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

# MINERAL COMMODITY SUMMARIES 2001

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**
**BRUCE BABBITT, 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. Information about the team may also be obtained from the MINES FaxBack system, a simple-to-operate automated fax response system that operates 24 hours a day, 7 days a week. MINES FaxBack is accessed by calling 703-648-4999 using the touch-tone telephone attached to the requestor's fax machine. After calling MINES FaxBack, the requestor is guided by a series of voice messages that assist her or him in ordering the desired documents. Information on approximately 90 commodities, 50 States, and 190 countries is available.

# 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 Yearbook is published in three volumes—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 provides economic indicators of selected metal industries.

*Stone, Clay, Glass, and Concrete Products Industry Indicators*—This monthly publication provides economic indicators of selected industrial minerals processing activities.

*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.

*Metal Prices in the United States Through 1998*—This publication provides an extended price history for a wide range of metals.

# WHERE TO OBTAIN PUBLICATIONS

- *Metal Prices in the United States Through 1998, Mineral Commodity Summaries,* 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.

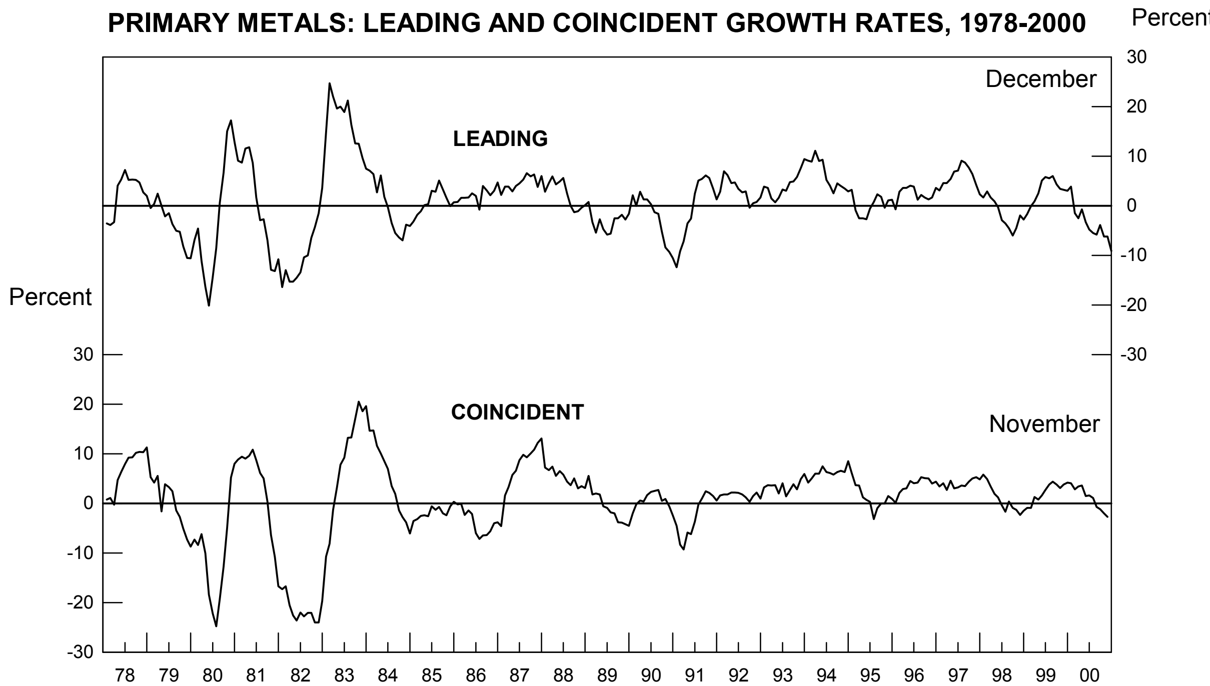
- *Mineral Industry Surveys* and *Metal Industry Indicators* can be obtained by calling (412) 386-6156 or by writing to NIOSH Printing Office, Pittsburgh Research Laboratory, P.O. Box 18070, Pittsburgh, PA 15236-0070.

- *Stone, Clay, Glass, and Concrete Products Industry Indicators* and materials flow studies are available in PDF format at URL <http://minerals.usgs.gov/minerals>.

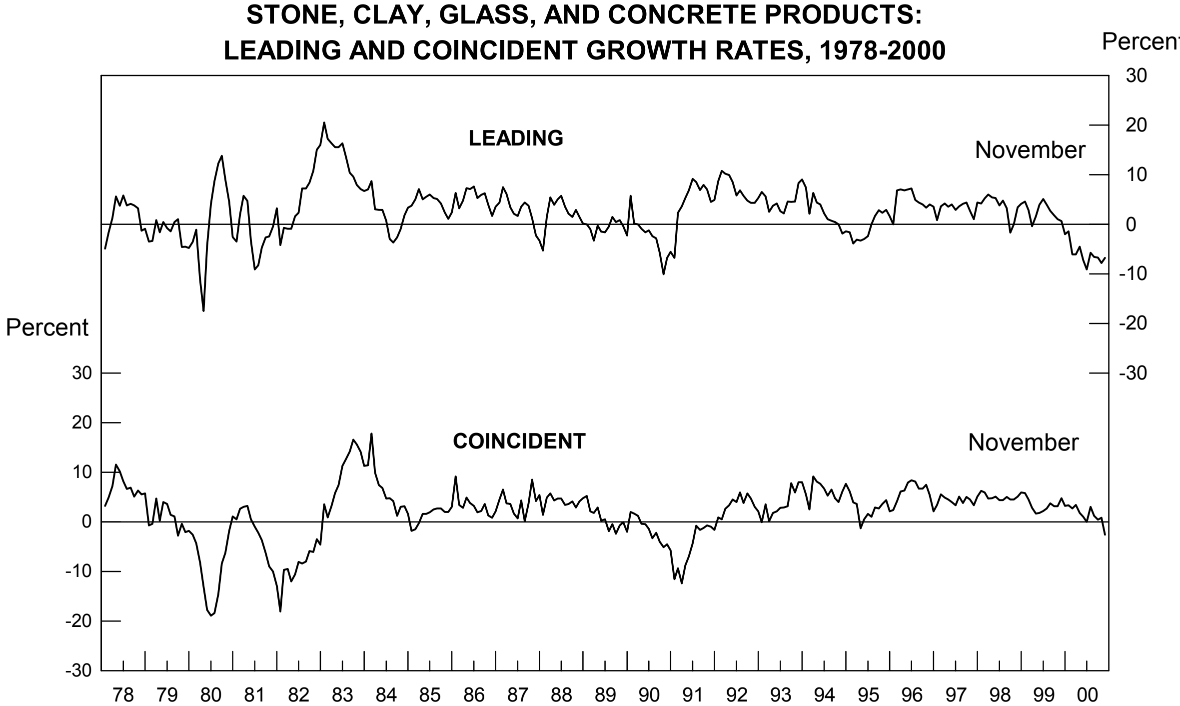
- All current publications are available in PDF format at URL <http://minerals.usgs.gov/minerals>.

# GROWTH RATES OF LEADING AND COINCIDENT INDEXES FOR MINERAL PRODUCTS

PRIMARY METALS: LEADING AND COINCIDENT GROWTH RATES, 1978-2000




STONE, CLAY, GLASS, AND CONCRETE PRODUCTS: LEADING AND COINCIDENT GROWTH RATES, 1978-2000

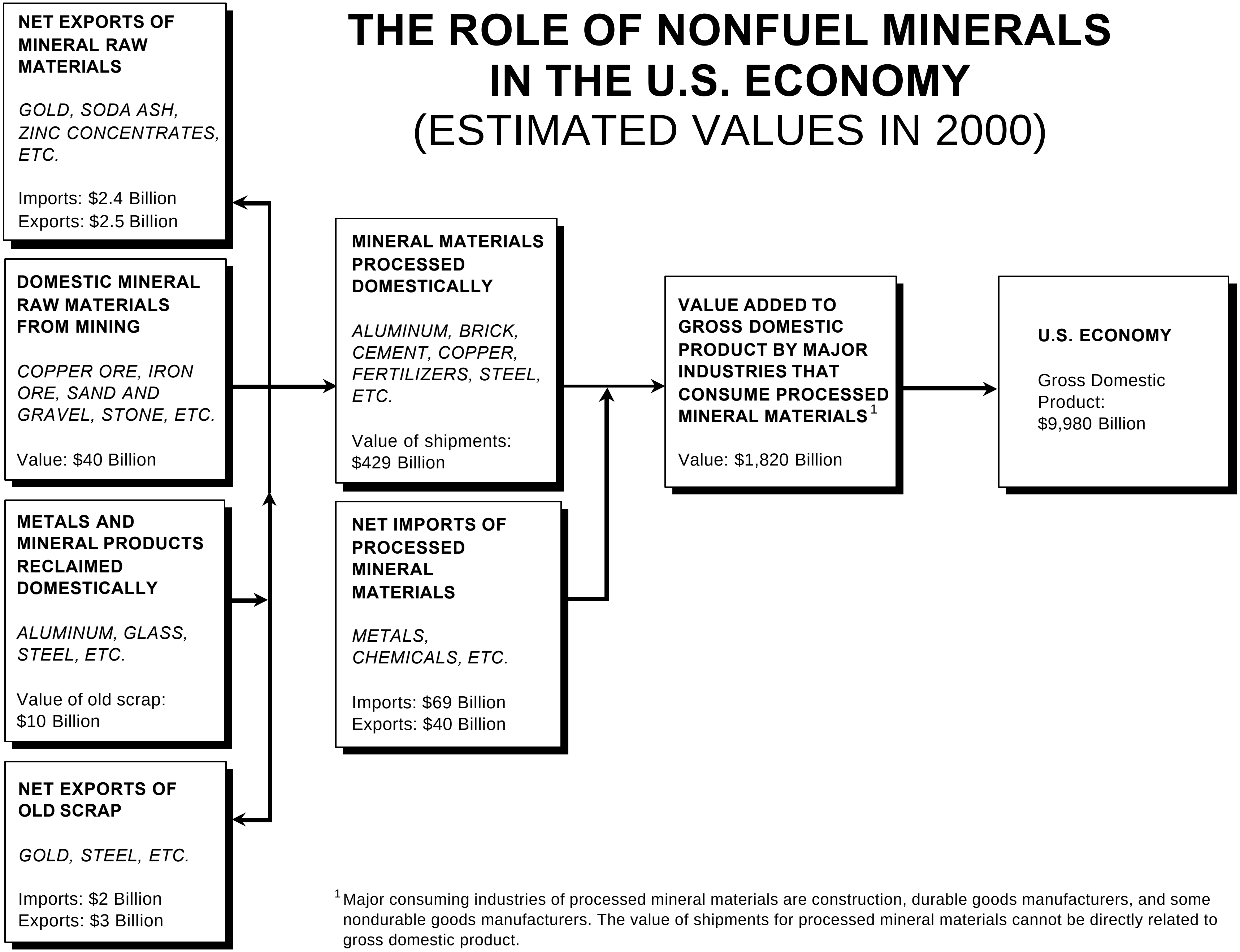



The leading indexes historically give signals several months in advance of major changes in the corresponding coincident index, which measures current industry activity. The growth rates, which can be viewed as trends, are expressed as compound annual rates based on the ratio of the current month's index to its average level during the preceding 12 months.

Sources: U.S. Geological Survey, *Metal Industry Indicators* and *Stone, Clay, Glass, and Concrete Products Industry Indexes.*

# THE ROLE OF NONFUEL MINERALS IN THE U.S. ECONOMY

## (ESTIMATED VALUES IN 2000)




[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

# 2000 U.S. NET IMPORT RELIANCE FOR SELECTED NONFUEL MINERAL MATERIALS

| Commodity | Percent | Major Sources (1996-99) [1] |
|---|---|---|
| ARSENIC TRIOXIDE | 100 | China, Chile, Mexico |
| ASBESTOS | 100 | Canada |
| BAUXITE and ALUMINA | 100 | Australia, Guinea, Jamaica, Brazil |
| COLUMBIUM (niobium) | 100 | Brazil, Canada, Germany, Russia |
| FLUORSPAR | 100 | China, South Africa, Mexico |
| GRAPHITE (natural) | 100 | China, Mexico, Canada |
| MANGANESE | 100 | South Africa, Gabon, Australia, France |
| MICA, sheet (natural) | 100 | India, Belgium, Germany, China |
| QUARTZ CRYSTAL | 100 | Brazil, Germany, Madagascar |
| STRONTIUM | 100 | Mexico, Germany |
| THALLIUM | 100 | Belgium, Canada, Germany, United Kingdom |
| THORIUM | 100 | France |
| YTTRIUM | 100 | China, Hong Kong, France, United Kingdom |
| GEMSTONES | 99 | Israel, India, Belgium |
| BISMUTH | 95 | Belgium, Mexico, United Kingdom, China |
| ANTIMONY | 94 | China, Mexico, South Africa, Bolivia |
| TIN | 86 | China, Brazil, Peru, Bolivia |
| PLATINUM | 83 | South Africa, United Kingdom, Russia, Germany |
| STONE (dimension) | 80 | Italy, Canada, Spain, India |
| TANTALUM | 80 | Australia, China, Thailand, Japan |
| CHROMIUM | 78 | South Africa, Kazakhstan, Russia, Zimbabwe |
| TITANIUM CONCENTRATES | 76 | South Africa, Australia, Canada, India |
| COBALT | 74 | Norway, Finland, Zambia, Canada |
| RARE EARTHS | 72 | China, France, Japan, United Kingdom |
| BARITE | 71 | China, India, Mexico, Morocco |
| POTASH | 70 | Canada, Russia, Belarus |
| IODINE | 69 | Chile, Japan, Russia |
| TUNGSTEN | 68 | China, Russia, Bolivia |
| TITANIUM (sponge) | 62 | Russia, Japan, Kazakhstan, China |
| ZINC | 60 | Canada, Mexico, Peru |
| NICKEL | 58 | Canada, Norway, Russia, Australia |
| PEAT | 52 | Canada |
| SILVER | 52 | Canada, Mexico, Peru |
| SILICON | 48 | Norway, South Africa, Russia, Canada |
| DIAMOND (dust, grit, and powder) | 47 | Ireland, China, Russia |
| MAGNESIUM COMPOUNDS | 45 | China, Canada, Austria, Australia |
| MAGNESIUM METAL | 40 | Canada, Russia, China, Israel |
| COPPER | 37 | Canada, Chile, Mexico |
| BERYLLIUM | 35 | Russia, Canada, Kazakhstan, Germany |
| ALUMINUM | 33 | Canada, Russia, Venezuela, Mexico |
| PUMICE | 33 | Greece, Turkey, Ecuador, Italy |
| LEAD | 24 | Canada, Mexico, Peru, Australia |
| GYPSUM | 22 | Canada, Mexico, Spain |
| SULFUR | 22 | Canada, Mexico, Venezuela |
| NITROGEN (fixed), AMMONIA | 21 | Trinidad and Tobago, Canada, Mexico, Venezuela |
| CEMENT | 20 | Canada, China, Spain, Venezuela |
| IRON ORE | 19 | Canada, Brazil, Venezuela, Australia |
| IRON and STEEL | 17 | European, Union, Canada, Japan, Mexico |
| MICA, scrap and flake (natural) | 17 | Canada, India, Finland, Japan |
| PERLITE | 15 | Greece |
| SALT | 15 | Canada, Chile, Mexico, The Bahamas |
| TALC | 12 | China, Canada, France, Japan |
| CADMIUM | 6 | Canada, Belgium, Australia |
| PHOSPHATE ROCK | 1 | Morocco |

[1] In descending order of import share

Additional mineral commodities for which there is some import dependency include:

| | |
|---|---|
| Gallium | France, Russia, Kazakhstan, Canada |
| Germanium | Russia, Belgium, China, United Kingdom |
| Indium | Canada, China, Russia, France |
| Mercury | Canada, United Kingdom, Kyrgyzstan, Spain |
| Rhenium | Chile, Germany, Kazakhstan, Russia |
| Selenium | Philippines, Canada, Belgium, Japan |
| Vanadium | South Africa, China |
| Vermiculite | South Africa, China |
| Zirconium | South Africa, Australia |

# SIGNIFICANT EVENTS, TRENDS, AND ISSUES

## The Mineral Sector of the U.S. Economy[1]

The longest economic expansion in U.S. history continued in 2000 and provided a stimulus for mineral materials demand. Economic growth, however, began to slow in the latter half of the year and was further dampened by higher energy costs and rising interest rates (U.S. Geological Survey, 2000, 2001). The slower economic growth, combined with declining growth rates in other industrialized economies, reduced production and shipment rates for U.S. primary metal products, particularly steel, late in the year. Moreover, low prices in the copper industry and high energy costs in the aluminum industry precipitated real declines in the output of both metals during 2000. Growth in the domestic production and shipments of nonmetallic mineral products also began to wane, particularly in the second half of the year (see page 3). Owing in part to a strong U.S. dollar relative to other currencies, lower prices and rising imports tended to restrain growth in the domestic output of processed metal and nonmetal mineral materials alike by yearend.

### Overall Performance

The estimated value of all mineral-based products manufactured in the United States during 2000 reached $429 billion (see page 4). The estimated value of U.S. raw nonfuel minerals production alone was $40.1 billion, about a 3% increase compared with that of 1999. Within the raw nonfuel minerals category, the estimated production value of industrial minerals increased to $30.3 billion, and the value of metals output rose to $9.9 billion.

Net imports of raw minerals and processed mineral materials during 2000 reflected the influence of a strong U.S. dollar, a still-expanding domestic economy, and a continuing reliance on other countries for mineral products (see page 5). Imports of raw and processed mineral materials rose to an estimated $71 billion, with increases primarily from purchases of aluminum, copper, and steel. Exports of raw and processed mineral materials during the year reached an estimated value of $43 billion. Imports and exports of metal ores and concentrates, as well as raw industrial minerals, totaled $5 billion.

Two key sectors of the U.S. economy, motor vehicle manufacturing and construction, continued to influence domestic demand for mineral-based materials in 2000. Total sales of automobiles, vans, sport-utility vehicles, and trucks, which incorporated large quantities of steel and other metals as well as significant amounts of glass and plastics, were among the highest ever recorded by motor vehicle manufacturers. The construction industry, which accounted for most of the consumption of all shipments of clay, cement, glass, sand and gravel, and stone, also reached near record high levels in 2000 for new residential housing units and commercial building startups. In addition, Federal expenditures for building highways and mass transit systems helped stimulate demand for cement, sand and gravel, steel, and stone in some areas.

U.S. output of mineral fertilizer nutrients changed little during 2000 in response to domestic and foreign demand. High natural gas prices led to significant price increases for fixed nitrogen and caused producers to operate well below rated plant capacity.

In fiscal year 2000, the Defense Logistics Agency (DLA) sold $668 million of excess mineral materials from the National Defense Stockpile (NDS) (see the "Government Stockpile" sections in the mineral commodity reports that follow). Under authority of The Defense Production Act of 1950, the U.S. Geological Survey advises the DLA on acquisitions and disposals of NDS mineral materials. At the end of the fiscal year, mineral materials valued at more than $2.8 billion remained in the stockpile.

### Outlook

Slower U.S. economic growth in the latter half of 2000 was expected to extend into 2001; consequently, levels of production and shipments of mineral-based products may remain the same or possibly decline early in the new year. Government and industry economists forecast that the U.S. gross domestic product (GDP) will expand at about a 2.5% annual rate in 2001, but growth will differ among various economic sectors. For example, construction industries and motor vehicle manufacturing, traditionally large consumers of metal and nonmetal mineral products, may grow more slowly than other sectors of the domestic economy through the first half of 2001. Monthly consumer surveys conducted during 2000 indicated late in the year a declining trend in the number of households that planned to purchase a new motor vehicle (Conference Board, 2000).

In late 2000, the Federal Reserve Board (FRB) began to express some concern about the slowing U.S. economy. In response to slower growth, the FRB reduced interest rates in early 2001. Lower rates could help to sustain growth in domestic mineral materials industries later in the year. For example, lower interest rates could lead to lower mortgage rates and benefit the building materials industry if unemployment remains low and demand for new housing increases.

## Significant International Events[2]

Following the financial shocks that began in 1997 in Asia and spread to much of the world, the pace of global economic activity has varied among nations. During 2000, in particular, a large part of the recovery appeared to stall, not only in East Asia and Southeast Asia, but also in several European countries as they adjusted to the requirements of the European Union (EU). The United States continued to be the central impetus for the

[1]Staff, U.S. Geological Survey

[2]David B. Doan and Staff, U.S. Geological Survey

## TABLE 1.—U.S. MINERAL INDUSTRY TRENDS

| | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Total mine production:[1] | | | | | |
| Metals | 13,000 | 13,100 | 11,400 | 9,570[p] | 9,890 |
| Industrial minerals | 25,800 | 27,400 | 28,200 | 29,500[p] | 30,300 |
| Coal | 19,700 | 19,400 | 19,200 | 19,400[p] | 19,600 |
| Employment:[2] | | | | | |
| Coal mining | 80 | 79 | 75 | 71 | 66 |
| Metal mining | 42 | 41 | 38 | 35 | 34 |
| Industrial minerals, except fuels | 81 | 82 | 83 | 85 | 84 |
| Chemicals and allied products | 575 | 573 | 587 | 585 | 582 |
| Stone, clay, and glass products | 423 | 431 | 439 | 440 | 441 |
| Primary metal industries | 553 | 555 | 560 | 547 | 545 |
| Average weekly earnings of production workers:[3] | | | | | |
| Coal mining | 858 | 863 | 857 | 866 | 871 |
| Metal mining | 763 | 791 | 812 | 812 | 835 |
| Industrial minerals, except fuels | 648 | 671 | 681 | 695 | 730 |
| Chemicals and allied products | 699 | 716 | 738 | 747 | 767 |
| Stone, clay, and glass products | 555 | 569 | 591 | 603 | 619 |
| Primary metal industries | 662 | 683 | 684 | 700 | 726 |

[e]Estimated. [p]Preliminary.
[1]Million dollars.
[2]Thousands of production workers.
[3]Dollars.

