse
Burma	Yolanda Fong-Sam
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	John C. Wu
Korea, Republic of	John C. Wu
Laos	John C. Wu
Malaysia	Pui-Kwan Tse
Mongolia	Pui-Kwan Tse
Nepal	Chin S. Kuo
New Caledonia	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
Timor, East	Pui-Kwan Tse
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	Steven T. Anderson
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
Serbia and Montenegro	Walter G. Steblez
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

North America, Central America, and the Caribbean

Antigua and Barbuda	Omayra Bermúdez-Lugo
Aruba	Omayra Bermúdez-Lugo
The Bahamas	Omayra Bermúdez-Lugo
Barbados	Omayra Bermúdez-Lugo
Belize	Steven T. Anderson
Bermuda	Omayra Bermúdez-Lugo
Canada	Alfredo C. Gurmendi
Costa Rica	Steven T. Anderson
Cuba	Omayra Bermúdez-Lugo
Dominica	Omayra Bermúdez-Lugo
Dominican Republic	Omayra Bermúdez-Lugo
El Salvador	Steven T. Anderson
Grenada	Omayra Bermúdez-Lugo
Guadeloupe	Omayra Bermúdez-Lugo
Guatemala	Steven T. Anderson
Haiti	Omayra Bermúdez-Lugo
Honduras	Steven T. Anderson
Jamaica	Omayra Bermúdez-Lugo
Martinique	Omayra Bermúdez-Lugo
Mexico	Ivette E. Torres
Montserrat	Omayra Bermúdez-Lugo
Netherlands Antilles	Omayra Bermúdez-Lugo
Nicaragua	Steven T. Anderson
Panama	Steven T. Anderson
St. Kitts and Nevis	Omayra Bermúdez-Lugo
St. Lucia	Omayra Bermúdez-Lugo
St. Vincent & the Grenadines	Omayra Bermúdez-Lugo
Trinidad and Tobago	Omayra Bermúdez-Lugo

South America

Argentina	Ivette E. Torres
Bolivia	Steven T. Anderson
Brazil	Alfredo C. Gurmendi
Chile	Steven T. Anderson
Colombia	Ivette E. Torres
Ecuador	Steven T. Anderson
French Guiana	Yolanda Fong-Sam
Guyana	Yolanda Fong-Sam
Paraguay	Yolanda Fong-Sam
Peru	Alfredo C. Gurmendi
Suriname	Yolanda Fong-Sam
Uruguay	Yolanda Fong-Sam
Venezuela	Ivette E. Torres

Country specialist	Telephone	E-mail
Steven T. Anderson	(703) 648-7744	sanderson@usgs.gov
Omayra Bermúdez-Lugo	(703) 648-4946	obermude@usgs.gov
George J. Coakley	(703) 648-7738	gcoakley@usgs.gov
Yolanda Fong-Sam	(703) 648-7756	yfong-sam@usgs.gov
Alfredo C. Gurmendi	(703) 648-7745	agurmend@usgs.gov
Chin S. Kuo	(703) 648-7748	ckuo@usgs.gov
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
John C. Wu	(703) 648-7751	jwu@usgs.gov
Thomas R. Yager	(703) 648-7739	tyager@usgs.gov