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

global economy, providing stability and growth and an opportunity for other countries to restructure financially. The United States, however, eventually had to cope with a rapidly expanding domestic economy through the FRB, which moved incrementally to restrict credit and, thereby, to guide the domestic economy to more stable, sustainable growth.

Recovery of base-metal prices continued from the lows of early 1999 that threatened the viability of the mining industry throughout much of the world. In spite of strengthening metals prices, mining continued to be affected by international developments in the availability and cost of energy, as well as the value of money itself.

In 2000, several unforeseen events made the global economy more risky and unpredictable. Any assessment of the world economy must deal with the statistics of rare events, albeit contingent and sequential. For example, the low market price of crude oil at $10 per barrel in 1999 was an anomaly that threatened the economies of such countries as Mexico, Russia, Saudi Arabia, and Venezuela. The Organization of Petroleum Exporting Countries (OPEC) adjusted production so as to create another anomaly—prices per barrel that exceeded $37 in 2000 before subsiding to levels more affordable to many developed nations. Simultaneously, domestic natural gas prices exceeded $9 per million British thermal units in futures markets (a new high) compared with $2.50 in late 1999. Spot prices reached $11 to $13 in New York and other Northeastern States and $67 in California. A prominent aluminum company began closing its aluminum potlines in order to (more profitably) sell its electricity directly to California and other States in the Pacific Northwest (Reporter, ABC Television News, oral commun., 6:30 p.m., December 11, 2000).

Energy price hikes not only affected U.S. consumers, but caused greater hardships in EU countries and Japan with the precipitation of rioting and strikes by transport workers. Underlying this situation was the growing world demand for hydrocarbon energy sources, which could tax existing productive capacity in the foreseeable future; such a situation could again lead to calls for energy conservation and accelerated exploration and development. During the past few years, wide publicity has been given to experiments with various configurations of fuel cells that would operate cleanly and produce only water as an exhaust product. However, fuel-cell propulsion of automobiles on a production basis will require more research and development and identification of sources of needed raw materials.

The U.S. dollar attracted investment from many countries, including EU nations and Japan, helping make the United States a primary driver of global economic growth. For this reason alone, the actions of the FRB in recent years have been and will be critical to the economic health of the entire world. In 2000, gold was being released by a number of central banks, particularly in the EU, in favor of other assets. Historically, when crises forced any outright decision

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

| | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Gross domestic product (billion dollars) | 7,810 | 8,320 | 8,790 | 9,300 | 9,980 |
| Industrial production (1992=100): | | | | | |
| Total index | 120 | 128 | 134 | 139 | 135 |
| Manufacturing | 121 | 131 | 138 | 144 | 140 |
| Stone, clay, and glass products | 118 | 122 | 128 | 132 | 123 |
| Primary metals | 120 | 125 | 128 | 130 | 123 |
| Iron and steel | 119 | 124 | 125 | 127 | 121 |
| Nonferrous metals | 121 | 127 | 132 | 135 | 126 |
| Chemicals and chemical products | 108 | 116 | 118 | 123 | 115 |
| Mining | 104 | 105 | 103 | 98 | 92 |
| Metals | 104 | 109 | 108 | 100 | 89 |
| Coal | 105 | 108 | 110 | 108 | 100 |
| Oil and gas extraction | 102 | 103 | 99 | 93 | 87 |
| Stone and earth minerals | 115 | 120 | 124 | 125 | 116 |
| Capacity utilization (percent): | | | | | |
| Total industry | 83 | 84 | 82 | 81 | 75 |
| Mining | 89 | 89 | 87 | 84 | 79 |
| Metals | 89 | 90 | 88 | 81 | 73 |
| Stone and earth minerals | 86 | 86 | 86 | 86 | 80 |
| Housing starts (thousands) | 1,480 | 1,470 | 1,620 | 1,670 | 1,640 |
| Automobile sales (thousands) | 7,250 | 6,910 | 6,750 | 6,990 | 6,980 |
| Highway construction, all public, expenditures (billion dollars) | 37 | 38 | 41 | 47 | 53 |

[e]Estimated.

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

between gold and paper money, gold generally prevailed because it could stand fast against paper devaluations. For citizens of many developing countries that have no banking facilities, gold traditionally has been the only universally accepted store of value. Instantaneous worldwide electronic transfer of capital and credit, however, has perhaps oriented gold toward more industrial and conventional jewelry uses. World gold demand was at the 3,000-metric-ton-per-year level, which was somewhat higher than world mine production. Hedging operations for self-protection and cost-reduction measures by many gold mining companies have, however, mitigated against any significant price decreases.

In 2000, the EU struggled to climb out of monetary doldrums, even to the extent of supporting its currency by intervention in market operations. Paradoxically, however, the establishment of a currency shared by 11 nations has been creating larger and more-liquid European stock and bond markets, reducing the cost of capital in Europe, liberating corporate borrowers from dependence on banks, and making acquisitions much easier to finance (Wall Street Journal, 2000c).

Meanwhile, the large economies of Asia moved with great caution. The Japanese economy, which was the second largest in the world in 2000, continued in a very mild deflationary mode and seemed to rely on Government spending more than business activity. Excess capacity and debt remaining from the economic collapse of the 1980's hung over domestic productivity. In addition, Japan's Government debt reached nearly 130% of its GDP (Financial Times, 2000). Whether tentative economic growth in the first half of 2000 could be sustained remained to be seen. China continued to work its way from central planning to central guidance by privatizing state-owned and military-operated production facilities of minerals and other goods for ownership by workers, investors, and, to some degree, the state. Although the trend toward decentralization was difficult and slow, the fact remained that a major new economy was created and evolving by peaceful means. Following 50 years of Government-mandated lending that left China's state banks technically insolvent, observers expected that those banks would fail after the Asian financial collapse of 3 years ago. They survived, however, and despite weak accounting, poor transparency, and much bad debt, they are today enjoying China's rebounding economy together with reforms that are engendering new confidence (Wall Street Journal, 2000b). Tax rebates on exports, which amounted to subsidies, were, in effect, a disguised devaluation; the Chinese central bank, however, quietly

## TABLE 3—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2000[p 1]

| State | Value (thousands) | Rank | Percent of U.S. total | Principal minerals, in order of value |
|---|---|---|---|---|
| Alabama | $1,070,000 | 13 | 2.65 | Stone (crushed), cement (portland), lime, sand and gravel (construction), cement (masonry). |
| Alaska | 1,140,000 | 12 | 2.83 | Zinc, gold, lead, silver, sand and gravel (construction). |
| Arizona | 2,550,000 | 3 | 6.35 | Copper, sand and gravel (construction), cement (portland), molybdenum concentrates, stone (crushed). |
| Arkansas | 506,000 | 29 | 1.26 | Bromine, stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial). |
| California | 3,350,000 | 1 | 8.34 | Sand and gravel (construction), cement (portland), boron, stone (crushed), gold. |
| Colorado | 566,000 | 27 | 1.41 | Sand and gravel (construction), cement (portland), stone (crushed), gold, helium (Grade-A). |
| Connecticut[2] | 99,500 | 44 | 0.25 | Stone (crushed), sand and gravel (construction), stone (dimension), clays (common), gemstones. |
| Delaware[2] | 12,000 | 50 | 0.03 | Magnesium compounds, sand and gravel (construction), gemstones. |
| Florida | 1,920,000 | 5 | 4.78 | Phosphate rock, stone (crushed), cement (portland), sand and gravel (construction), cement (masonry). |
| Georgia | 1,660,000 | 7 | 4.13 | Clays (kaolin), stone (crushed), cement (portland), clays (fuller's earth), sand and gravel (construction). |
| Hawaii | 91,400 | 45 | 0.23 | Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry), gemstones. |
| Idaho | 398,000 | 34 | 0.99 | Phosphate rock, silver, sand and gravel (construction), molybdenum concentrates, lead. |
| Illinois | 907,000 | 17 | 2.26 | Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), lime. |
| Indiana | 729,000 | 21 | 1.82 | Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry). |
| Iowa | 510,000 | 28 | 1.27 | Stone (crushed), cement (portland), sand and gravel (construction), gypsum (crude), lime. |
| Kansas | 624,000 | 24 | 1.55 | Cement (portland), stone (crushed), helium (Grade-A), salt, sand and gravel (construction). |
| Kentucky | 497,000 | 30 | 1.24 | Stone (crushed), lime, cement (portland), sand and gravel (construction), clays (ball). |
| Louisiana | 404,000 | 33 | 1.01 | Salt, sulfur (Frasch), sand and gravel (construction), stone (crushed), clays (common). |
| Maine | 102,000 | 43 | 0.25 | Sand and gravel (construction), cement (portland), stone (crushed), cement (masonry), peat. |
| Maryland[2] | 357,000 | 35 | 0.89 | Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry), stone (dimension). |
| Massachusetts | 210,000 | 39 | 0.52 | Stone (crushed), sand and gravel (construction), stone (dimension), lime, clays (common). |
| Michigan | 1,670,000 | 6 | 4.17 | Cement (portland), iron ore (usable), sand and gravel (construction), stone (crushed), magnesium compounds. |
| Minnesota | 1,570,000 | 8 | 3.90 | Iron ore (usable), sand and gravel (construction), stone (crushed), sand and gravel (industrial), stone (dimension). |
| Mississippi | 157,000 | 42 | 0.39 | Sand and gravel (construction), cement (portland), clays (fuller's earth), stone (dimension), clays (ball). |
| Missouri | 1,320,000 | 10 | 3.28 | Stone (crushed), cement (portland), lead, lime, zinc. |
| Montana | 582,000 | 25 | 1.45 | Palladium, gold, cement (portland), sand and gravel (construction), copper. |
| Nebraska | 170,000 | 41 | 0.42 | Cement (portland), sand and gravel (construction), stone (crushed), lime, cement (masonry). |
| Nevada | 2,800,000 | 2 | 6.96 | Gold, sand and gravel (construction), silver, lime, diatomite. |

See footnotes at end of table.

## TABLE 3—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2000[p 1]—Continued

| State | Value (thousands) | Rank | Percent of U.S. total | Principal minerals, in order of value |
|---|---|---|---|---|
| New Hampshire[2] | $59,200 | 46 | 0.15 | Sand and gravel (construction), stone (crushed), stone (dimension), gemstones. |
| New Jersey[2] | 286,000 | 37 | 0.71 | Stone (crushed), sand and gravel (construction), sand and gravel (industrial), peat, clays (common). |
| New Mexico | 812,000 | 18 | 2.02 | Copper, potash ($K_2O$), sand and gravel (construction), cement (portland), stone (crushed). |
| New York | 970,000 | 15 | 2.42 | Stone (crushed), salt, cement (portland), sand and gravel (construction), zinc. |
| North Carolina | 779,000 | 19 | 1.94 | Stone (crushed), phosphate rock, sand and gravel (construction), sand gravel (industrial), clays (common). |
| North Dakota | 42,000 | 48 | 0.10 | Sand and gravel (construction), lime, stone (crushed), sand and gravel (industrial), clays (common). |
| Ohio | 1,060,000 | 14 | 2.63 | Stone (crushed), sand and gravel (construction), salt, lime, cement (portland). |
| Oklahoma | 453,000 | 31 | 1.13 | Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), helium (Grade-A). |
| Oregon | 439,000 | 32 | 1.09 | Cement (portland), stone (crushed), sand and gravel (construction), diatomite, pumice and pumicite. |
| Pennsylvania[2] | 1,250,000 | 11 | 3.12 | Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry). |
| Rhode Island[2] | 23,700 | 49 | 0.06 | Stone (crushed), sand and gravel (construction), sand and gravel (industrial), gemstones. |
| South Carolina | 560,000 | 26 | 1.40 | Cement (portland), stone (crushed), cement (masonry), sand and gravel (construction), clays (kaolin). |
| South Dakota | 260,000 | 38 | 0.65 | Gold, cement (portland), sand and gravel (construction), stone (crushed), stone (dimension). |
| Tennessee | 770,000 | 20 | 1.92 | Stone (crushed), zinc, cement (portland), sand and gravel (construction), clays (ball). |
| Texas | 2,050,000 | 4 | 5.09 | Cement (portland), stone (crushed), sand and gravel (construction), lime, salt. |
| Utah | 1,420,000 | 9 | 3.53 | Copper, gold, cement (portland), sand and gravel (construction), magnesium metal. |
| Vermont[2] | 43,000 | 47 | 0.11 | Stone (dimension), stone (crushed), sand and gravel (construction), talc and pyrophyllite, gemstones. |
| Virginia | 692,000 | 22 | 1.72 | Stone (crushed), cement (portland), sand and gravel (construction), lime, clays (fuller's earth). |
| Washington | 691,000 | 23 | 1.72 | Sand and gravel (construction), stone (crushed), magnesium metal, cement (portland), gold. |
| West Virginia | 182,000 | 40 | 0.45 | Stone (crushed), cement (portland), sand and gravel (industrial), lime, salt. |
| Wisconsin[2] | 349,000 | 36 | 0.87 | Sand and gravel (construction), stone (crushed), lime, sand and gravel (industrial), stone (dimension). |
| Wyoming | 922,000 | 16 | 2.30 | Soda ash, clays (bentonite), helium (Grade-A), cement (portland), stone (crushed). |
| Undistributed | 94,400 | XX | 0.24 | XX. |
| Total | 40,100,000 | XX | 100.00 | XX. |

[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."

increased its capital-adequacy ratio requirements for major state banks from about 6% to 8% in conformance with the policy of the Bank for International Settlements in Geneva and the G-10 industrialized nations (Wall Street Journal, 2000a). This move was expected to enhance the competitiveness of China's banking sector as the country prepares to join the World Trade Organization and would provide the advantage of solid domestic banking in support of China's mining and energy industries.

New developments on the Korean Peninsula that were essentially unforeseen until 2000 suggest the possibility of rapprochement between North Korea and the Republic of Korea. Such a momentous event could eventually create a single Korean economy that would combine the mineral resources of the North with the agricultural and manufacturing resources of the South—an economy that might well be greater than the sum of its parts. Such an enhanced economy could provide a buffer between China and Japan and add constructively to financial strength in East Asia. Challenges of the type that accompanied German reunification may arise, however, and significantly delay the benefits of reunion.

The Republic of Korea was facing some serious economic problems at the end of 2000. Despite vigorous growth, a GDP that exceeded 10% per year, and strong export earnings, the nation's stock market dropped almost 50% in total value during the year, causing billions of dollars of equity value to disappear. Exports were strong by yearend, but inflation continued rising toward 4%. Consequently, the country that played a principal role in leading Asia out of the 1997 financial crisis by rebuilding investor confidence must further restructure and eliminate bad debts (Wall Street Journal, 2000d).

For several years, Africa's mineral riches, gold certainly, but especially diamonds, have reportedly been used to finance civil wars that have destabilized several nations in the central part of the continent and caused great loss of life. Revenues from these so-called "blood," or "conflict," diamonds that have supported civil strife were as much as $255 million in 1999; this represented about 4% of the diamond market. The United Nations appointed a special commission to investigate the situation, and Government officials from the United Kingdom, the United States, and other countries have tried to design a boycott of conflict diamonds but such efforts have been greatly complicated because of the difficulty in establishing the specific origin of the diamonds (Northern Miner, 2000).

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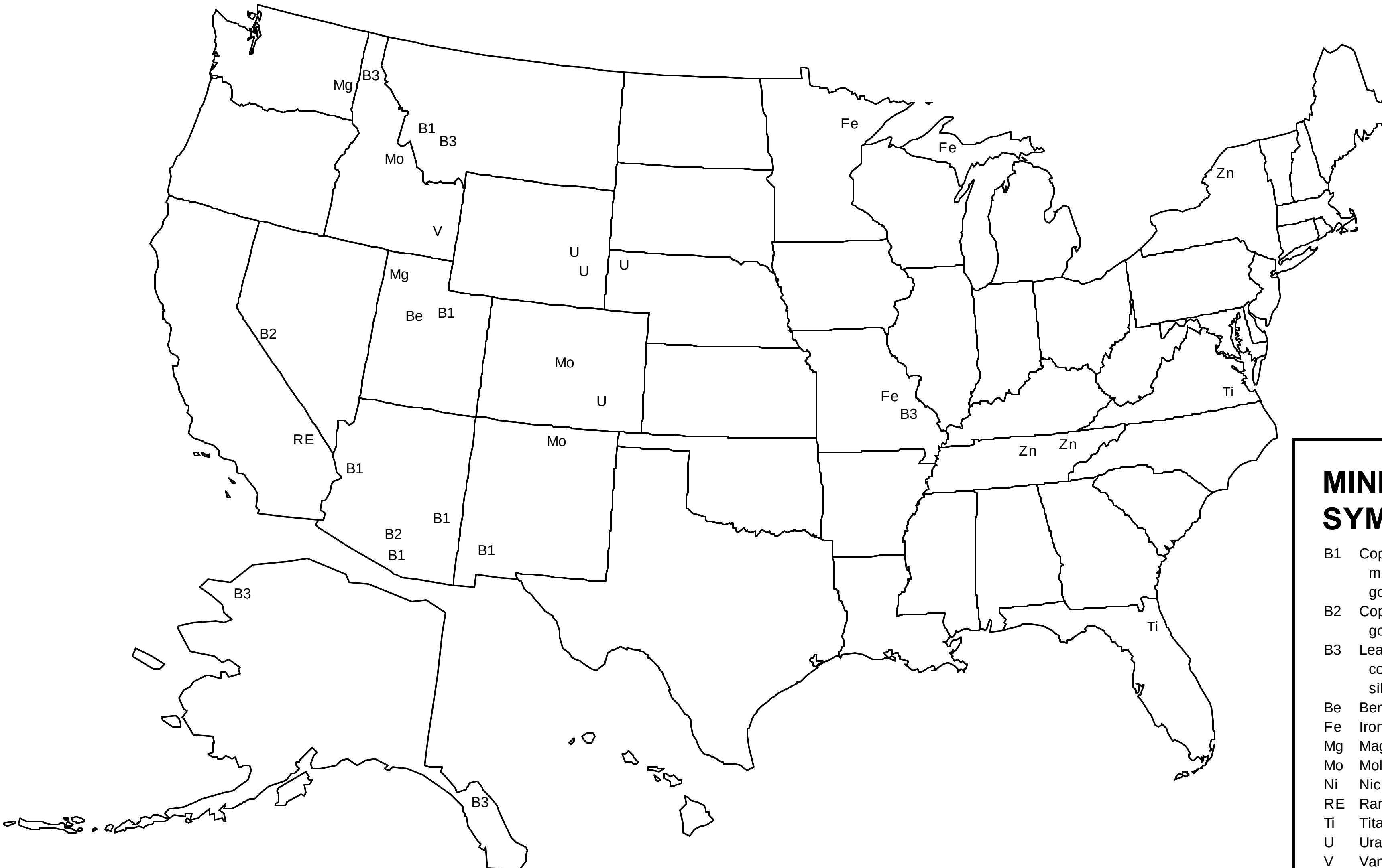
————2000d, Will half-finished reforms jeopardize South Korea's rebound?: Wall Street Journal, October 12, p. A21.

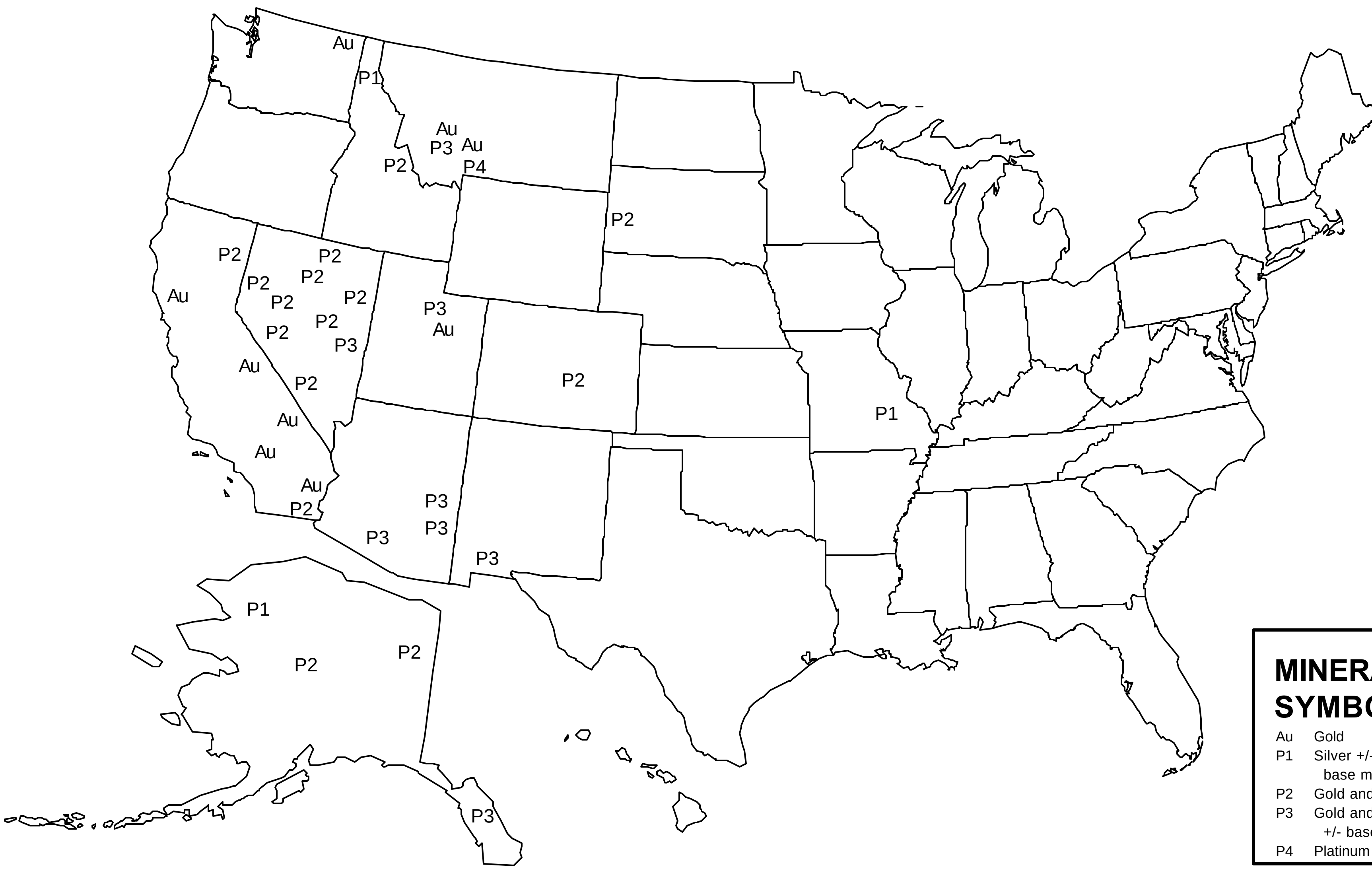
# MAJOR BASE AND FERROUS METAL PRODUCING AREAS




## MINERAL SYMBOLS

| | |
|---|---|
| B1 | Copper and molybdenum +/- gold, silver |
| B2 | Copper +/- gold, silver |
| B3 | Lead, zinc +/- copper +/- gold +/- silver |
| Be | Beryllium |
| Fe | Iron |
| Mg | Magnesium |
| Mo | Molybdenum |
| Ni | Nickel |
| RE | Rare earths |
| Ti | Titanium minerals |
| U | Uranium |
| V | Vanadium |
| Zn | Zinc |

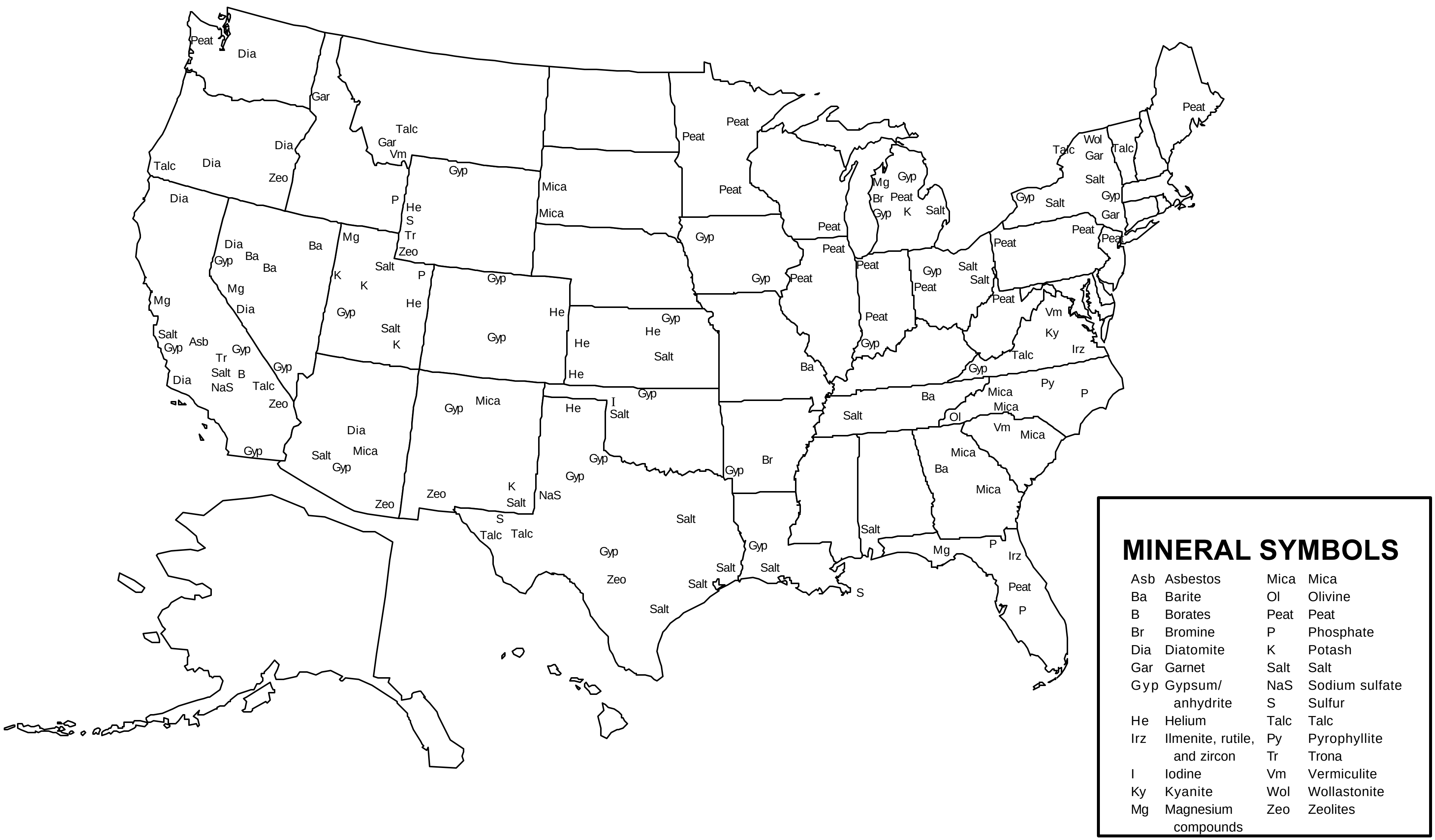
# MAJOR PRECIOUS METAL PRODUCING AREAS




**MINERAL SYMBOLS**

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

# MAJOR INDUSTRIAL ROCK AND MINERAL PRODUCING AREAS - PART I



# 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 three companies at six plants in the United States and Canada. Production of regular-grade fused aluminum oxide was valued at about $33 million, and production of high-purity fused aluminum oxide was estimated at a value of more than $5.4 million. Silicon carbide was produced by three companies at three plants in the United States and Canada. Domestic and Canadian production of crude silicon carbide had an estimated value of more than $38 million. Bonded and coated abrasive products accounted for most abrasive uses of fused aluminum oxide and silicon carbide.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, United States and Canada (crude): | | | | | |
| Fused aluminum oxide, regular | 124,000 | 93,500 | 99,600 | [e]93,000 | [1]90,000 |
| Fused aluminum oxide, high-purity | 22,700 | 14,200 | [1]20,000 | [1]10,000 | [1]10,000 |
| Silicon carbide | 73,600 | 68,200 | [1]70,000 | [e]70,000 | [1]50,000 |
| Imports for consumption (U.S.): | | | | | |
| Fused aluminum oxide | 131,000 | 138,000 | 180,000 | 166,000 | 214,000 |
| Silicon carbide | 182,000 | 240,000 | 268,000 | 169,000 | 195,000 |
| Exports (U.S.): | | | | | |
| Fused aluminum oxide | 11,900 | 10,700 | 8,910 | 9,020 | 4,620 |
| Silicon carbide | 14,200 | 16,100 | 11,600 | 8,260 | 10,700 |
| Consumption, apparent (U.S.): | | | | | |
| Fused aluminum oxide | NA | NA | NA | NA | NA |
| Silicon carbide | NA | NA | NA | NA | NA |
| Price, range of value, dollars per ton United States and Canada: | | | | | |
| Fused aluminum oxide, regular | 353 | 370 | 361 | 351 | 329 |
| Fused aluminum oxide, high-purity | 576 | 570 | 550 | 425 | 550 |
| Silicon carbide | 490 | 490 | 610 | 600 | 579 |
| Net import reliance[2] as a percent of apparent consumption (U.S.) | NA | NA | NA | NA | NA |

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

**Import Sources (1996-99):** Fused aluminum oxide crude: Canada, 73%; China, 24%; and other, 3%. Fused aluminum oxide grain: China, 48%; Canada, 16%; Austria, 12%; and other, 24%. Silicon carbide crude: China, 80%; Canada, 15%; and other, 5%. Silicon carbide grain: China, 51%; Brazil, 15%; Norway, 12%; Germany, 6%; and other, 16%.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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:** In February 2000, the Department of Defense sold the remaining 227 tons of silicon carbide in the National Defense Stockpile (NDS). During the first half of 2000, the remaining 37,400 tons of fused crude aluminum oxide in the NDS was sold. No further stockpiling of fused crude aluminum oxide or silicon carbide by the Department of Defense is anticipated. If current disposal rates and sale schedules continue, all fused aluminum oxide abrasive grain in the NDS will be sold by yearend 2003.

**Stockpile Status—9-30-00[3]**

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Fused aluminum oxide, crude | — | 33,205 | — | 58,967 | 54,325 |
| Fused aluminum oxide, grain | 16,451 | 104 | 16,451 | 5,443 | 2,268 |
| Silicon carbide, crude | — | 4 | — | 8,165 | 1,225 |

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# ABRASIVES (MANUFACTURED)

**Events, Trends, and Issues:** Imports and higher operating costs continued to challenge producers in the United States and Canada. Strong 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 | |
|---|---|---|---|---|
| | 1999 | 2000[e] | 1999 | 2000[e] |
| United States and Canada | 220,000 | 220,000 | 90,000 | 90,000 |
| 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 | 450,000 | 450,000 | 450,000 | 450,000 |
| 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 | 50,000 | 50,000 | 60,000 | 60,000 |
| Mexico | — | — | 30,000 | 30,000 |
| Norway | — | — | 80,000 | 80,000 |
| Venezuela | — | — | 40,000 | 40,000 |
| Other countries | 80,000 | 80,000 | 190,000 | 190,000 |
| World total (rounded) | 1,100,000 | 1,100,000 | 1,000,000 | 1,000,000 |

**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.
[1]Rounded to the nearest 10,000 tons to protect proprietary data.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.

# ALUMINUM[1]

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

**Domestic Production and Use:** In 2000, 12 companies operated 23 primary aluminum reduction plants. Montana, Oregon, and Washington accounted for 35% of the production; Maryland, New York, Ohio, and West Virginia, 20%; and other States, 45%. Based upon published market prices, the value of primary metal production in 2000 was $6.1 billion. Aluminum consumption, by an estimated 25,000 firms, was centered in the East Central United States. Transportation accounted for an estimated 37% of domestic consumption in 2000; packaging, 22%; building, 15%; consumer durables, 8%; electrical, 8%; and other, 10%.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: Primary | 3,577 | 3,603 | 3,713 | 3,779 | 3,700 |
| Secondary (from old scrap) | 1,570 | 1,530 | 1,500 | 1,550 | 1,600 |
| Imports for consumption | 2,810 | 3,080 | 3,550 | 4,000 | 4,200 |
| Exports | 1,500 | 1,570 | 1,590 | 1,640 | 1,750 |
| Shipments from Government stockpile excesses | — | 57 | ([2]) | — | — |
| Consumption, apparent[3] | 6,610 | 6,720 | 7,090 | 7,740 | 7,900 |
| Price, ingot, average U.S. market (spot), cents per pound | 71.3 | 77.1 | 65.5 | 65.7 | 75.0 |
| Stocks: Aluminum industry, yearend | 1,860 | 1,860 | 1,930 | 1,870 | 1,700 |
| LME, U.S. warehouses, yearend[4] | 33 | 8 | 13 | 14 | 2 |
| Employment, primary reduction, number | 18,200 | 18,000 | 18,400 | 18,200 | 18,100 |
| Net import reliance[5] as a percent of apparent consumption | 22 | 23 | 27 | 31 | 33 |

**Recycling:** Aluminum recovered in 2000 from purchased scrap was about 4 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 20% of apparent consumption.

**Import Sources (1996-99):** Canada, 61%; Russia, 18%; Venezuela, 5%; Mexico, 3%; and other, 13%.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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.

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# ALUMINUM

**Events, Trends, and Issues:** Domestic primary aluminum production decreased owing in large part to the smelter production cutbacks caused by increased energy costs, particularly in the Pacific Northwest. Domestic smelters operated at about 87% of rated or engineered capacity.

The mergers of Alcoa Inc. with Reynolds Metals Company[6] and Alcan Aluminium Limited with algroup (the aluminum division of Alusuisse Lonza Group Inc.),[7] announced in 1999, were approved by the U.S. Department of Justice and the European Union. Stock option plans and required facility divestments were initiated by both groups during 2000. Century Aluminum Co. reached a definitive agreement with Southwire Co. to acquire Southwire's 237,000-ton-per-year primary aluminum smelter in Hawesville, KY. The acquisition was subject to the completion of a labor agreement, the arrangement of financing, and the receipt of regulatory approval.[8]

Imports for consumption continued to increase, a trend that began in 1996. Canada and Russia accounted for more than three-fourths of the total imports. U.S. exports also continued to increase in 2000.

The price of primary aluminum ingot fluctuated through September 2000. In January, the average monthly U.S. market price for primary ingot quoted by Platt's Metals Week was 80.1 cents per pound; in September, the price was 77.2 cents per pound. Prices on the London Metal Exchange (LME) followed the trend of U.S. market prices. The monthly average LME cash price for September was 72.6 cents per pound. Prices in the aluminum scrap markets paralleled the general trend of primary ingot prices.

World production increased slightly compared with that for 1999. Inventories of metal held by producers, as reported by the International Primary Aluminium Institute, and LME inventories decreased significantly during the first half of 2000.

**World Smelter Production and Capacity:**

| | Production | | Yearend capacity | |
|---|---|---|---|---|
| | 1999 | 2000[e] | 1999 | 2000[e] |
| United States | 3,779 | 3,700 | 4,270 | 4,270 |
| Australia | 1,720 | 1,740 | 1,770 | 1,770 |
| Brazil | 1,250 | 1,260 | 1,220 | 1,260 |
| Canada | 2,390 | 2,370 | 2,300 | 2,300 |
| China | 2,450 | 2,600 | 2,640 | 2,640 |
| France | 400 | 450 | 430 | 430 |
| Norway | 1,030 | 1,030 | 1,000 | 1,020 |
| Russia | 3,150 | 3,200 | 3,190 | 3,200 |
| South Africa | 687 | 690 | 676 | 676 |
| Venezuela | 570 | 580 | 640 | 640 |
| Other countries | 5,650 | 6,240 | 7,240 | 7,480 |
| World total (rounded) | 23,100 | 23,900 | 25,400 | 25,700 |

**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, wood, and steel can substitute for aluminum in construction. Glass, plastics, paper, and steel can substitute for aluminum in packaging.

[e]Estimated.
[1]See also Bauxite and Alumina.
[2]Less than ½ unit.
[3]Domestic primary metal production + recovery from old aluminum scrap + net import reliance.
[4]Includes aluminum alloy.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]Alcoa Inc., 2000, Alcoa completes merger with Reynolds Metals: Pittsburgh, PA, and Richmond, VA, Alcoa Inc. press release, May 3, 1 p.
[7]Alcan Aluminium Limited, 2000, Alcan and algroup to merge: Montreal, Canada, and Zurich, Switzerland, Alcan Aluminium Limited press release, June 1, 2 p.
[8]Platt's Metals Week, 2000, Century/Southwire reach deal: Platt's Metals Week, v. 71, no. 36, September 4, p. 9.

# ANTIMONY

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

**Domestic Production and Use:** One silver mine in Idaho produced antimony as a byproduct, and an additional very small amount of antimony was recovered as a byproduct of the smelting of lead and silver-copper ores. Primary antimony metal and oxide was produced by five companies at processing plants that used foreign feedstock and a small amount of domestic feed material. Two plants were in Texas, and three other plants were in Idaho, Montana, and New Jersey. The estimated value of primary antimony metal and oxide produced in 2000 was $58 million. Secondary antimony was recovered, mostly in alloy form, at lead smelters; its value, based on the price of antimony metal, was about $3 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:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: Mine (recoverable antimony)[1] | 242 | 356 | 498 | 449 | 340 |
| Smelter: Primary | 25,600 | 26,400 | 24,000 | 23,800 | 22,400 |
| Secondary | 7,780 | 7,550 | 7,710 | 8,220 | 2,500 |
| Imports for consumption | 37,600 | 39,300 | 34,600 | 36,800 | 39,400 |
| Exports of metal, alloys,[2] oxide, and waste and scrap[2] | 4,450 | 3,880 | 4,170 | 3,660 | 2,570 |
| Shipments from Government stockpile | 4,300 | 2,930 | 4,160 | 5,790 | 5,500 |
| Consumption, apparent[3] | 45,000 | 46,600 | 42,700 | 36,500 | 44,900 |
| Price, metal, average, cents per pound[4] | 147 | 98 | 72 | 63 | 68 |
| Stocks, yearend | 11,000 | 10,800 | 10,600 | 10,700 | 11,000 |
| Employment, plant, number[e] | 100 | 100 | 80 | 75 | 75 |
| Net import reliance[5] as a percent of apparent consumption | 82 | 83 | 81 | 82 | 94 |

**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 this industry in recent years have caused lesser amounts of secondary antimony to be produced.

**Import Sources (1996-99):** Metal: China, 83%; Mexico, 6%; Hong Kong, 4%; Kyrgyzstan, 2%; and other, 5%. Ore and concentrate: China, 31%; Australia, 20%; Mexico, 7%; Austria, 5%; and other, 37%. Oxide: China, 43%; Mexico, 14%; South Africa, 13%; Bolivia, 12%; and other, 18%. Total: China, 59%; Mexico, 11%; South Africa, 7%; Bolivia, 6%; and other, 17%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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:** Government stockpile sales of antimony continued for the eighth year, after being resumed in 1993 for the first time since 1988. Public Law 103-160 provided authorization for the sales. During the year, the Defense Logistics Agency (DLA) held monthly sales for antimony using a negotiated bid process. The DLA announced that its Annual Materials Plan for fiscal year 2001 permitted the disposal of up to 5,000 metric tons of antimony, the same amount allotted in 2000. Antimony was stockpiled in eight DLA depots, with the largest inventories stored in New Haven, IN, and Somerville, NJ.

**Stockpile Status—9-30-00[6]**

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Antimony | 10,332 | 1,109 | 10,332 | 5,000 | 5,000 |

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# ANTIMONY

**Events, Trends, and Issues:** In 2000, antimony production from domestic source materials was derived mainly from the recycling of lead-acid batteries. Recycling plus U.S. mine output supplied only a minor portion of estimated domestic demand.

The price of antimony metal continued to decline during the first half of 2000. Prices started the year at $0.65 per pound, and, by spring, declined to $0.55 per pound. In late summer, the price rebounded with the price rising to $0.70 per pound. Industry observers attributed the price increase to more stringent enforcement of smuggling laws and newly enacted export controls by the Government of China.

Environmental and ecological problems associated with the treatment of antimony raw materials were minimal, because all domestic processors of raw materials now avoid sulfide-containing materials.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[7] | Reserve base[7] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 449 | 340 | 80,000 | 90,000 |
| Bolivia | 4,800 | 5,000 | 310,000 | 320,000 |
| China | 100,000 | 100,000 | 900,000 | 1,900,000 |
| Kyrgyzstan | 100 | 200 | 120,000 | 150,000 |
| Russia | 4,000 | 3,000 | 350,000 | 370,000 |
| South Africa | 6,000 | 6,000 | 240,000 | 250,000 |
| Tajikistan | 1,800 | 1,500 | 50,000 | 60,000 |
| Other countries | 4,900 | 5,000 | 25,000 | 75,000 |
| World total (may be rounded) | 122,000 | 121,000 | 2,100,000 | 3,200,000 |

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

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

[e]Estimated.

[1]Data for 1996-99 from the United States Securities and Exchange Commission 10-K report. Estimate for 2000 based upon 10-Q reports for the first two quarters.

[2]Gross weight.

[3]Domestic mine production + secondary production from old scrap + net import reliance.

[4]New York dealer price for 99.5% to 99.6% metal, c.i.f. U.S. ports.

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

[6]See Appendix B for definitions.

[7]See Appendix C for definitions.

# ARSENIC

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

**Domestic Production and Use:** Because arsenic is not recovered from domestic ores, all arsenic metal and compounds consumed in the United States are imported. More than 95% of the arsenic consumed was in compound form, principally arsenic trioxide, which was subsequently converted to arsenic acid. Production of chromated copper arsenate (CCA), a wood preservative, accounted for more than 90% of the domestic consumption of arsenic trioxide; CCA was manufactured primarily by three companies. Another company used arsenic acid to produce arsenical herbicides. Arsenic metal was consumed in the manufacture of nonferrous alloys, principally lead alloys for use in lead-acid batteries. About 15 tons per year of high-purity arsenic were estimated to have been used in the manufacture of semiconductor material. The value of arsenic metal and compounds consumed domestically in 2000 was estimated to be $20 million.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production | — | — | — | — | — |
| Imports for consumption: | | | | | |
| Metal | 252 | 909 | 997 | 1,300 | 1,000 |
| Compounds | 21,200 | 22,800 | 29,300 | 22,100 | 33,000 |
| Exports, metal | 36 | 61 | 177 | 1,350 | 40 |
| Estimated consumption[1] | 21,400 | 23,700 | 30,100 | 22,000 | 34,000 |
| Value, cents per pound, average:[2] | | | | | |
| Metal (China) | 40 | 32 | 57 | 59 | 35 |
| Trioxide (Mexico) | 33 | 31 | 32 | 29 | 32 |
| Net import reliance[3] as a percent of apparent consumption | 100 | 100 | 100 | 100 | 100 |

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

**Import Sources (1996-99):** Metal: China, 87%; Hong Kong, 5%; Japan, 3%; and other, 5%. Trioxide: China, 49%; Chile, 30%; Mexico, 7%; and other, 14%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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.

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# ARSENIC

**Events, Trends, and Issues:** Wood preservatives are expected to remain the major domestic use for arsenic. As a result, the demand for arsenic in the United States should continue to correlate closely with demand for new housing and growth in the renovation or replacement of existing structures using pressure–treated lumber. In general, the demand for arsenic-based wood preservatives appears positive, barring greater acceptance of alternative preservatives or adverse regulatory activity.

Because of the toxicity of arsenic and its compounds, environmental regulation is expected to become increasingly stringent. This should adversely affect the demand for arsenic in the long term but have only minor impacts in the near term. Mitigating the pollution effects and potential health hazards of naturally occurring and anthropogenic arsenic should continue as important research areas.

**World Production, Reserves, and Reserve Base:**

| | Production (Arsenic trioxide) 1999 | 2000[e] | Reserves and reserve base[5] (Arsenic content) |
|---|---|---|---|
| Belgium | 1,500 | 1,500 | |
| Chile | 8,000 | 8,000 | World reserves and reserve base are thought to be about 20 and 30 times, respectively, annual world production. The reserve base for the United States is estimated to be 80,000 tons. |
| China | 16,000 | 16,000 | |
| France | 1,000 | 1,000 | |
| Ghana | 5,000 | 5,000 | |
| Kazakhstan | 1,500 | 2,000 | |
| Mexico | 2,500 | 3,000 | |
| Russia | 1,500 | 1,500 | |
| Other countries | 1,800 | 2,000 | |
| World total | 38,800 | 40,000 | |

**World Resources:** World resources of copper and lead contain about 11 million tons of arsenic. Substantial resources of arsenic occur in copper ores in northern Peru and the Philippines and in copper-gold ores in Chile. In addition, world gold resources, particularly in Canada, contain substantial resources of arsenic.

**Substitutes:** Substitutes for arsenic compounds exist in most of its major uses, although arsenic compounds may be preferred because of lower cost and superior performance. The wood preservatives pentachlorophenol and creosote may be substituted for CCA when odor and paintability are not problems and where permitted by local regulations. Ammoniacal copper quaternary, copper azole, copper citrate, and copper dimethyldithiocarbamate are some of the alternative wood preservatives available which use no arsenic. Nonwood alternatives, such as concrete, steel, or plastic lumber, may be substituted in some applications for treated wood.

[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]Tariff is free 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:** One firm in California accounted for 100% of domestic production. Asbestos was consumed in roofing products, 61%; gaskets, 19%; friction products, 13%; and other, 7%.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production (sales), mine | 10 | 7 | 6 | 7 | 5 |
| Imports for consumption | 22 | 21 | 16 | 16 | 15 |
| Exports[1] | 15 | 20 | 18 | 22 | 20 |
| Shipments from Government stockpile excesses | — | — | 3 | 5 | — |
| Consumption, estimated | 22 | 21 | 16 | 16 | 15 |
| Price, average value, dollars per ton[2] | 210 | 210 | 210 | 210 | 210 |
| Stocks, producer, yearend | NA | NA | NA | NA | NA |
| Employment, mine and mill, number | 25 | 25 | 25 | 25 | 25 |
| Net import reliance[3] as a percent of estimated consumption | 100 | 100 | 100 | 100 | 100 |

**Recycling:** Insignificant.

**Import Sources (1996-99):** Canada, 97%; and other, 3%.

| **Tariff:** Item | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Asbestos | 2524.00.0000 | Free. |

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

**Government Stockpile:**

**Stockpile Status—9-30-00[4]**
**(Metric tons)**

| **Material** | **Uncommitted inventory** | **Committed inventory** | **Authorized for disposal** | **Disposal plan FY 2000** | **Disposals FY 2000** |
|---|---|---|---|---|---|
| Amosite | 11,500 | — | 11,500 | — | — |
| Chrysotile | 1 | — | 1 | — | — |

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# ASBESTOS

**Events, Trends, and Issues:** Domestic sales of asbestos decreased from those of 1999. Imports and exports decreased by 6% and 9%, respectively, from those of 1999, according to the U.S. Census Bureau. Estimated consumption decreased by 6%. Some reported exports were likely to have been reexports, asbestos-containing products, or nonasbestos products. Exports of asbestos fiber were estimated to be approximately 5,000 tons. Essentially all the asbestos used in the United States was chrysotile. Canada remained the largest supplier of asbestos for domestic consumption.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[5] | Reserve base[5] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 7 | 5 | Moderate | Large |
| Brazil | 170 | 170 | Moderate | Moderate |
| Canada | 337 | 335 | Large | Large |
| China | 300 | 300 | Large | Large |
| Kazakhstan | 125 | 125 | Large | Large |
| Russia | 700 | 700 | Large | Large |
| South Africa | 20 | 20 | Moderate | Moderate |
| Zimbabwe | 135 | 130 | Moderate | Moderate |
| Other countries | 136 | 114 | Large | Large |
| World total | 1,930 | 1,900 | Large | Large |

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

**Substitutes:** Numerous materials substitute for asbestos in products. The substitutes include calcium silicate; carbon fiber; cellulose fiber; ceramic fiber; glass fiber; steel fiber; wollastonite; and several organic fibers, such as aramid, polyethylene, polypropylene, and polytetrafluoroethylene. Several nonfibrous minerals were considered to be possible asbestos substitutes for products in which the reinforcement properties of fibers were not required. No single substitute was as versatile and as cost effective as asbestos.

[e]Estimated. NA Not available.
[1]Probably includes nonasbestos materials and reexports.
[2]Average price for Group 7 Canadian chrysotile, ex-mine.
[3]Defined as imports - exports + adjustments for Government and industry stock changes. Most domestic production is exported; imports account for almost all domestic consumption.
[4]See Appendix B for definitions.
[5]See Appendix C for definitions.

# BARITE

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** Barite sales by domestic producers increased significantly to about 600,000 tons in 2000 from 434,000 tons in 1999; the value increased to a lesser extent, to about $14 million. Sales came from three States, with the preponderance coming from Nevada, followed by Georgia and Tennessee. In 2000, an estimated 2.0 million tons of ground barite was sold from six States from domestic production and imports by domestic crushers and grinders. Nearly 95% of the barite sold in the United States was used as a weighting agent in gas- and oil-well-drilling fluids. Shipments went mostly to the gas drilling industry in the Gulf of Mexico and onshore in Louisiana and Texas, which had a little less than 70% of gas production in the conterminous United States. Smaller amounts were used in the Western United States, which had about 20% of gas production in the conterminous United States, in western Canada, and in Alaska. Industrial end uses for barite include an additive to cement, rubber, and urethane foam as a weighing material. Barite is also used in automobile paint primer for metal protection and gloss, and "leaded" glass, and as the raw material for barium chemicals. In the metal casting industry, barite is part of the mold-release compounds. Barite has become part of the friction products (brake and clutch pads) for transportation vehicles. Because barite strongly reduces X-rays and gamma rays, it is used in cement vessels that contain radioactive materials, gastrointestinal X-ray "milkshakes," and the faceplate and funnelglass of cathode-ray tubes used for television sets and computer monitors to block radiation towards the viewer.

| **Salient Statistics—United States:** | | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|---|
| Sold or used, mine | | 662 | 692 | 476 | 434 | 600 |
| Imports for consumption: | Crude barite | 1,470 | 2,210 | 1,850 | 836 | 1,460 |
| | Ground barite | 70 | 31 | 20 | 17 | 22 |
| | Other | 14 | 12 | 13 | 18 | 13 |
| Exports | | 31 | 22 | 15 | 22 | 20 |
| Consumption, apparent[1] (crude barite) | | 2,170 | 2,920 | 2,340 | 1,280 | 2,080 |
| Consumption[2] (ground and crushed) | | 1,870 | 2,180 | 1,890 | 1,370 | 2,000 |
| Price, average value, dollars per ton, mine | | 22.21 | 22.45 | 22.70 | 25.60 | 24.00 |
| Employment, mine and mill, number[e] | | 350 | 380 | 410 | 300 | 300 |
| Net import reliance[3] as a percent of apparent consumption | | 70 | 76 | 80 | 66 | 71 |

**Recycling:** None.

**Import Sources (1996-99):** China, 82%; India, 12%; Mexico, 2%; Morocco, 1%; Canada, 1%; and other, 2%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Crude barite | 2511.10.5000 | $1.25/t. |
| Ground barite | 2511.10.1000 | Free. |
| Oxide, hydroxide, and peroxide | 2816.30.0000 | 2% ad val. |
| Other chlorides | 2827.38.0000 | 4.2% ad val. |
| Other sulfates | 2833.27.0000 | 0.6% ad val. |
| Other nitrates | 2834.29.5000 | 3.5% ad val. |
| Carbonate | 2836.60.0000 | 2.3% ad val. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

**Events, Trends, and Issues:** The domestic demand for barite collapsed in mid-1998 as world oil prices dropped owing to over-production of oil. Imports of barite decreased from about 1.5 million tons for the first half of 1998 to about 400,000 tons for the second half of 1998 and both halves of 1999, rising to nearly 1 million tons in the first half of 2000. Starting in early 1998, the number of oil-directed rigs in the United States decreased from about 400 rigs to about 110 rigs in March-April 1999 as light sweet crude oil price futures declined from about $18.30 to about $11.70 per barrel. As oil prices rose from March 1999 to about $35.50 per barrel in September 2000, the oil-directed rig count rose to about 135 rigs in June and fell to about 100 rigs in August 1999, then rose to about 200 rigs in the period between May and October 2000. Gas prices rose from $1.79 per million BTU in March 1999 to $5.28 per million BTU in September 2000. The number of gas-directed rigs in the United States declined steadily from about 600 rigs in January 1998 to about 360 rigs in March 1999 and then increased unevenly, reaching about 800 rigs in September 2000. The ratio of gas-directed rigs to total U.S. rigs went from about 60% in January 1998 with about 640 rigs to about 80% in January 1999 with about 530 total rigs and stayed at about 80% into October 2000 with about 850 rigs.

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# BARITE

A possible explanation for the lack of drilling for oil comes from an industry analysis that claimed that the Finding and Development Cost and the Reserve and Replacement Cost in the United States were significantly higher in 1998 than between 1988 and 1995 in the United States, and for the world average in 1998.[4] The result indicates that oil companies expended less effort to search for oil to replace produced reserves in the United States but instead purchased proven reserves, which led to the lack of response of barite consumption to the oil price increase in 1999 and 2000. The industry analysis also noted that oil reserves were cheaper to find by the large, integrated oil firms in the "frontier" areas of the world (e.g., Africa/Middle East, Latin America, and Asia Pacific) than by the smaller firms searching in the "mature" areas (most parts of the United States). This analysis, for which individual company financial data were used, reported that the Reserve and Replacement Cost in the United States was about $4 per barrel of oil equivalent greater than the average "frontier" cost during the 5 years to 1999 . It also reported that the Reserve and Replacement Cost in Canada was about $2 per barrel of oil equivalent less than the U.S. cost. This appears to explain the lack of oil well drilling in the United States following the rise in oil prices in 1999 and 2000.

Imports for consumption of lower cost foreign barite increased by about 75% compared with 1999 levels and was more than double the U.S. production rate. The major sources of imported barite have high-grade deposits, relatively low labor costs, and relatively low (per ton-mile) ocean transportation (compared to land transportation) cost to the U.S. Gulf Coast grinding plants. There was a relatively large stockpile of unground ore in place at the beginning of 1999, and the Gulf grinders worked down that stockpile while importing at a low rate. When demand returned to higher levels, the companies increased their rates of imports again. The Nevada mines, crushers, and grinders were competitive in the California market, the Great Plains, and the Canadian markets.

The principal environmental impact of chemically inert barite is the land disturbance normally associated with mining. Mud pits at well drilling sites, which contain barite, are treated according to the content of the base drilling fluid, not the barite. The mud in the pits may be dewatered and covered, dewatered and spread over the ground, or transported to special waste-handling facilities according to whether the base drilling fluid was water, oil, or synthetic.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[5] | Reserve base[5] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 434 | 600 | 26,000 | 60,000 |
| Bulgaria | 100 | 120 | 10,000 | 20,000 |
| Canada | 126 | 130 | 11,000 | 15,000 |
| China | 2,800 | 2,500 | 30,000 | 150,000 |
| France | 60 | 60 | 2,000 | 2,500 |
| Germany | 120 | 120 | 1,000 | 1,500 |
| India | 600 | 650 | 28,000 | 32,000 |
| Iran | 170 | 180 | NA | NA |
| Mexico | 137 | 150 | 7,000 | 8,500 |
| Morocco | 330 | 310 | 10,000 | 11,000 |
| Peru | 75 | 75 | 2,000 | 3,000 |
| Thailand | 80 | 80 | 9,000 | 15,000 |
| Turkey | 130 | 150 | 4,000 | 20,000 |
| United Kingdom | 55 | 50 | 100 | 600 |
| Other countries | 440 | 520 | 10,000 | 160,000 |
| World total (rounded) | 5,660 | 5,700 | 150,000 | 490,000 |

**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 in all categories are about 2 billion tons, but only about 550 million tons are identified.

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

[e]Estimated. NA Not available.
[1]Sold or used by domestic mines - exports + imports.
[2]Domestic and imported crude barite sold or used by domestic grinding establishments.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]Cacchione, N.D., and Teittinen, Matti, September 1, 2000, Herold 33[d] Annual Reserve Replacement Cost Analysis: 2000 Final Report, accessed November 1, 2000, via URL http://www.herold.com/research/.
[5]See Appendix C for definitions.

# BAUXITE AND ALUMINA[1]

(Data in thousand metric dry tons, unless otherwise noted)

**Domestic Production and Use:** Domestic ore, which for many years has accounted for less than 1% of the U.S. requirement for bauxite, was mined by one company from surface mines in Alabama and Georgia; virtually all of it was used in the production of nonmetallurgical products, such as abrasives, chemicals, and refractories. Thus, nearly all bauxite consumed in the United States was imported; of the total, about 95% was converted to alumina. Also, the United States imported more than one-half of the alumina it required. Of the total alumina used, about 90% went to primary aluminum smelters and the remainder went to nonmetallurgical uses. Annual alumina capacity was 5.1 million tons, with four Bayer refineries in operation at midyear.

| **Salient Statistics—United States:**[2] | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, bauxite, mine | W | NA | NA | NA | NA |
| Imports of bauxite for consumption[3] | 10,800 | 11,300 | 11,600 | 10,400 | 9,300 |
| Imports of alumina[4] | 4,330 | 3,830 | 4,050 | 3,810 | 4,500 |
| Exports of bauxite[3] | 154 | 97 | 108 | 168 | 180 |
| Exports of alumina[4] | 918 | 1,270 | 1,280 | 1,230 | 1,000 |
| Shipments of bauxite from Government stockpile excesses[3] | 612 | 1,430 | 3,300 | 4,180 | 500 |
| Consumption, apparent, bauxite and alumina (in aluminum equivalents)[5] | 4,380 | 4,210 | 5,000 | 4,880 | 4,200 |
| Price, bauxite, average value U.S. imports (f.a.s.) dollars per ton | 27 | 25 | 23 | 22 | 24 |
| Stocks, bauxite, industry, yearend[3] | 1,930 | 2,260 | 1,860 | 1,440 | 1,000 |
| Net import reliance,[6] bauxite and alumina, as a percent of apparent consumption | 100 | 100 | 100 | 100 | 100 |

**Recycling:** None.

**Import Sources (1996-99):**[7] Bauxite: Guinea, 39%; Jamaica, 29%; Brazil, 16%; Guyana, 9%; and other, 7%. Alumina: Australia, 69%; Suriname, 10%; Jamaica, 8%; and other, 13%. Total: Australia, 31%; Guinea, 22%; Jamaica, 20%; Brazil, 10%; and other, 17%.

**Tariff:** Import duties on bauxite and alumina were abolished in 1971 by Public Law 92-151. Only imports from non-normal-trade-relations nations were dutiable. Countries that supplied commercial quantities of bauxite or alumina to the United States during the first 8 months of 2000 had normal-trade-relations status.

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

**Government Stockpile:**

**Stockpile Status—9-30-00**[8]

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Bauxite, metal grade: | | | | | |
| Jamaica-type | 5,500 | 3,640 | 5,500 | 2,030 | 2,040 |
| Suriname-type | 820 | 2,310 | 820 | 1,520 | 1,520 |
| Bauxite, refractory-grade, calcined | 45 | 28 | 45 | 0 | 0 |

**Events, Trends, and Issues:** World production of bauxite was essentially unchanged from that of 1999. World production of alumina, however, increased slightly to accommodate the modest increase in world primary aluminum metal production.

Domestic alumina production decreased owing to the continued closure of Kaiser Aluminum & Chemical Corp.'s 1.05-million-ton-per-year Gramercy, LA, refinery. Reconstruction of the area of the plant damaged during an explosion on July 5, 1999, continued. Kaiser expected to complete the first phase of its restart by yearend 2000 and to have the facility operating at full capacity in the first quarter of 2001.[9]

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# BAUXITE AND ALUMINA

The revised fiscal year (FY) Annual Materials Plan (AMP) submitted by the Defense National Stockpile Center proposed the sale of 3.05 million dry metric tons of metallurgical-grade bauxite (2.03 million tons of Jamaica-type and 1.02 million tons of Suriname-type) during the period October 1, 2000, to September 30, 2001. These are the maximum amounts that could be sold under the FY 2001 AMP, and are not necessarily the amounts that would actually be offered for sale.

Spot prices for metallurgical-grade alumina, as published by Metal Bulletin, increased slightly during the first 2 months of the year, and held steady for a few months, before beginning a precipitous decline that began in mid-May. The decline was attributed in part to announced smelter closures in the United States, a general slowdown in the growth of metal demand, and increased alumina production as refinery capacity expansions came on-stream. The published price range began the year at $375 to $385 per ton. In mid-February, the price range reached $420 to $440 per ton and held steady until mid-May. By the end of September, the price range had declined to $190 to $205 per ton.

**World Bauxite Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[10] | Reserve base[10] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | NA | NA | 20,000 | 40,000 |
| Australia | 48,400 | 49,000 | 3,800,000 | 7,400,000 |
| Brazil | 12,900 | 13,200 | 3,900,000 | 4,900,000 |
| China | 8,500 | 8,000 | 720,000 | 2,000,000 |
| Guinea | 15,000 | 15,000 | 7,400,000 | 8,600,000 |
| Guyana | 3,300 | 3,300 | 700,000 | 900,000 |
| India | 6,200 | 6,200 | 1,500,000 | 2,300,000 |
| Jamaica | 11,700 | 11,200 | 2,000,000 | 2,500,000 |
| Russia | 3,750 | 3,900 | 200,000 | 250,000 |
| Suriname | 4,000 | 4,000 | 580,000 | 600,000 |
| Venezuela | 4,190 | 4,400 | 320,000 | 350,000 |
| Other countries | 9,200 | 8,900 | 4,100,000 | 4,700,000 |
| World total (rounded) | 127,000 | 127,000 | 25,000,000 | 35,000,000 |

**World Resources:** Bauxite resources are estimated to be 55 to 75 billion tons, located in South America (33%), Africa (27%), Asia (17%), Oceania (13%), and elsewhere (10%). Domestic resources of bauxite are inadequate to meet long-term demand, but the United States and most other major aluminum-producing countries have essentially inexhaustible subeconomic resources of aluminum in materials other than bauxite.

**Substitutes:** Bauxite is the only raw material used in the production of alumina on a commercial scale in the United States. However, the vast U.S. resources of clay are technically feasible sources of alumina. Other domestic raw materials, such as anorthosite, alunite, coal wastes, and oil shales, offer additional potential alumina sources. Although it would require new plants using new technology, alumina from these nonbauxitic materials could satisfy the demand for primary metal, refractories, aluminum chemicals, and abrasives. Synthetic mullite, produced from kyanite and sillimanite, substitutes for bauxite-based refractories. Although more costly, silicon carbide and alumina-zirconia substitute for bauxite-based abrasives.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]See also Aluminum. As a general rule, 4 tons of dried bauxite are required to produce 2 tons of alumina, which, in turn, provide 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 (all in aluminum equivalents).
[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 44% for alumina in 2000. For the years 1996-99, the net import reliance was 100% for bauxite and ranged from 33% to 42% for alumina.
[7]Aluminum equivalents.
[8]See Appendix B for definitions.
[9]Kaiser Aluminum & Chemical Corp., 2000, Kaiser Aluminum revises start-up schedule for Gramercy alumina refinery: Houston, TX, Kaiser Aluminum & Chemical Corp. press release, September 18, 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 390 tons was valued at about $140 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:** | **1996** | **1997** | **1998** | **1999** | **2000**[e] |
|---|---|---|---|---|---|
| Production, mine shipments | 211 | 231 | 243 | 200 | 255 |
| Imports for consumption, ore and metal | 20 | 20 | 50 | 20 | 15 |
| Exports, metal | 57 | 40 | 60 | 40 | 30 |
| Government stockpile releases[e 1] | — | 76 | 57 | 145 | 140 |
| Consumption: Apparent | 197 | 316 | 320 | 385 | 390 |
| Reported, ore | 234 | 259 | 270 | 260 | 260 |
| Price, dollars: | | | | | |
| Domestic, metal, vacuum-cast ingot, per pound | 327 | 327 | 327 | 327 | 421 |
| Domestic, metal, powder blend, per pound | 385 | 385 | 385 | 385 | 492 |
| Domestic, beryllium-copper master alloy, per pound of contained beryllium | 160 | 160 | 160 | 160 | 160 |
| Domestic, beryllium oxide, powder, per pound | 77 | 77 | 77 | 77 | 100 |
| Stocks, consumer, yearend | 139 | 110 | 80 | 20 | 10 |
| Employment, number: | | | | | |
| Mine, full-time equivalent employees[e] | 25 | 25 | NA | NA | NA |
| Primary refineries[e] | 400 | 400 | NA | NA | NA |
| Net import reliance[2] as a percent of apparent consumption | E | 27 | 24 | 48 | 35 |

**Recycling:** Quantities of new scrap generated in the processing of beryllium-copper alloys and quantities of obsolete military equipment containing metallic beryllium were recycled. Data on beryllium recycled in this manner are not available.

**Import Sources (1996-99):** Ore, metal, scrap, and master alloy: Russia, 31%; Canada, 20%; Kazakhstan, 12%; Germany, 10%; and other, 27%.

| **Tariff:** **Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Beryllium ore 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: | | |
| Waste and scrap | 8112.11.3000 | Free. |
| Other | 8112.11.6000 | 8.5% ad val. |
| Beryllium, wrought | 8112.19.0000 | 5.5% ad val. |

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

**Government Stockpile:**

**Stockpile Status—9-30-00**[3]

| **Material** | **Uncommitted inventory** | **Committed inventory** | **Authorized for disposal** | **Disposal plan FY 2000** | **Disposals FY 2000** |
|---|---|---|---|---|---|
| Beryl ore (11% BeO) | 351 | 122 | 351 | 145 | 73 |
| Beryllium-copper master alloy | 81 | 44 | 81 | 54 | 82 |
| Beryllium metal | 322 | 29 | 277 | 36 | 23 |

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# BERYLLIUM

**Events, Trends, and Issues:** For the first one-half year, sales of alloy products increased compared with those of the previous year, owing to strong demand for copper beryllium alloys from the telecommunications, computer, automotive electronics, aerospace, and oil and gas markets. Imports for consumption of beryllium ore and metal decreased; Germany, Russia, and the United Kingdom were the leading suppliers. Metal exports were down; France, Japan, the Netherlands, and the United Kingdom were the major recipients.

For fiscal year 2000, ending September 30, 2000, the Defense National Stockpile Center (DNSC) sold about 1,810 tons of beryl ore (about 73 tons of beryllium content) valued at about $158,000, about 2,040 tons beryllium copper master alloy (BCMA) (about 82 tons of beryllium content) valued at about $12 million, and about 23 tons of beryllium metal valued at about $4.15 million (multiyear awards) from the National Defense Stockpile. The DNSC also proposed maximum disposal limits in fiscal year 2001 of about 3,630 tons of beryl ore (about 145 tons of beryllium content), about 2,000 tons of BCMA (about 80 tons of beryllium content), and about 36 tons of beryllium metal.

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

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production 1999 | Mine production 2000[e] |
|---|---|---|
| United States | 200 | 255 |
| China | 55 | 55 |
| Kazakhstan | 4 | 4 |
| Russia | 40 | 40 |
| Other countries | 2 | 2 |
| World total | 301 | 356 |

**Reserves and reserve base[4]**

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 19,000 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:** Although 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. E Net exporter. NA Not available.
[1]Net quantity (uncommitted inventory).
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.
[4]See Appendix C for definitions.

# BISMUTH

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

**Domestic Production and Use:** There is no domestic refinery production of primary bismuth. One refinery in Nebraska formerly produced bismuth as a byproduct of lead refining, but bismuth operations there ceased on June 30, 1997. Bismuth is contained in some domestically mined lead ores, but no byproduct bismuth was produced. Forty-four companies, mostly in the eastern United States, accounted for an estimated three-fourths of the bismuth consumed in 2000. The value of bismuth consumed was estimated at almost $17 million. About 40% of the bismuth was used in pharmaceuticals and chemicals; 40% in fusible alloys, solders, and cartridges; 18% in metallurgical additives; and 2% in other uses.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000**[e] |
|---|---|---|---|---|---|
| Production, refinery | W | W | — | — | — |
| Imports for consumption, metal | 1,490 | 2,170 | 2,720 | 2,110 | 2,200 |
| Exports, metal, alloys, scrap | 151 | 206 | 245 | 257 | 300 |
| Shipments from Government stockpile excesses | 137 | 229 | — | — | — |
| Consumption, reported | 1,520 | 1,530 | 2,000 | 2,050 | 2,200 |
| Price, average, domestic dealer, dollars per pound | 3.65 | 3.50 | 3.60 | 3.85 | 3.50 |
| Stocks, yearend, consumer | 122 | 213 | 150 | 121 | 100 |
| Employment, refinery, number of workers[1] | [e]30 | [e]30 | — | — | — |
| Net import reliance[2] as a percent of apparent consumption | W | W | [e]95 | [e]95 | 95 |

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

**Import Sources (1996-99):** Belgium, 33%; Mexico, 25%; United Kingdom, 18%; China, 15%; and other, 9%.

| **Tariff:** **Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Articles thereof, including waste and scrap | 8106.00.0000 | Free. |

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

**Government Stockpile:** The final 85 tons of bismuth in the National Defense Stockpile was sold on November 4, 1997.

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# BISMUTH

**Events, Trends, and Issues:** Bismuth was used in several applications designed to provide nontoxic substitutes for lead. The Safe Drinking Water Act Amendment of 1996 required that all new and repaired fixtures and pipes for potable water be lead-free after August 1998. Bismuth use in water meters was one particular application that increased. Other major areas of development included bismuth shot for waterfowl hunting, bismuth-containing solders, and lubricating greases, especially extreme pressure lubricants. The use of new zinc-bismuth alloys in galvanizing to achieve better processing continued to grow. Bismuth was also used in ceramic glazes, crystal ware, and pigments.

World lead mine production and world primary lead refinery production has not increased significantly in recent years, limiting the amount of bismuth that can be produced as a lead byproduct. Bismuth was also recovered from some copper ores and from tungsten ores, especially in Asia. World mine and refinery production of bismuth increased in 2000. The domestic price decreased from $4.30 per pound to $3.93 per pound during the first quarter and decreased to $3.53 per pound by the end of the second quarter. The price decreased to $3.23 per pound during the third quarter, but it stabilized above $3.00 per pound for the remainder of the year. The average price for the year decreased for the first time since 1997.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[3] | Reserve base[3] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | — | — | 9,000 | 14,000 |
| Australia | — | — | 18,000 | 27,000 |
| Bolivia | 255 | 300 | 10,000 | 20,000 |
| Canada | 311 | 300 | 5,000 | 30,000 |
| China | 400 | 500 | 20,000 | 40,000 |
| Japan | 135 | 150 | 9,000 | 18,000 |
| Kazakhstan | 130 | 130 | 5,000 | 10,000 |
| Mexico | 1,250 | 1,250 | 10,000 | 20,000 |
| Peru | 1,000 | 1,000 | 11,000 | 42,000 |
| Other countries | 139 | 150 | 15,000 | 35,000 |
| World total (rounded) | 3,620 | 3,780 | 110,000 | 260,000 |

**World Resources:** World reserves of bismuth are usually associated with lead deposits, except in China and North Korea, where economically recoverable bismuth is found with tungsten ores, and in Australia, where it is found with copper-gold ores. Bismuth minerals rarely occur in sufficient quantities to be mined as principal products, except in Bolivia and possibly in China. Bismuth is potentially recoverable as a byproduct of the processing of molybdenum and non-Asian tungsten ores, although extraction of bismuth from these ores usually is not economic.

**Substitutes:** Antibiotics, magnesia, and alumina can replace bismuth in pharmaceutical applications. 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 alloy jigs used for holding metal shapes during machining. Glycerine-filled glass bulbs can replace bismuth alloys as a triggering device for fire sprinklers. Selenium, tellurium, and lead could replace bismuth in free-machining alloys.

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Data for first 6 months of 1997, until shutdown of only domestic refiner.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]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 2000 was $498 million. Domestic production of boron minerals, primarily as sodium borates, by four companies was centered in southern California. The largest producer operated an open pit tincal and kernite mine and associated compound plants. A second firm, using Searles Lake brines as raw material, accounted for the majority of the remaining output. A third company continued to process small amounts of calcium and calcium sodium borates. A fourth company used an in-situ process. Principal consuming firms were in the North Central United States and the Eastern United States. The reported distribution pattern for boron compounds consumed in the United States in 1999 was as follows: glass products, 73%; soaps and detergents, 6%; agriculture, 3%; fire retardants, 4%; and other, 14%.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production[1] | 581 | 604 | 587 | 618 | 627 |
| Imports for consumption, gross weight: | | | | | |
| Borax | 11 | 54 | 14 | 8 | 1 |
| Boric acid | 25 | 26 | 23 | 30 | 37 |
| Colemanite | 44 | 44 | 47 | 42 | 63 |
| Ulexite | 136 | 157 | 170 | 178 | 104 |
| Exports, gross weight: | | | | | |
| Boric acid | 42 | 92 | 106 | 107 | 40 |
| Refined sodium borates | 381 | 473 | 453 | 450 | 380 |
| Consumption: | | | | | |
| Apparent | 234 | 483 | 412 | 534 | 503 |
| Reported | 367 | 403 | NA | 416 | NA |
| Price, dollars per ton, granulated pentahydrate borax in bulk, carload, works[2] | 375 | 340 | 340 | 376 | 376 |
| Stocks, yearend[3] | NA | NA | NA | NA | NA |
| Employment, number | 900 | 900 | 900 | 900 | 900 |
| Net import reliance[4] as a percent of apparent consumption | E | E | E | E | E |

**Recycling**: Insignificant.

**Import Sources (1996-99)**: Boric acid: Chile, 37%; Turkey, 30%; Bolivia, 19%; Italy, 6%; Peru, 5%; other, 3%.

| **Tariff: Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| 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.

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# BORON

**Events, Trends, and Issues:** The United States was the world's largest producer of boron compounds during 2000 and exported about one-half of domestic production. All production was from California. Exported materials competed with borax, boric acid, colemanite, and ulexite primarily from Turkey, the largest producer of boron ore in the world.

The large surface mine increased its stripping ratio to 36 to 1 during the year. An unforseen slide involving some 32 million tons of material during 1999 increased the quantity of stripped overburden during the year to 100 million tons. The increased overburden removal is a result of a plan to increase the stability by constructing less steep benches. An agreement between the largest producer of borates and a large producer of flame retardants was signed to develop and expand the use of borates in plastics and as polymer additives. Potential opportunities for growth include the use of zinc borates in styrenics, engineering plastics and other compounds that take advantage of the low toxicity and flame-retardant performance of zinc borates.

The production of boron, sodium bicarbonate, and sodium sulfate production from underground brines in California continued, and the company planned a sale of the assets.

**World Production, Reserves, and Reserve Base:** [5]

| | Production—all forms | | Reserves[6] | Reserve base[6] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 1,220 | 1,120 | 40,000 | 80,000 |
| Argentina | 350 | 350 | 2,000 | 9,000 |
| Bolivia | 10 | 10 | 4,000 | 19,000 |
| Chile | 200 | 200 | 8,000 | 41,000 |
| China | 110 | 110 | 27,000 | 36,000 |
| Iran | 1 | 1 | 1,000 | 1,000 |
| Kazakhstan | 1 | 1 | 14,000 | 15,000 |
| Peru | 30 | 30 | 4,000 | 22,000 |
| Russia | 1,000 | 1,000 | 40,000 | 100,000 |
| Turkey | 1,410 | 1,400 | 30,000 | 150,000 |
| World total (rounded) | 4,370 | 4,270 | 170,000 | 470,000 |

**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 use other glass-producing substances, such as phosphates. Insulation substitutes include 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]Chemical Market Reporter.

[3]Stocks data are not available and are assumed to be zero for net import reliance and apparent consumption calculations.

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

[5]Gross weight of ore in thousand metric tons.

[6]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 four companies operating in Arkansas and Michigan accounted for 100% of elemental bromine production valued at an estimated $207 million. Arkansas, with six plants, continued to be the Nation's leading bromine producer, and bromine was the leading mineral commodity in terms of value produced in the State. A new elemental bromine plant that opened in 1999 was closed during 2000.

One domestic producer of bromine and a major producer of borates signed an agreement to market zinc borate flame retardants and smoke suppressants in Asia. The two companies, with leading positions in global flame and smoke suppressant markets, planned to jointly produce new products in halogen and halogen-free flame retardant systems.

Bromine was used in fire retardants, 27%; agriculture, 15%; petroleum additives, 15%; well drilling fluids, 10%; sanitary preparations, 5%; and other applications, 28%. Other applications included intermediate chemicals for the manufacture of other products and bromide solutions used alone or in combination with other chemicals.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production[1] | 227 | 247 | 230 | 239 | 229 |
| Imports for consumption, elemental bromine and compounds[2] | 14 | 11 | 10 | 10 | 9 |
| Exports, elemental bromine and compounds | 17 | 14 | 12 | 10 | 10 |
| Consumption, apparent[3] | 225 | 244 | 235 | 238 | 228 |
| Price, cents per kilogram, bulk, purified bromine | 66.0 | 80.2 | 70.0 | 87.0 | 90.0 |
| Employment, number | 1,700 | 1,700 | 1,700 | 1,700 | 1,700 |
| Net import reliance[4] as a percent of apparent consumption | E | E | — | E | E |

**Recycling:** Approximately 35% of U.S. bromine production was converted to byproduct sodium bromide solutions, which were recycled to obtain elemental bromine. This recycled bromine is not included in the virgin bromine production reported by the companies.

**Import Sources (1996-99):** Israel, 83%; Belgium, 5%; United Kingdom, 4%; and other, 8%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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 | 11.3% 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 | 0.6¢/kg + 11.1% ad val. |
| Vinyl bromide, methyl | 2903.30.1520 | Free. |

**Depletion Allowance:** 5% on brine wells (Domestic and foreign).

**Government Stockpile:** None.

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# BROMINE

**Events, Trends, and Issues:** Three bromine companies accounted for 64% of world production. Two of these companies are located in the United States and accounted for about 94% of U.S. production. A U.S. company signed a joint-venture agreement with a company in Jordan to build a bromine complex at Safi, Jordan. Construction, which was planned to begin in 2000 and be completed by 2002, includes a 50,000-ton-per-year bromine plant.

Israel was the second largest producer of bromine in the world and the largest producer of elemental bromine. Approximately 90% of production was for export, accounting for about 80% of international trade in bromine and bromine compounds to more than 100 countries. A company produced bromine from Dead Sea bromine-rich brines after production of potash by another company. Exports of elemental bromine by the bromine producer are used to produce bromine compounds at its plant in the Netherlands.

Under the Montreal Protocol, the global phaseout of methyl bromide as a crop pesticide will occur during 2001-2005 in the United States. Imports of crops treated with methyl bromide in Mexico are expected to continue, however, because Mexico does not have to phaseout methyl bromide until 2015.

China announced that construction has commenced on the first phase of a bromide manufacturing facility that is a joint venture between a Chinese company and the Israeli bromine producer.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[5] | Reserve base[5] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States[1] | 239 | 229 | 11,000 | 11,000 |
| Azerbaijan | 2.0 | 2.0 | 300 | 300 |
| China | 45.0 | 45.0 | NA | NA |
| France | 2.0 | 2.0 | 1,600 | 1,600 |
| India | 1.5 | 1.5 | ([6]) | ([6]) |
| Israel | 185 | 185 | ([7]) | ([7]) |
| Italy | 0.3 | 0.3 | ([6]) | ([6]) |
| Japan | 20.0 | 20.0 | ([8]) | ([8]) |
| Spain | 0.1 | 0.1 | 1,400 | 1,400 |
| Turkmenistan | 0.2 | 0.2 | 700 | 700 |
| Ukraine | 3.0 | 3.0 | 400 | 400 |
| United Kingdom | 30.0 | 30.0 | ([6]) | ([6]) |
| World total (rounded) | 530 | 520 | NA | NA |

**World Resources:** Resources of bromine are virtually unlimited. The Dead Sea in the Middle East is estimated to contain 1 billion tons of bromine. Seawater contains about 65 parts per million of bromine or an estimated 100 trillion tons. The bromine content of underground water in Poland has been estimated at 36 million tons.

**Substitutes:** Chlorine and iodine may be substituted for bromine in a few chemical reactions and for sanitation purposes. Aniline and some of its derivatives, methanol, ethanol, and gasoline-grade tertiary butyl alcohol, are effective nonlead substitutes for ethylene dibromide and lead in gasoline in some cars. There are no comparable substitutes for bromine in various oil and gas well completion and packer applications. Alumina, magnesium hydroxide, organic chlorine compounds, and phosphorous compounds can be substituted for bromine as fire retardants in some uses.

[e]Estimated. E Net exporter. NA Not available.
[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 solar salt.
[7]From the Dead Sea. See World Resources section.
[8]From seawater. See World Resources section.

# CADMIUM

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

**Domestic Production and Use:** Primary cadmium metal in the United States is produced by two companies, one in Illinois and one in Tennessee, as a byproduct of smelting and refining zinc metal from sulfide ore concentrates. Secondary cadmium is recovered from spent nickel-cadmium (Ni-Cd) batteries by one Pennsylvania company. Based on the average New York dealer price, the combined output of primary and secondary metal in 2000 was valued at about $265,000. Consumption of cadmium during the past 3 years declined by about 50% in response to environmental concern. About 75% of total apparent consumption was for batteries. The remaining 25% was distributed as follows: pigments, 13%; coatings and plating, 7%; stabilizers for plastics, 4%; and nonferrous alloys and other uses, 1%.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, refinery[1] | 1,530 | 2,060 | 1,240 | 1,190 | 1,200 |
| Imports for consumption, metal | 843 | 790 | 514 | 294 | 250 |
| Exports of metal, alloys, and scrap | 201 | 554 | 180 | 20 | 40 |
| Shipments from Government stockpile excesses | 230 | 161 | 128 | 5 | 10 |
| Consumption, apparent | 2,250 | 2,510 | 2,030 | 1,300 | 1,270 |
| Price, metal, dollars per pound[2] | 1.24 | 0.51 | 0.28 | 0.14 | 0.10 |
| Stocks, yearend, producer and distributor | 1,110 | 1,060 | 729 | 893 | 1,040 |
| Employment, smelter and refinery | NA | NA | NA | NA | NA |
| Net import reliance[3] as a percent of apparent consumption | 32 | 19 | 38 | 9 | 6 |

**Recycling:** To date, cadmium recycling has been practical only for Ni-Cd batteries, some alloys, and dust from electric arc furnaces (EAF). The exact amount of recycled cadmium is unknown. In 2000, the U.S. steel industry generated more than 0.6 million tons of EAF dust, typically containing 0.003% to 0.07% cadmium. At least nine States required collection of rechargeable Ni-Cd batteries.

**Import Sources (1996-99):** Metal: Canada, 56%; Australia, 14%; Belgium, 10%; and other, 20%.

| **Tariff:** Item | Number | Normal Trade Relations[4] 12/31/00 |
|---|---|---|
| Cadmium sulfide | 2830.30.0000 | 3.1% ad val. |
| Pigments and preparations based on cadmium compounds | 3206.30.0000 | 3.1% ad val. |
| Unwrought cadmium; waste and scrap; powders | 8107.10.0000 | Free. |

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

**Government Stockpile:**

**Stockpile Status—9-30-00[5]**

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Cadmium | 799 | 215 | 799 | 544 | 329 |

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# CADMIUM

**Events, Trends, and Issues:** During the last 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 agencies regulate cadmium content in the environment. To help unify different standards, the U.S. Environmental Protection Agency created a list of persistent and bioaccumulative toxic pollutants. Cadmium is 1 of 11 metals on the list, and it is targeted for a 50% reduction by 2005. The International Cadmium Association objected to the rating used for creating the list because no distinction was made between various cadmium compounds and cadmium metal. The European Commission issued a new proposal to ban all Ni-Cd batteries containing more than 0.002% cadmium beginning on January 1, 2008, and to increase the collection rate for all spent industrial and automotive batteries to 95% by weight by December 31, 2003.

**World Refinery Production, Reserves, and Reserve Base:**

| | Refinery production | | Reserves[6] | Reserve base[6] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 1,190 | 1,200 | 90,000 | 270,000 |
| Australia | 600 | 630 | 110,000 | 300,000 |
| Belgium | 1,400 | 1,200 | — | — |
| Canada | 1,390 | 2,350 | 55,000 | 160,000 |
| China | 2,200 | 2,250 | 13,000 | 35,000 |
| Germany | 1,100 | 1,100 | 6,000 | 8,000 |
| Japan | 2,600 | 2,550 | 10,000 | 15,000 |
| Kazakhstan | 1,060 | 1,000 | 25,000 | 40,000 |
| Mexico | 1,300 | 1,100 | 35,000 | 40,000 |
| Russia | 900 | 850 | 16,000 | 30,000 |
| Other countries | 5,360 | 5,070 | 240,000 | 330,000 |
| World total (may be rounded) | 19,100 | 19,300 | 600,000 | 1,200,000 |

**World Resources:** Estimated world resources of cadmium were about 6 million tons based on zinc resources containing about 0.3% cadmium. The zinc-bearing coals of the central United States, and Carboniferous-age coals of other countries, also contain large potential resources of cadmium.

**Substitutes:** Ni-Cd 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 the coating are critical (e.g., fasteners for aircraft), coatings of zinc or vapor-deposited aluminum can substitute for cadmium in plating applications. Cerium sulfide is used as a replacement for cadmium pigments, mostly for plastics.

[e]Estimated. NA Not available.
[1]Primary and secondary metal.
[2]Average New York dealer price for 99.95% purity in 5-short-ton lots. Source: Platt's Metals Week.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]No tariff for Canada and Mexico for items shown.
[5]See Appendix B for definitions.
[6]See Appendix C for definitions.

# CEMENT

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** In 2000, about 86 million tons of portland cement and 5 million tons of masonry cement were produced at a total of 116 plants, in 37 States, by 1 State agency and about 40 companies. There were also two plants in Puerto Rico. The ex-plant value of cement production, excluding Puerto Rico, was about $7.2 billion, and the value of total sales (including imported cement) was about $8.7 billion. Most of the cement was used to make concrete, worth at least $35 billion. Total domestic cement consumption (sales) was again at record levels. Imported cement and clinker (to make cement) accounted for about 25% of the cement sold; total imports were down slightly, reflecting additional domestic production capacity. Clinker, the main intermediate product in cement manufacture, was produced at 109 plants, with a combined apparent annual capacity of about 88 million tons. Including seven facilities that merely ground clinker produced elsewhere, total finished cement (grinding) capacity was about 100 million tons. Including Puerto Rico, clinker and cement capacities totaled about 90 and 102 million tons, respectively. California, Texas, Pennsylvania, Michigan, Missouri, and Alabama, in descending order, were the six largest producing States and accounted for about 50% of U.S. production. About 73% of cement sales went to ready-mixed concrete producers, 12% to concrete product manufacturers, 8% to contractors (mainly for road paving), 5% to building materials dealers, and 2% to other users.

| **Salient Statistics—United States:**[1] | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, portland and masonry[2] | 79,266 | 82,582 | 83,931 | 85,952 | 90,600 |
| Production, clinker | 70,361 | 72,686 | 74,523 | 76,003 | 78,500 |
| Shipments to final customers, including exports | 91,438 | 96,801 | 103,696 | 108,862 | 113,000 |
| Imports of hydraulic cement for consumption | 11,565 | 14,523 | 19,878 | 24,578 | 24,000 |
| Imports of clinker for consumption | 2,402 | 2,867 | 3,905 | 4,164 | 4,000 |
| Exports of hydraulic cement and clinker | 803 | 791 | 743 | 694 | 450 |
| Consumption, apparent[3] | 90,354 | 96,018 | 102,457 | 108,862 | 113,300 |
| Price, average mill value, dollars per ton | 71.19 | 73.49 | 76.46 | 78.27 | 77.50 |
| Stocks, mill, yearend | 5,488 | 5,784 | 5,393 | 6,367 | 7,200 |
| Employment, mine and mill, number[e] | 17,900 | 17,900 | 17,900 | 18,000 | 18,000 |
| Net import reliance[4] as a percent of apparent consumption | 12 | 14 | 19 | 21 | 20 |

**Recycling**: Cement kiln dust is routinely recycled to the kilns, which can also burn a variety of waste fuels and recycled raw materials such as slags. Cement itself generally is not recycled, but there is a small amount of recycling of concrete for use as aggregate.

**Import Sources (1996-99):**[5] Canada, 26%; China, 10%; Spain, 9%; Venezuela, 9%; and other, 46%. Imports were coming from an increasing number of countries, with Asian sources (especially China, Korea, and Thailand) becoming major suppliers since 1998; Thailand became the single largest supplier of imported cement and clinker in 2000.

| **Tariff: Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| 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:** Bolstered by continued low interest rates, the construction market in 2000 continued strong and again generated record consumption levels for cement. However, although strong, public sector spending on highways was less than had been expected, given the enhanced funding commitments of the Transportation Equity Act for the 21st Century ("TEA-21"), signed in mid-1998. A sunset review of decade-long antidumping remedies against cement and clinker imports from Japan, Mexico, and Venezuela was completed in October 2000 and upheld the remedies (tariffs) against Japan and Mexico, but dropped them against Venezuela.

Concern continued over the environmental impact of cement manufacture, particularly the emissions of carbon dioxide and cement kiln dust (CKD). The Intergovernmental Panel on Climate Change released guidelines for calculating

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# CEMENT

national $CO_2$ emissions from cement manufacture within a compendium designed to help evaluate compliance with targeted emissions reductions called for in the Kyoto Protocol, signed in 1997. This accord had yet to be ratified by the U.S. Congress, and debate continued as to how this reduction was to be achieved and what its cost would be to the economy. The U.S. Environmental Protection Agency evaluated public comments in 2000 to its standards for handling CKD which were published in mid-1999; final standards had not been issued as of yearend.

Rapidly rising fossil fuel costs in 2000 were of increasing concern to the cement industry. Some cement companies burn solid or liquid waste materials in their kilns as a low-cost substitute for fossil fuels. Cement kilns can be an effective and benign way of destroying such wastes; the viability of the practice and the type of waste(s) burned hinge on current and future environmental regulations and their associated costs. The trend, tempered by administrative constraints, appears to be towards increased use of waste fuels. Environmental issues common to mining, such as restrictions on silica in dust, also affect cement raw materials quarries.

Although still relatively minor in the United States, there is growing use worldwide of natural and synthetic pozzolans as partial or complete replacements for portland cement. Pozzolans are materials that, in the presence of free lime, have hydraulic cementitious properties; examples include certain volcanic rocks and industrial byproducts such as granulated blast furnace slag, fly ash, and silica fume. Pozzolanic cements, including blends with portland, can have performance advantages over some straight portland cements for certain applications. Because pozzolans do not require the energy-intensive clinker manufacturing (kiln) phase of production, their use reduces the unit monetary and environmental costs of cement manufacture. In the United States, most pozzolan consumption continued to be as sales directly to concrete manufacturers rather than within blended cements sold by cement plants.

**World Production and Capacity:**

| | Cement production | | Yearend clinker capacity | |
|---|---|---|---|---|
| | **1999** | **2000[e]** | **1999[e]** | **2000[e]** |
| United States (includes Puerto Rico) | 87,777 | 92,300 | [6]87,781 | 90,000 |
| Brazil | 40,270 | 41,500 | 45,000 | 45,000 |
| China | 573,000 | 576,000 | 550,000 | 570,000 |
| Egypt | 22,000 | 23,000 | 22,000 | 22,000 |
| France | 19,527 | 20,000 | 24,000 | 24,000 |
| Germany | 38,099 | 37,000 | 43,000 | 43,000 |
| India | 90,000 | 95,000 | 100,000 | 100,000 |
| Indonesia | 24,000 | 27,000 | 45,000 | 46,000 |
| Italy | 36,000 | 35,000 | 46,000 | 46,000 |
| Japan | 80,120 | 77,500 | 95,000 | 95,000 |
| Korea, Republic of | 48,157 | 50,000 | 57,000 | 57,000 |
| Mexico | 29,413 | 30,000 | 43,000 | 43,000 |
| Russia | 28,400 | 30,000 | 63,000 | 63,000 |
| Spain | 30,800 | 30,000 | 40,000 | 40,000 |
| Taiwan | 18,283 | 19,000 | 24,000 | 24,000 |
| Thailand | 34,500 | 38,000 | 45,000 | 45,000 |
| Turkey | 34,403 | 33,000 | 32,000 | 32,000 |
| Other countries (rounded) | 375,000 | 450,000 | 340,000 | 350,000 |
| World total (rounded) | 1,600,000 | 1,700,000 | 1,700,000 | 1,800,000 |

**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 foreseeable future. Local shortages generally can be met through imports of cement and/or clinker.

**Substitutes:** Virtually all portland cement is utilized either in making concrete or mortars and, as such, competes with substitutes for concrete in the construction sector. These substitutes include brick clay, glass, aluminum, steel, fiberglass, wood, stone, and asphalt. Pozzolans and similar materials are being used as partial or complete substitutes for portland cement for some concrete applications.

[e]Estimated.
[1]Portland plus masonry cement, unless otherwise noted. Excludes Puerto Rico.
[2]Includes cement made from imported clinker.
[3]Production of cement (including from imported clinker) + imports (excluding clinker) - exports - changes in stocks.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]Hydraulic cement and clinker.
[6]Reported.

# CESIUM

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

**Domestic Production and Use:** Although cesium was not recovered from any domestically mined ores, it is thought that at least one domestic company manufactured cesium products from imported pollucite ore. Cesium, usually in the form of chemical compounds, was used in research and development and commercially in electronic, photoelectric, and medical applications.

**Salient Statistics—United States:** Salient statistics, such as production, consumption, imports, and exports, are not available. The cesium market is very small, with annual consumption probably amounting to only a few thousand kilograms. As a result, there is no active trading of the metal, and, therefore, no official market price. However, several companies publish prices for cesium and cesium compounds. These prices remain relatively stable for several years. The per-unit price for the metal or compounds purchased from these companies varies inversely with the quantity of material purchased. For example, in 2000, one company offered 1-gram ampoules of 99.98%-grade cesium metal at $63.30. The price for 100 grams of the same material from this company was $956.00, or $9.56 per gram. At another company, the price for a 1-gram ampoule of 99.95%-pure cesium was $49.40.

**Recycling:** None.

**Import Sources (1996-99):** The United States is 100% import reliant. Canada is the major source of cesium ores. Other possible sources of cesium-bearing material include Germany and the United Kingdom.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Alkali metals, other | 2805.19.0000 | 5.5% ad val. |
| Chlorides, other | 2827.39.5000 | 3.7% ad val. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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# CESIUM

**Events, Trends, and Issues:** U.S. demand for cesium remained essentially unchanged. The United States is likely to continue to be dependent upon foreign sources unless domestic deposits are discovered or technology is developed to use low-grade raw materials. The high cost and extreme reactivity of cesium limit its application at present. Because of the small scale of production of cesium products, no significant environmental problems have been encountered.

**World Mine Production, Reserves, and Reserve Base:** Data on mine production of cesium are not available, and data on resources are sketchy. The estimates of reserves and of the reserve base are based upon occurrences of the cesium aluminosilicate mineral pollucite, found in 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 contain about 20% cesium by weight.

| | Reserves[1] | Reserve base[1] |
|---|---|---|
| Canada | 70,000,000 | 73,000,000 |
| Namibia | 7,000,000 | 9,000,000 |
| Zimbabwe | 23,000,000 | 23,000,000 |
| Other countries | NA | NA |
| World total (may be rounded) | 100,000,000 | 110,000,000 |

**World Resources:** World resources of cesium have not been estimated.

**Substitutes:** The properties of rubidium and its compounds are quite similar to those of cesium and its compounds; thus, rubidium and cesium are used interchangeably in many applications.

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

# CHROMIUM

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

**Domestic Production and Use:** In 2000, the United States consumed about 13% of world chromite ore production in various forms of imported materials, such as chromite ore, chromium chemicals, chromium ferroalloys, and chromium metals. Imported chromite was consumed by two chemical firms and two refractory firms to produce chromium chemicals and chromite-containing refractories, respectively. 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 $327 million.

| **Salient Statistics—United States:**[1] | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: Mine | — | — | — | — | — |
| Secondary | 98 | 120 | 104 | 118 | 110 |
| Imports for consumption | 362 | 350 | 385 | 476 | 398 |
| Exports | 51 | 30 | 62 | 60 | 46 |
| Government stockpile releases | 52 | 47 | 93 | 19 | 51 |
| Consumption: Reported[2] (excludes secondary) | 275 | 333 | 277 | 298 | 280 |
| Apparent[3] (includes secondary) | 467 | 490 | 531 | 558 | 499 |
| Price, chromite, yearend: | | | | | |
| South African, dollars per metric ton, South Africa | 75 | 73 | 68 | 63 | 63 |
| Turkish, dollars per metric ton, Turkey | 225 | 180 | 145 | 145 | 145 |
| Stocks, industry, yearend | 74 | 71 | 56 | 54 | 68 |
| Net import reliance[4] as a percent of apparent consumption | 79 | 75 | 80 | 79 | 78 |

**Recycling:** In 2000, chromium contained in purchased stainless steel scrap accounted for 21% of apparent consumption.

**Import Sources (1996-99):** Chromium contained in chromite ore and chromium ferroalloys and metal: South Africa, 46%; Kazakhstan, 14%; Russia, 10%; Zimbabwe, 10%; Turkey, 9%; and other, 11%.

| **Tariff:**[5] Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Ore and concentrate | 2610.00.0000 | Free. |
| Ferrochromium, high-carbon | 7202.41.0000 | 1.9% ad valorem. |
| New chromium metal | 8112.20.6000 | 3.0% ad valorem. |

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

**Government Stockpile:** The Defense Logistics Agency, U.S. Department of Defense, submitted the Annual Materials Plan for 2001 in February 2000. In addition to the stockpile-grade uncommitted inventory listed below, the stockpile contained the following nonstockpile-grade uncommitted inventory, in thousand metric tons: metallurgical chromite ore, 33; high-carbon ferrochromium, 0.4.

**Stockpile Status—9-30-00**[6]

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 | Average chromium content |
|---|---|---|---|---|---|---|
| Chromite ore: | | | | | | |
| Chemical-grade | 153 | 49.8 | 153 | 90.7 | 9.07 | 28.6% |
| Metallurgical-grade | 90.6 | 110 | 90.6 | 227 | 52.8 | 28.6% |
| Refractory-grade | 216 | 25.0 | 216 | 90.7 | 18.3 | [e]23.9% |
| Chromium ferroalloys: | | | | | | |
| Ferrochromium: | | | | | | |
| High-carbon | 561 | 27.1 | 561 | 136 | 43.2 | 71.4% |
| Low-carbon | 270 | 0.015 | 270 | — | 3.14 | 71.4% |
| Ferrochromium-silicon | 12.1 | 22.2 | 12.1 | — | 37.4 | 42.9% |
| Chromium metal | 7.34 | 0.209 | 4.16 | 0.454 | 0.377 | [e]100% |

**Events, Trends, and Issues:** In the Western Hemisphere, chromite ore is produced only in Brazil and Cuba. Most of Brazilian production is consumed in Brazil; some is exported to Norway. Cuban production is small. The largest chromite-ore-producing countries (India, Kazakhstan, South Africa, and Turkey) accounted for about 80% of world production. South Africa alone accounts for more than 40% of world production and has been the major supplier of

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# CHROMIUM

chromium in the form of chromite ore and ferrochromium to Western industrialized countries. Stainless steel, the major end use market for chromium, has shown long-term growth equivalent to about one or two new ferrochromium furnaces per year. To meet this demand, South African plants were built or expanded. Production capacity was then expanded through the addition of furnaces and plant enhancements that improved recovery and reduced cost, such as agglomeration and preheating of furnace feed and recovery from slag. South African chromite ore and ferrochromium producers financed these process changes through joint ventures with stainless steel producers in Asia. By financing capacity growth and production efficiency, consumers have lowered their cost and secured their supply, and producers have secured market share and stabilized production rates. With existing South African plants efficiently meeting current (2000) demand, a new round of plant development and furnace additions is expected in Kazakhstan and South Africa to meet anticipated demand growth.

Economic and political reorganization in the countries of the Commonwealth of Independent States resulted in reduced demand in those countries. This reduction may eventually be followed by strong growth-driven demand resulting from the institution of reforms in those countries. The economic slowdown that started with the Asian financial crisis in 1997 resulted in reduced demand for stainless steel in Asia and forced Asian produced stainless steel prices down. This resulted in pressure to lower the price of stainless steel produced in Europe and North America. Oversupply of stainless steel in the world market kept ferrochromium in excess supply until late in 1999 when the price of ferrochromium rose, indicating a return to supply balance. Stainless steel production in the first half of 2000 exceeded that of the same time period in 1999 by about 12%.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[7] | Reserve base[7] |
|---|---|---|---|---|
| | 1999 | 2000[e] | (shipping grade)[8] | |
| United States | — | — | — | 10,000 |
| Albania | 86 | 90 | 6,100 | 6,100 |
| Brazil | 360 | 350 | 14,000 | 17,000 |
| Finland | 611 | 610 | 41,000 | 120,000 |
| India | 1,310 | 1,400 | 27,000 | 67,000 |
| Iran | 212 | 200 | 2,400 | 2,400 |
| Kazakhstan | 1,600 | 1,600 | 320,000 | 320,000 |
| Russia | 130 | 130 | 4,000 | 460,000 |
| South Africa | 6,480 | 6,500 | 3,000,000 | 5,500,000 |
| Turkey | 1,400 | 1,500 | 8,000 | 20,000 |
| Zimbabwe | 660 | 650 | 140,000 | 930,000 |
| Other countries | 701 | 700 | 40,000 | 99,000 |
| World total (rounded) | 13,500 | 13,700 | 3,600,000 | 7,600,000 |

**World Resources:** World resources exceed 11 billion tons of shipping-grade chromite, sufficient to meet conceivable demand for centuries. About 95% of chromium resources is geographically concentrated in southern Africa. Reserves and reserve base are geographically concentrated in Kazakhstan and southern Africa. The largest U.S. chromium resource is in the Stillwater Complex in Montana.

**Substitutes:** Chromite ore has no substitute in the production of ferrochromium, chromium chemicals, or chromite refractories. Chromium has no substitute in stainless steel, the largest end use, or for chromium in superalloys, the major strategic end use. Chromium-containing scrap can substitute for ferrochromium in metallurgical uses. Substitutes for chromium-containing alloys, chromium chemicals, and chromite refractories generally increase cost or limit performance. In 1978, the National Academy of Sciences found that substituting chromium-free materials for chromium-containing products could save about 60% of chromium used in alloying metals, about 15% of chromium used in chemicals, and 90% of chromite used in refractories, given 5 to 10 years to develop technically acceptable substitutes and to accept increased cost.

[e]Estimated.
[1]Data in thousand metric tons of contained chromium, unless noted otherwise.
[2]The years 1996 through 1998 include chromite ore; 1999 through 2000 exclude chromite ore.
[3]Calculated demand for chromium is production + imports - exports + stock adjustment.
[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 U.S. Code, chapter 26, sections 4661 and 4672) are subject to excise tax.
[6]See Appendix B for definitions.
[7]See Appendix C for definitions.
[8]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 2000, clays were produced in all States except Alaska, Delaware, Hawaii, Idaho, New Hampshire, Rhode Island, Vermont, and Wisconsin. A total of 233 companies operated approximately 650 clay pits or quarries. The leading 20 firms supplied 50% of the tonnage and 77% of the value for all types of clay sold or used in the United States. U.S. production was estimated to be 40.7 million metric tons valued at $1.56 billion. Major domestic uses for specific clays were estimated as follows: ball clay—29% floor and wall tile, 24% sanitaryware, 10% pottery, and 37% other uses; bentonite—24% foundry sand bond, 22% pet waste absorbent, 18% drilling mud, 15% iron ore pelletizing, and 21% other uses; common clay—56% brick, 20% cement, 16% lightweight aggregate, and 8% other uses; fire clay—81% refractories and 19% other uses; fuller's earth—72% absorbent uses, 8% fertilizer and pesticide carriers, and 20% other uses; and kaolin—56% paper, 11% refractories, and 33% other uses.

| Salient Statistics—United States:[1] | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, mine: | | | | | |
| Ball clay | 935 | 1,060 | 1,130 | 1,200 | 1,220 |
| Bentonite | 3,740 | 4,020 | 3,820 | 4,070 | 4,080 |
| Common clay | 26,200 | 24,600 | 24,500 | 24,800 | 23,600 |
| Fire clay[2] | 505 | 415 | 410 | 402 | 442 |
| Fuller's earth | 2,600 | 2,370 | 2,350 | 2,560 | 2,530 |
| Kaolin | 9,180 | 9,280 | 9,450 | 9,160 | 8,870 |
| Total[3] | 43,100 | 41,800 | 41,600 | 42,200 | 40,700 |
| Imports for consumption | 45 | 64 | 86 | 90 | 97 |
| Exports | 4,830 | 5,080 | 5,230 | 4,800 | 5,060 |
| Consumption, apparent | 38,300 | 36,800 | 36,500 | 37,500 | 35,700 |
| Price, average, dollars per ton: | | | | | |
| Ball clay | 44 | 47 | 45 | 40 | 40 |
| Bentonite | 36 | 42 | 46 | 43 | 43 |
| Common clay | 5 | 6 | 6 | 6 | 7 |
| Fire clay | 21 | 19 | 18 | 16 | 22 |
| Fuller's earth | 106 | 107 | 109 | 90 | 90 |
| Kaolin | 120 | 111 | 111 | 104 | 107 |
| Stocks, yearend[4] | NA | NA | NA | NA | NA |
| Employment, number:[e] Mine | 4,900 | 4,900 | 4,800 | 4,700 | 4,600 |
| Mill | 4,500 | 4,500 | 4,500 | 4,300 | 4,300 |
| Net import reliance[5] as a percent of apparent consumption | E | E | E | E | E |

**Recycling:** Insignificant.

**Import Sources (1996-99):** Brazil, 35%; Mexico, 23%; United Kingdom, 21%; Canada, 8%; and other, 13%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Kaolin and other kaolinitic clays, whether or not calcined | 2507.00.0000 | Free. |
| Bentonite | 2508.10.0000 | Free. |
| Fuller's and decolorizing earths | 2508.20.0000 | Free. |
| Fire clay | 2508.30.0000 | Free. |
| Common blue and other ball clays | 2508.40.0010 | Free. |
| Other clays | 2508.40.0050 | Free. |
| Chamotte or dina's earth | 2508.70.0000 | Free. |
| Activated clays and earths | 3802.90.2000 | 2.5% ad val. |
| Expanded clays and mixtures | 6806.20.0000 | Free. |

**Depletion Allowance:** Ball clay, bentonite, fire clay, fuller's earth, and kaolin, 14% (Domestic and foreign); clay used in the manufacture of common brick, lightweight aggregate, and sewer pipe, 7.5% (Domestic and foreign); clays used in the manufacture of drain and roofing tile, flower pots, and kindred products, 5% (Domestic and foreign); clay used for alumina and aluminum compounds, 22% (Domestic).

**Government Stockpile:** None.

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# CLAYS

**Events, Trends, and Issues:** The amount of clay and shale sold or used by domestic producers decreased 4% in 2000. Small increases were reported for ball clay, bentonite, and fire clay. Common clay, fuller's earth, and kaolin declined. Imports for consumption increased to 97,000 tons in 2000 from 90,000 tons in 1999. Imports of kaolin from Brazil continued to rise, increasing from less than 1,000 tons in 1996 to a projected 53,000 tons in 2000. Brazil, Mexico, and the United Kingdom were the major sources for imported clays. Exports increased to 5.06 million tons in 2000 from 4.80 million tons in 1999. Canada, Finland, Japan, and the Netherlands were major markets for exported clays.

**World Mine Production, Reserves, and Reserve Base:** Not available.

**World Resources:** Clays are divided for commercial purposes into ball clay, bentonite, common clay, fire clay, fuller's earth, and kaolin. Resources of these types of clay are extremely large except for lesser resources of high-grade ball clay and sodium-bentonite. Resources of kaolin in Georgia are estimated to be 5 to 10 billion tons.

**Substitutes:** Limited substitutes and alternatives, such as calcium carbonate and talc, are available for filler and extender applications.

[e]Estimated. E Net exporter. NA Not available.
[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 2000; however, negligible amounts of byproduct cobalt were produced as intermediate products from some mining operations. U.S. supply was comprised of imports, stock releases, and secondary materials, such as superalloy scrap, cemented carbide scrap, and spent catalysts. There were two domestic producers of extra-fine cobalt powder: One produced powder from imported primary metal, and another produced powder from recycled materials. In addition to the powder producers, seven companies were known to be active in the production of cobalt compounds. More than 100 industrial consumers were surveyed on a monthly or annual basis. Approximately 45% of U.S. cobalt usage was in superalloys, which are used primarily in aircraft gas turbine engines; 9% was in cemented carbides for cutting and wear-resistant applications; 9% was in magnetic alloys; and the remaining 37% was in various other metallic and chemical uses. The total estimated value of cobalt consumed in 2000 was $300 million.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000**[e] |
|---|---|---|---|---|---|
| Production: Mine | — | — | — | — | — |
| Secondary | 2,280 | 2,750 | 3,080 | 2,720 | 2,800 |
| Imports for consumption | 6,710 | 8,430 | 7,670 | 8,150 | 8,000 |
| Exports | 1,660 | 1,570 | 1,680 | 1,550 | 2,300 |
| Shipments from Government stockpile excesses | 2,050 | 1,620 | 2,310 | 1,530 | 2,300 |
| Consumption: | | | | | |
| Reported (includes secondary) | 7,990 | 8,910 | 9,130 | 8,420 | 8,400 |
| Apparent (includes secondary) | 9,380 | 11,200 | 11,500 | 10,700 | 10,900 |
| Price, average annual spot for cathodes, dollars per pound | 25.50 | 23.34 | 21.43 | 17.02 | 15.50 |
| Stocks, industry, yearend | 1,070 | 1,090 | 1,000 | 1,160 | 1,060 |
| Net import reliance[1] as a percent of apparent consumption | 76 | 76 | 73 | 75 | 74 |

**Recycling:** About 2,800 tons of cobalt was recycled from purchased scrap in 2000. This represented about 33% of estimated reported consumption for the year.

**Import Sources (1996-99):** Cobalt content of metal, oxide, and salts: Norway, 23%; Finland, 20%; Zambia, 13%; Canada, 12%; and other, 32%.

| **Tariff:** Item | **Number** | **Normal Trade Relations**[2] **12/31/00** |
|---|---|---|
| Unwrought cobalt, alloys | 8105.10.3000 | 4.4% ad val. |
| Unwrought cobalt, other | 8105.10.6000 | Free. |
| Cobalt matte, waste, and scrap | 8105.10.9000 | 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 2001.

**Stockpile Status—9-30-00**[3]

| **Material** | **Uncommitted inventory** | **Committed inventory** | **Authorized for disposal** | **Disposal plan FY 2000** | **Disposals FY 2000** |
|---|---|---|---|---|---|
| Cobalt | 10,100 | 1,020 | 10,100 | 2,720 | 2,720 |

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# COBALT

**Events, Trends, and Issues:** World cobalt production is expected to continue to increase. Recently commissioned projects in Australia and Uganda plan to ramp up their production during the next few years, and output from established producers is likely to increase from 1999 levels. Cobalt supply during this period will also include cobalt in recycled scrap and sales from the U.S. Government's National Defense Stockpile. Demand for cobalt in any given year depends upon world economic conditions. In the near to medium term, the overall growth in cobalt demand is anticipated to be between 3% and 6% per year. In the medium to long term, cobalt supply is expected to grow faster than demand. A generally downward trend in cobalt prices would be the likely response to a growing market surplus. During the first 10 months of 2000, the average spot price of cobalt cathode varied between $13.50 per pound and $17.50 per pound.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[4] | Reserve base[4] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | — | — | — | 860,000 |
| Australia | 4,100 | 5,700 | 880,000 | 1,300,000 |
| Canada | 5,300 | 5,000 | 45,000 | 260,000 |
| Congo (Kinshasa)[5] | 7,000 | 7,000 | 2,000,000 | 2,500,000 |
| Cuba | 2,200 | 2,300 | 1,000,000 | 1,800,000 |
| New Caledonia[6] | 1,100 | 1,100 | 230,000 | 860,000 |
| Philippines | NA | NA | NA | 400,000 |
| Russia | 3,300 | 4,000 | 140,000 | 230,000 |
| Zambia | 4,700 | 4,000 | 360,000 | 540,000 |
| Other countries | 2,300 | 3,200 | 90,000 | 1,200,000 |
| World total (rounded) | 29,900 | 32,300 | 4,700,000 | 9,900,000 |

**World Resources:** The cobalt resources of the United States are estimated to be about 1.3 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 cobalt production from these deposits would be as a byproduct of another metal. The identified world cobalt resources are about 11 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:** Periods of high prices and concern about availability have resulted in various efforts to conserve, reduce, or substitute for cobalt. In many applications, further 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; nickel or manganese in batteries; and manganese, iron, cerium, or zirconium in paints.

[e]Estimated. NA Not available.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]No tariff for Canada and Mexico for items shown.
[3]See Appendix B for definitions.
[4]See Appendix C for definitions.
[5]Formerly Zaire.
[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 six 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 2000 was about $70 million. Major end-use distribution of reported columbium consumption was as follows: carbon steels, 35%; superalloys, 19%; high-strength low-alloy steels, 19%; stainless and heat-resisting steels, 18%; alloy steels, 8%; and other, 1%.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, mine | — | — | — | — | — |
| Imports for consumption: | | | | | |
| Concentrates, tin slags, other[1] | NA | NA | NA | NA | NA |
| Ferrocolumbium[e] | 2,970 | 4,260 | 4,900 | 4,450 | 4,400 |
| Exports, concentrate, metal, alloys[e] | 190 | 70 | 50 | 160 | 50 |
| Government stockpile releases[e 2] | 30 | 126 | 145 | 280 | 139 |
| Consumption, reported, ferrocolumbium[e 3] | 3,380 | 3,770 | 3,640 | 3,380 | 3,500 |
| Consumption, apparent | 3,830 | 4,030 | 4,150 | 4,100 | 4,200 |
| Price: Columbite, dollars per pound[4] | 3.00 | 3.00 | 3.00 | 3.00 | 3.70 |
| Pyrochlore, dollars per pound[5] | NA | NA | NA | NA | NA |
| Stocks, industry, processor and consumer, yearend | NA | NA | NA | NA | NA |
| Employment | NA | NA | NA | NA | NA |
| Net import reliance[6] as a percent of apparent consumption | 100 | 100 | 100 | 100 | 100 |

**Recycling:** While columbium is not recovered from scrap steel and superalloys containing it, recycling of these alloys is significant, and columbium content is reused. Data on the quantities of columbium recycled in this manner are not available.

**Import Sources (1996-99):** Brazil, 74%; Canada, 11%; Germany, 4%; Russia, 3%; and other, 8%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Columbium ores and concentrates | 2615.90.6030 | Free. |
| Columbium oxide | 2825.90.1500 | 3.7% ad val. |
| Ferrocolumbium | 7202.93.0000 | 5.0% ad val. |
| Columbium, unwrought: | | |
| Waste and scrap | 8112.91.0500 | Free. |
| Alloys, metal, powders | 8112.91.4000 | 4.9% ad val. |
| Columbium, wrought | 8112.99.0000 | 4.0% ad val. |

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

**Government Stockpile:** For fiscal year 2000, ending September 30, 2000, the Defense National Stockpile Center (DNSC) sold about 182 tons of columbium contained in ferrocolumbium valued at about $2.79 million and about 9 tons of columbium metal ingots valued at about $567,000 from the National Defense Stockpile (NDS). The DNSC disposed of about 78 tons of columbium contained in tantalum minerals that were sold in fiscal year 2000; no value obtained as columbium was contained within the tantalum minerals. There were no sales of columbium carbide powder in fiscal year 2000. The DNSC also proposed maximum disposal limits in fiscal year 2001 of about 68 tons of columbium contained in ferrocolumbium, about 10 tons[7] of columbium contained in columbium carbide, about 170 tons of columbium contained in columbium concentrates, and about 9 tons of columbium metal ingots. The NDS uncommitted inventories shown below include about 313 tons of columbium contained in nonstockpile-grade concentrates.

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# COLUMBIUM (NIOBIUM)

**Stockpile Status—9-30-00[8]**

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Columbium: | | | | | |
| Carbide powder | 10 | — | 10 | [7]10 | — |
| Concentrates | 597 | 69 | 597 | 170 | [9]78 |
| Ferrocolumbium | 52 | 37 | 52 | [7]181 | 182 |
| Metal | 55 | — | 55 | 9 | 9 |

**Events, Trends, and Issues:** For the first one-half year, domestic demand for columbium ferroalloys in steelmaking increased compared with the similar period of 1999, in line with an increase in raw steel production. Demand for columbium in superalloys increased, with aircraft engines the dominant end-use market. For the same period, overall columbium imports decreased slightly; the volume of ferrocolumbium imports from Brazil decreased while ferrocolumbium imports from Canada increased. Brazil continued as the leading supplier, providing more than 70% of total columbium imports. Exports decreased, with Germany, Mexico, and the Netherlands receiving most of the columbium materials. In November, the published price for columbite ore was quoted at a range of $4.80 to $5.30 per pound of pentoxide content. The published price for steelmaking-grade ferrocolumbium was quoted at a range of $6.75 to $7 per pound of columbium content, and high-purity ferrocolumbium was quoted at a range of $17.50 to $18 per pound of columbium content. Industry sources indicated in December 1999 that nickel columbium sold at about $18.50 per pound of columbium content, columbium metal products sold in the range of about $24 to $100 per pound in ingot and special shape forms, and columbium oxide for master alloy production sold for about $8.80 per pound.

No domestic columbium mine production is expected in 2001, and it is estimated that U.S. apparent consumption will be about 4,300 tons. Most of total U.S. demand will be met by columbium imports in upgraded forms.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[10] | Reserve base[10] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | — | — | — | Negligible |
| Australia | 140 | 150 | 16,000 | NA |
| Brazil | 21,100 | 21,000 | 3,200,000 | 5,000,000 |
| Canada | 2,370 | 2,400 | 140,000 | 400,000 |
| Congo (Kinshasa) | — | — | 30,000 | 50,000 |
| Nigeria | 30 | 30 | 60,000 | 90,000 |
| Other countries[11] | — | — | NA | NA |
| World total (rounded) | 23,600 | 23,600 | 3,500,000 | 5,500,000 |

**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 2000 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.
[1]Metal, alloys, synthetic concentrates, and columbium oxide.
[2]Net quantity (uncommitted inventory).
[3]Includes nickel columbium.
[4]Average value, contained pentoxides for material having a $Nb_2O_5$ to $Ta_2O_5$ ratio of 10 to 1.
[5]Average value, contained pentoxide.
[6]Defined as imports - exports + adjustments for Government and industry stock changes.
[7]Actual quantity limited to remaining sales authority or inventory.
[8]See Appendix B for definitions.
[9]Columbium units contained in the disposal of tantalum minerals.
[10]See Appendix C for definitions.
[11]Bolivia, China, Russia, and Zambia also produce (or are thought to produce) columbium, 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 2000 declined to 1.45 million metric tons and was valued at about $2.8 billion. The principal mining States, in descending order, Arizona, Utah, New Mexico, and Montana, accounted for 99% of domestic production; copper was also recovered at mines in three other States. Although copper was recovered at about 30 mines operating in the United States, 15 mines accounted for about 99% of production. At yearend, 4 primary smelters and 1 secondary smelter, 4 electrolytic and 4 fire refineries, and 15 solvent extraction-electrowinning facilities were operating. Refined copper and direct melt scrap were consumed at about 35 brass mills; 15 rod mills; and 600 foundries, chemical plants, and miscellaneous consumers. Copper and copper alloy products consumed[1] in building construction totaled 41%; electric and electronic products, 27%; transportation equipment, 12%; industrial machinery and equipment, 10%; and consumer and general products, 10%.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: Mine | 1,920 | 1,940 | 1,860 | 1,600 | 1,450 |
| Refinery: Primary[2] | 2,010 | 2,070 | 2,140 | 1,890 | 1,610 |
| Secondary[3] | 345 | 396 | 349 | 230 | 210 |
| Copper from all old scrap | 428 | 498 | 466 | 381 | 360 |
| Imports for consumption: | | | | | |
| Ores and concentrates | 72 | 44 | 217 | 143 | 1 |
| Refined | 543 | 632 | [4]725 | [4]915 | [4]970 |
| Unmanufactured | 961 | 999 | 1,190 | 1,280 | 1,320 |
| Exports: Ores and concentrates | 195 | 127 | 37 | 64 | 220 |
| Refined | 169 | 93 | 86 | 25 | 110 |
| Unmanufactured | 748 | 628 | 412 | 395 | 740 |
| Consumption: Reported refined | 2,610 | 2,790 | 2,890 | 2,990 | 3,000 |
| Apparent unmanufactured[5] | 2,830 | 2,950 | 3,020 | 3,130 | 3,120 |
| Price, average, cents per pound: | | | | | |
| Domestic producer, cathode | 109.0 | 107.0 | 78.6 | 75.9 | 89 |
| London Metal Exchange, high-grade | 104.0 | 103.2 | 75.0 | 71.3 | 83 |
| Stocks, yearend, refined[6] | 146 | 314 | 532 | 564 | 280 |
| Employment, mine and mill, thousands | 13.3 | 13.2 | 13.0 | 11.6 | 10 |
| Net import reliance[7] as a percent of apparent consumption | 14 | 13 | 14 | 27 | 37 |

**Recycling:** Old scrap, converted to refined metal and alloys, provided 360,000 tons of copper, equivalent to 12% of apparent consumption. Purchased new scrap, derived from fabricating operations, yielded 970,000 tons of contained copper; about 90% of the copper contained in new scrap was consumed at brass or wire-rod mills. Of the total copper recovered from scrap, brass mills recovered 67%; copper smelters and refiners,18%; ingot makers, 11%; and miscellaneous manufacturers, foundries, and chemical plants, 4%. Copper in all old and new, refined or remelted scrap contributed 33% of the U.S. copper supply.

**Import Sources (1996-99):** Unmanufactured: Canada, 38%; Chile, 24%; Mexico, 14%; and other, 24%. Refined copper accounted for 61% of imports of unwrought copper.

| Tariff: Item | Number | Normal Trade Relations[8] 12/31/00 |
|---|---|---|
| Unrefined copper; anodes | 7402.00.0000 | Free |
| Refined and alloys; unwrought | 7403.00.0000 | 1.0% ad val. |
| Copper powder | 7406.10.0000 | Free |
| 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. For details on inventories of beryllium-copper master alloys (4% beryllium), see the section on beryllium.

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# COPPER

**Events, Trends, and Issues:** World mine capacity continued its upward trend, rising about 300,000 tons, or 2%, in 2000. World mine production kept pace with the increased capacity, rising by about 300,000 tons. Though world refined copper production was projected to rise by about 400,000 tons owing to increases in primary and secondary production, the increase was not sufficient to keep pace with the projected growth in world refined consumption. According to the International Copper Study Group,[9] world consumption of refined copper for the first half of 2000 rose by almost 600,000 tons, and reported global inventories of refined copper, which had risen by 800,000 tons during the previous 3 years, declined significantly. Prices trended upward with declining stocks; the U.S. producer price averaged almost $0.96 per pound in September.

Reorganization of the U.S. copper industry was completed by yearend 1999; Phelps Dodge Corp. acquired the assets of Cyprus Amax Minerals Corp., and Grupo Mexico, S.A. de C.V. acquired the assets of ASARCO Incorporated. The Broken Hill Propriety Ltd. mine, smelter, and refinery operations closed in 1999 and remained shuttered. (For details, see USGS Mineral Industry Surveys, Copper in June 1999 and Copper in August 1999.) Previously announced cutbacks contributed to a decline in mine, smelter, and refinery production in 2000. In May, Southwire Company closed its secondary smelter and associated refinery in Georgia (For details see USGS Mineral Industry Surveys, Copper in February 2000.) Power disruptions and high energy costs resulted in production losses by at least one producer and led to the temporary closure of one mine in Montana during the third quarter. One new leaching operation in Nevada began commercial production during the second quarter. Consumption of refined copper was essentially unchanged in 2000. Growing industrial demand for wire-rod was met by increased imports. The shortfall in domestic refined production was met by imports and a drawdown in metal exchange inventories. U.S. mine production is expected to decline further in 2001 as one major mine converts to an all leach operation. The U.S. import dependance for refined copper and wire-rod is expected to increase with growing industrial demand.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[10] | Reserve base[10] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 1,600 | 1,450 | 45,000 | 90,000 |
| Australia | 735 | 760 | 9,000 | 23,000 |
| Canada | 614 | 650 | 10,000 | 23,000 |
| Chile | 4,382 | 4,500 | 88,000 | 160,000 |
| China | 500 | 510 | 18,000 | 37,000 |
| Indonesia | 740 | 850 | 19,000 | 25,000 |
| Kazakhstan | 374 | 380 | 14,000 | 20,000 |
| Mexico | 362 | 390 | 15,000 | 27,000 |
| Peru | 536 | 530 | 19,000 | 40,000 |
| Poland | 460 | 480 | 20,000 | 36,000 |
| Russia | 530 | 520 | 20,000 | 30,000 |
| Zambia | 260 | 260 | 12,000 | 34,000 |
| Other countries | 1,500 | 1,600 | 50,000 | 110,000 |
| World total (may be rounded) | 12,600 | 12,900 | 340,000 | 650,000 |

**World Resources:** Land-based resources are estimated to be 1.6 billion tons of copper, and resources in deep-sea nodules are estimated to be 700 million tons.

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

[e]Estimated.
[1]Some electrical components are included in each end use. Distribution by Copper Development Association, 2000.
[2]From domestic and imported ores and concentrates.
[3]From primary and secondary refineries.
[4]General imports of refined copper.
[5]Defined as primary refined production + copper from old scrap converted to refined metal and alloys + refined imports - refined exports ± changes in refined stocks. In 1998 and 1999, general imports of 725,000 tons and 915,000 tons, respectively, were used to calculate apparent consumption.
[6]Held by industry, COMEX, and London Metal Exchange warehouses in the United States.
[7]Defined as imports - exports + adjustments for Government and industry stock changes for refined copper.
[8]No tariff for Canada and Mexico for items shown.
[9]International Copper Study Group, 2000, Copper Bulletin: Lisbon, Portugal, International Copper Study Group September, 48 p.
[10]See Appendix C for definitions.

# DIAMOND (INDUSTRIAL)

(Data in million carats, unless otherwise noted)

**Domestic Production and Use:** In 2000, production reached a record high for the fourth consecutive year and the United States remained the world's largest market for industrial diamond. Virtually all output was synthetic grit and powder. Two firms, one in New Jersey and the other in Ohio, accounted for all of the production. Nine other firms produced polycrystalline diamond from diamond powder. Four companies recovered used industrial diamond as one of their principal operations. Most consumption was accounted for by the following industry sectors: 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 accounted for most of the industrial stone consumption. More than 90% of the industrial diamond market is now accounted for by synthetic industrial diamonds, whose quality can be controlled and whose properties can be customized to fit specific requirements.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Bort, grit, and dust and powder; natural and synthetic: | | | | | |
| Production: Manufactured diamond | 114 | 125 | 140 | 208 | 248 |
| Secondary | 20 | 10 | 10 | 10 | 10 |
| Imports for consumption | 218 | 254 | 221 | 208 | 325 |
| Exports[1] | 105 | 126 | 104 | 98 | 99 |
| Sales from Government stockpile excesses | 1 | .7 | ([2]) | ([2]) | — |
| Consumption, apparent | 248 | 264 | 267 | 328 | 484 |
| Price, value of imports, dollars per carat | .46 | .43 | .44 | .44 | .37 |
| Net import reliance[3] as a percent of apparent consumption | 46 | 49 | 44 | 36 | 47 |
| Stones, natural: | | | | | |
| Production: Mine | ([2]) | ([2]) | ([2]) | ([2]) | ([2]) |
| Secondary | .4 | .5 | .5 | .4 | .5 |
| Imports for consumption[4] | 2.9 | 2.8 | 4.7 | 3.1 | 2.9 |
| Exports[1] | .5 | .6 | .8 | .7 | 1.7 |
| Sales from Government stockpile excesses | .5 | 1.2 | .8 | .6 | 1.0 |
| Consumption, apparent | 3.3 | 3.9 | 5.2 | 3.4 | 2.7 |
| Price, value of imports, dollars per carat | 7.54 | 7.69 | 3.92 | 4.61 | 5.16 |
| Net import reliance[3] as a percent of apparent consumption | 88 | 87 | 90 | 88 | 81 |

**Recycling:** Lower prices and greater competition appear to be reducing the number and scale of recycling operations.

**Import Sources (1996-99):** Bort, grit, and dust and powder; natural and synthetic: Ireland, 47%; China, 17%; Russia, 8%; and other, 28%. Stones, primarily natural: United Kingdom, 19%; Switzerland, 13%; Belgium, 11%; Ireland, 11%; and other, 46%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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).

**Government Stockpile:**

**Stockpile Status—9-30-00[5]**

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Industrial stones | 1.51 | 0.681 | 1.51 | 1.000 | 0.989 |

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# DIAMOND (INDUSTRIAL)

**Events, Trends, and Issues:** The United States will continue to be the world's largest market for industrial diamond well into the next decade and will remain a significant producer and exporter of industrial diamond as well. The most dramatic increase in U.S. demand for industrial diamond is likely to occur in the construction sector as the $200 billion Transportation Equity Act for the 21st Century (Public Law 105-178; enacted June 9, 1998) is further implemented. The act provides funding for building and repairing the Nation's highway system through 2003. Industrial diamond coats the cutting edge of saws used to cut cement in highway construction and repair work.

World and U.S. demand for diamond grit and powder will grow during the next 5 years. Increases in demand for synthetic grit and powder are expected to be greater than for natural diamond material. Constant-dollar prices of synthetic diamond products probably will continue to decline as production technology becomes more cost-effective; the decline is even more likely if competition from low-cost producers in China and Russia increases.

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

| | Mine production | | Reserves[7] | Reserve base[7] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | ([2]) | ([2]) | Unknown | Unknown |
| Australia | 16.4 | 18.5 | 90 | 230 |
| Botswana | 5.0 | 5.0 | 130 | 200 |
| Brazil | .6 | .6 | 5 | 15 |
| China | .9 | .9 | 10 | 20 |
| Congo (Kinshasa) | 14.5 | 14.5 | 150 | 350 |
| Russia | 11.5 | 11.7 | 40 | 65 |
| South Africa | 6.0 | 6.2 | 70 | 150 |
| Other countries | 1.4 | 1.2 | 80 | 200 |
| World total (may be rounded) | 56.3 | 58.6 | 580 | 1,200 |

**World Resources:** Natural diamond resources have been discovered in more than 35 countries. Nevertheless, natural diamond accounts for less than 10% of all industrial diamond used; synthetic diamond accounts for the remainder. At least 15 countries have the technology to produce synthetic diamond.

**Substitutes:** Materials that can compete with industrial diamond in some applications include manufactured abrasives, such as cubic boron nitride, fused aluminum oxide, and silicon carbide. Synthetic diamond rather than natural diamond is used for more than 90% of industrial applications.

[e]Estimated.
[1]Reexports no longer are combined with exports, as in previous Mineral Commodity Summaries, because increasing amounts of U.S. reexports obscure apparent consumption rates.
[2] Less than ½ unit.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]May include synthetic miners' diamond.
[5]See Appendix B for definitions.
[6]Natural industrial diamond only. Note, however, that synthetic diamond production far exceeds natural industrial diamond output. Worldwide production of manufactured industrial diamond totaled at least 467 million carats in 1999; the largest producers included Ireland, Japan, Russia, and the United States.
[7]See Appendix C for definitions.

# DIATOMITE

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** The estimated value of processed diatomite, f.o.b. plant, was $185 million in 2000. Production was from 7 companies with 12 processing facilities in 4 States. Two companies produced more than 75% of the total. California and Nevada were the principal producing States. Estimated end uses of diatomite were filter aids, 62%; absorbents, 16%; fillers, 11%; and other (mostly cement manufacture), 11%.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production[1] | 729 | 773 | 725 | 747 | 808 |
| Imports for consumption | 2 | 2 | 2 | ([2]) | ([2]) |
| Exports | 143 | 140 | 138 | 123 | 131 |
| Consumption, apparent | 588 | 635 | 588 | 625 | 677 |
| Price, average value, dollars per ton, f.o.b. plant | 242 | 244 | 248 | 238 | 228 |
| Stocks, producer, yearend | 36 | 36 | 36 | 36 | 36 |
| Employment, mine and plant, number[e] | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Net import reliance[3] as a percent of apparent consumption | E | E | E | E | E |

**Recycling:** None.

**Import Sources (1996-1999):** France, 87%; Italy, 9%; and other, 4%.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Siliceous fossil meals, including diatomite | 2512.00.0000 | Free. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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# DIATOMITE

**Events, Trends, and Issues:** Filtration (including for beer, wine, liquors, oils, and greases) continued to be the largest end use for diatomite, also known as diatomaceous earth (D.E.). Another application is for removal of microbial contaminants, such as bacteria, viruses, and protozoa, in public water systems. D.E. filter aids have been successfully deployed in over 200 locations throughout the United States for the treatment of potable water. Emerging small-scale applications for diatomite include pharmaceutical processing and as a nontoxic insecticide.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[4] | Reserve base[4] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States[1] | 747 | 808 | 250,000 | 500,000 |
| China | 340 | 340 | | NA |
| Denmark[5] | 185 | 185 | | NA |
| France | 80 | 80 | Other | 2,000 |
| Japan | 190 | 190 | countries: | NA |
| Korea, Republic of | 35 | 35 | 550,000 | NA |
| Mexico | 70 | 70 | | 2,000 |
| Spain | 36 | 36 | | NA |
| Former Soviet Union[6] | 80 | 80 | | NA |
| Other countries | 200 | 200 | | NA |
| World total (may be rounded) | 1,960 | 2,020 | 800,000 | Large |

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

**Substitutes:** Many materials can be substituted for diatomite. However, the unique properties of diatomite assure its continuing use for many applications. Expanded perlite and silica sand compete for filtration purposes. Other filtration technologies use ceramic, polymeric, or carbon membrane. Alternate filler materials include talc, ground silica sand, ground mica, clay, perlite, vermiculite, and ground limestone. For thermal insulation, materials such as various clays and special brick, mineral wool, expanded perlite, and exfoliated vermiculite can be used.

[e]Estimated. E Net exporter. NA Not available.
[1]Processed ore sold and used by producers.
[2]Less than ½ unit.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions.
[5]Includes sales of moler production.
[6]As constituted before December 1991.

# FELDSPAR

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** U.S. feldspar production in 2000 had an estimated value of about $42 million. The three largest producers accounted for about 70% of the output, with six other companies supplying the remainder. Operations in North Carolina provided about 45% of the output, and facilities in six other States contributed smaller quantities. Feldspar processors reported coproduct recovery of mica and silica sand.

Feldspar is ground for industry use 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. Estimated 2000 end-use distribution of domestic feldspar was glass, 68%, and pottery and other, 32%.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000**[e] |
|---|---|---|---|---|---|
| Production, marketable | 890 | [e]900 | [e]820 | [e]875 | 850 |
| Imports for consumption | 7 | 9 | 7 | 7 | 7 |
| Exports | 10 | 7 | 13 | 10 | 14 |
| Consumption, apparent | 887 | [e]900 | [e]814 | [e]872 | 843 |
| Price, average value, marketable production, dollars per ton | 44.27 | [e1]47.00 | [e1]50.00 | [e1]49.00 | 48.91 |
| Stocks, producer, yearend[2] | NA | NA | NA | NA | NA |
| Employment, mine and preparation plant, number | 400 | 400 | 400 | 400 | 400 |
| Net import reliance[3] as a percent of apparent consumption | E | ([4]) | E | E | E |

**Recycling:** Insignificant.

**Import Sources (1996-99):** Mexico, 95%; and other, 5%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Feldspar | 2529.10.0000 | Free. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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# FELDSPAR

**Events, Trends, and Issues:** Glass, including glass containers and glass fiber for insulation, continued to be the largest end use of feldspar (68% by tonnage) in the United States. According to the U.S. Census Bureau, total shipments of glass containers during the first 8 months of 2000 were about 171 million gross, or 2% less than in the corresponding period of 1999. Recycled glass (cullet) and competition from metal, paper, and plastic containers have affected growth in usage of glass containers.

Pottery, including whiteware such as dinnerware, sanitaryware, and tile, continued to be the second largest end use of feldspar. Ceramic tile use in housing construction has done well in recent years against other products, such as carpets and hardwood flooring. According to the U.S. Census Bureau, housing starts during the first 9 months of 2000 were about 1.23 million housing units, or a decrease of 4% (+/- 2%) compared with the same period in 1999. According to the Tile Council of America, new housing construction in 2000 could decrease by 7% compared with that of the previous year.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves and reserve base[5] |
|---|---|---|---|
| | 1999 | 2000[e] | |
| United States | [e]875 | 850 | Significant in the United States and assumed to be similar in other countries. |
| Argentina | 80 | 80 | |
| Brazil | 230 | 240 | |
| Colombia | 55 | 60 | |
| France | 600 | 600 | |
| Germany | 460 | 470 | |
| Greece | 65 | 70 | |
| India | 105 | 110 | |
| Italy | 2,600 | 2,600 | |
| Japan | 52 | 60 | |
| Korea, Republic of | 250 | 260 | |
| Mexico | 210 | 220 | |
| Norway | 75 | 80 | |
| Portugal | 120 | 130 | |
| Spain | 425 | 430 | |
| Thailand | 500 | 520 | |
| Turkey | 1,100 | 1,100 | |
| Uzbekistan | 70 | 80 | |
| Venezuela | 160 | 170 | |
| Other countries | 948 | 970 | |
| World total | 8,980 | 9,100 | |

**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 granites, pegmatites, and feldspathic sands 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 feldspar-silica mixtures, clays, talc, pyrophyllite, spodumene, or electric-furnace slag. Imported nepheline syenite, however, was the major alternative material.

[e]Estimated. E Net exporter. NA Not available.
[1]Rounded
[2]Change in stocks assumed to be zero for apparent consumption and net import reliance calculations.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]Negligible.
[5]See Appendix C for definitions.

# FLUORSPAR

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** There was no domestic mine production of fluorspar in 2000. There was some recovery of byproduct calcium fluoride from industrial waste streams, although it is not included in the data shown below. Material purchased from the National Defense Stockpile or imported was screened and dried for resale to customers. Domestically, an estimated 90% 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 estimated 10% of the reported fluorspar consumption was consumed as a flux in steelmaking, in iron and steel foundries, primary aluminum production, glass manufacture, enamels, welding rod coatings, and other uses or products. To supplement domestic fluorine supplies, about 68,200 tons of fluorosilicic acid (equivalent to 120,000 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, and to make aluminum fluoride for the aluminum industry.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000**[e] |
|---|---|---|---|---|---|
| Production: Finished, all grades[e 1] | 8 | — | — | — | — |
| Fluorspar equivalent from phosphate rock | 119 | 121 | 118 | 122 | 120 |
| Imports for consumption: | | | | | |
| Acid grade | 474 | 485 | 462 | 419 | 510 |
| Metallurgical grade | 39 | 51 | 41 | 59 | 41 |
| Fluorspar equivalent from hydrofluoric acid plus cryolite | 131 | 175 | 204 | 192 | 215 |
| Exports[2] | 62 | 62 | 24 | 55 | 48 |
| Shipments from Government stockpile | 287 | 97 | 110 | 131 | 106 |
| Consumption: Apparent[3] | 719 | 551 | 591 | 615 | 612 |
| Reported | 527 | 491 | 538 | 515 | 550 |
| Stocks, yearend, consumer and dealer[4] | 234 | 375 | 468 | 373 | 350 |
| Employment, mine and mill, number | 5 | — | — | — | — |
| Net import reliance[5] as a percent of apparent consumption | 99 | 100 | 100 | 100 | 100 |

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

**Import Sources (1996-99):** China, 67%; South Africa, 22%; and Mexico, 11%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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 2000, the Defense National Stockpile Center (DNSC) sold 54,400 tons (60,000 short dry tons) of metallurgical grade. Under the proposed fiscal year 2001 Annual Materials Plan, the DNSC will be authorized to sell an additional 54,400 tons (60,000 short dry tons) of metallurgical grade. In addition to the material below, the stockpile contains 57,000 tons (62,800 short dry tons) of nonstockpile-grade material.

**Stockpile Status—9-30-00**[6]

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Acid grade | 9 | 179 | 9 | — | — |
| Metallurgical grade | 40 | 79 | 40 | 54 | 43 |

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# FLUORSPAR

**Events, Trends, and Issues:** After the Chinese export license fees more than doubled to $56 to $60 per ton in the first half of 1999 (although very little material actually sold at those fee rates), the fees for 2000 stabilized at about $39 per ton. This was still an increase of $13 per ton compared to the fees in 1998.

After a review of the antidumping duties (established in December 1995) on imports of Chinese fluorspar in the form of filtercake or powder into the European Union, the Council of the European Union determined that the duty should be maintained. The duty remained equal to the difference between a minimum price of 113.5 European Currency Units per dry ton and the net free-at-Community-frontier price, before customs clearance.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[7 8] | Reserve base[7 8] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | — | — | — | 6,000 |
| China | 2,400 | 2,400 | 23,000 | 94,000 |
| France | 107 | 110 | 10,000 | 14,000 |
| Italy | 110 | 110 | 6,000 | 7,000 |
| Kenya | 98 | 100 | 2,000 | 3,000 |
| Mexico | 564 | 542 | 32,000 | 40,000 |
| Mongolia | 154 | 150 | 10,000 | NA |
| Morocco | 110 | 110 | NA | NA |
| South Africa | 217 | 220 | 30,000 | 36,000 |
| Spain | 133 | 125 | 6,000 | 8,000 |
| Other countries | 617 | 610 | 100,000 | 170,000 |
| World total (may be rounded) | 4,510 | 4,480 | 220,000 | 380,000 |

**World Resources:** Identified world fluorspar resources were approximately 400 million tons of contained fluorspar. Resources of equivalent fluorspar from domestic phosphate rock were approximately 32 million tons. World resources of fluorspar from phosphate rock were estimated at 330 million tons.

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

[e]Estimated. NA Not available.
[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 plus 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.

# GALLIUM

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

**Domestic Production and Use:** No domestic primary gallium recovery was reported in 2000. Two companies in Oklahoma and Utah recovered and refined gallium from scrap and impure gallium metal. Imports of gallium, which supplied most of U.S. gallium consumption, were valued at about $15 million. Gallium arsenide (GaAs) components represented about 95% of domestic gallium consumption. About 44% of the gallium consumed was used in optoelectronic devices, which include light-emitting diodes (LED's), laser diodes, photodetectors, and solar cells. Integrated circuits represented 54% of gallium demand. The remaining 2% was used in research and development, specialty alloys, and other applications. Optoelectronic devices were used in areas such as consumer goods, medical equipment, industrial components, telecommunications, and aerospace applications. Integrated circuits were used in defense applications and high-performance computers.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production, primary | — | — | — | — | — |
| Imports for consumption | 30,000 | 19,100 | 26,300 | 24,100 | 36,000 |
| Exports | NA | NA | NA | NA | NA |
| Consumption: Reported | 21,900 | 23,600 | 26,900 | 29,800 | 36,000 |
| Apparent | NA | NA | NA | NA | NA |
| Price, yearend, dollars per kilogram, 99.99999%-pure | 425 | 595 | 595 | 640 | 640 |
| Stocks, producer, yearend | NA | NA | NA | NA | NA |
| Employment, refinery, number[e] | 20 | 20 | 20 | 20 | 20 |
| Net import reliance[1] as a percent of apparent consumption | NA | NA | NA | NA | NA |

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

**Import Sources (1996-99):** France, 44%; Russia, 17%; Kazakhstan, 14%; Canada, 6%; and other, 19%.

| **Tariff:** Item | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Gallium metal | 8112.91.1000 | 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.

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# GALLIUM

**<u>Events, Trends, and Issues</u>:** Gallium supplies were tight during 2000, resulting in higher prices for crude and refined material. By midyear, spot prices for crude gallium had risen to $600 to $640 per kilogram, which were higher than the price for refined gallium. One producer's price for refined gallium increased to $600 per kilogram from $543 per kilogram in 1999. The increase in demand for gallium mainly resulted from continued growth in the wireless telecommunications industry. GaAs producers in the United States, Europe, and Asia completed some of their previously announced plant expansions and announced plans for additional increases in capacity. Much of this new capacity will have the capability to process 6-inch-diameter wafers, a significant advancement from the industry standard of 4-inch-diameter wafers.

Imports continued to supply almost all U.S. demand for gallium and increased significantly from those in 1999. Using partial-year data, France, Kazakhstan, Russia, and the United Kingdom were the principal U.S. gallium suppliers in 2000.

Consumption of high-purity gallium in Japan also was projected to increase in 2000. Total gallium consumption was projected to increase 30% to 148 metric tons. Domestic production of 14 metric tons, imports of 61 metric tons, and scrap recycling of 73 metric tons were the components of Japanese consumption.

In addition to increased use in wireless communications applications, new gallium-based devices are being developed for the optoelectronic market. White-light LED's, based on gallium technology, have been installed in prototype vehicles as low-beam lights. If these devices are to be used in high-volume applications, improvements in efficiency and reductions in costs are needed. Japanese and U.S. firms continued competing to be the first to successfully commercialize gallium nitride laser diodes and LED's, which have potential markets in laser printers, medical equipment, and digital video recorders.

**<u>World Production, Reserves, and Reserve Base</u>:** Data on world production of primary gallium were unavailable because data on the output of the few producers were considered to be proprietary. However, in 2000, world primary production was estimated to be about 100 metric tons, with Australia, Germany, Japan, Kazakhstan, and Russia being the largest producers. Countries with smaller output were China, Hungary, Slovakia, and Ukraine. Refined gallium production was estimated to be about 110 metric tons. France was the largest producer of refined gallium, using as feed material crude gallium produced in Australia. Japan and the United States were the other large gallium-refining countries. Gallium was recycled from new scrap in Germany, Japan, the United Kingdom, and the United States.

Gallium occurs in very small concentrations in many rocks and ores of other metals. Most gallium was produced as a byproduct of treating bauxite, and the remainder was produced from zinc-processing residues. Only part of the gallium present in bauxite and zinc ores was recoverable, and the factors controlling the recovery were proprietary. Therefore, a meaningful estimate of current reserves could not 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 can be considered to have only long-term availability.

**<u>World Resources</u>:** 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 are 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.

**<u>Substitutes</u>:** Liquid crystals made from organic compounds are used in visual displays as substitutes for LED's. Researchers are also working to develop organic-based LED's that may compete with GaAs in the future. Indium phosphide components can be substituted for GaAs-based infrared laser diodes in some specific-wavelength applications, and GaAs competes with helium-neon lasers in visible laser diode applications. Silicon is the principal competitor for GaAs in solar cell applications. GaAs-based 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.

[e]Estimated. NA Not available.

[1]Defined as imports - exports + adjustments for Government and industry stock changes.

# GARNET, INDUSTRIAL[1]

(Data in metric tons of garnet, unless otherwise noted)

**Domestic Production and Use:** Garnet for industrial use was mined in 2000 by five firms, three in New York, one in Montana, and one in Idaho. Output of crude garnet was valued at more than $5 million, while refined material sold or used was valued at $11.7 million. Major end uses for garnet were abrasive blasting media, 45%; water filtration, 15%; waterjet cutting, 10%; and abrasive powders, 10%.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production (crude) | 60,900 | 64,900 | 74,000 | 60,700 | 50,000 |
| Sold by producers | 46,200 | 53,600 | 51,900 | 43,900 | 44,400 |
| Imports for consumption[e] | 9,000 | 10,000 | 20,000 | 12,000 | 23,000 |
| Exports[e] | 12,000 | 12,000 | 12,000 | 10,000 | 10,000 |
| Consumption, apparent | 34,500 | 46,300 | 39,900 | 39,100 | 56,900 |
| Price, range of value, dollars per ton[2] | 50-2,000 | 50-2,000 | 50-2,000 | 55-2,000 | 50-2,000 |
| Stocks, producer[e] | 14,600 | 19,900 | 39,900 | 46,700 | 47,200 |
| Employment, mine and mill, number | 210 | 250 | 230 | 220 | 220 |
| Net import reliance[3] as a percent of apparent consumption | E | E | E | E | 22 |

**Recycling:** Small amounts of garnet reportedly are recycled.

**Import Sources (1996-99)[e]:** Australia, 65%; India, 20%; and China, 15%.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Emery, natural corundum, natural garnet, and other natural abrasives, crude | 2513.20.1000 | Free. |
| Emery, natural corundum, natural garnet, and other natural abrasives, other than crude | 2513.20.9000 | Free. |
| Natural abrasives on woven textile | 6805.10.0000 | Free. |
| Natural abrasives on paper or paperboard | 6805.20.0000 | Free. |
| Natural abrasives sheets, strips, disks, belts, sleeves, or similar form | 6805.30.1000 | Free. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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# GARNET, INDUSTRIAL

**Events, Trends, and Issues:** During 2000, U.S. garnet consumption grew significantly; demand was met by imports and by sales of producer stocks. Sweetwater Garnet, Inc. shut down in 1999 and continued to be offered for sale in 2000. The sale of the Cominco American Mine to Montana-Oregon Investment Group LLC took effect December 31, 1999, and the name was changed to the Ruby Garnet Mine. Although U.S. producer sales increased only slightly during 2000, some forecasts indicate that domestic and foreign markets for industrial garnet may continue to grow in the next several years. Markets for waterjet cutting and blasting media are expected to exhibit the highest demand. With the worldwide increases in petroleum prices, there has been an increase in the use of garnet for cleaning drillpipe by the oil and gas industry. China has now joined Australia and India as an important garnet exporter.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[4] | Reserve base[4] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 60,700 | 50,000 | 5,000,000 | 25,000,000 |
| Australia | 116,000 | 125,000 | 1,000,000 | 7,000,000 |
| China | 20,000 | 25,000 | Moderate to Large | Moderate to Large |
| India | 55,000 | 60,000 | 500,000 | 20,000,000 |
| Other countries | 20,300 | 30,000 | 6,500,000 | 20,000,000 |
| World total (rounded) | 272,000 | 290,000 | Moderate | Large |

**World Resources:** World resources of garnet are large and occur in a wide variety of rocks, particularly gneisses and schists. Garnet also occurs as contact-metamorphic deposits in crystalline limestones, pegmatites, serpentinites, and vein deposits. In addition, alluvial garnet is present in many heavy mineral sand and gravel deposits throughout the world. Large domestic resources of garnet also are concentrated in coarsely crystalline gneiss near North Creek, NY, and other significant domestic resources of garnet occur in Idaho, Maine, Montana, New Hampshire, North Carolina, and Oregon. In addition to the United States, major garnet deposits exist in Australia, China, and India, where they are mined for foreign and domestic markets; deposits in Russia and Turkey also have been mined in recent years, primarily for internal markets. Additional garnet resources are located in Canada, Chile, Czech Republic, Pakistan, South Africa, Spain, Thailand, and Ukraine; small mining operations have been reported in most of these areas.

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

[e]Estimated. E Net exporter.
[1]Excludes gem and synthetic garnet.
[2]Includes both crude and refined garnet; most crude concentrate is $50 to $100 per ton, and most refined material is $150 to $400 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:** Total U.S. gemstone output has decreased in recent years owing to a decline in foreign demand for freshwater shell, a major component of the domestic industry. Domestic gemstone production also included agates, amber, beryl, coral, garnet, jade, jasper, opal, pearl, quartz, sapphire, topaz, turquoise, and many other gem materials. Output of natural gemstones was primarily from Tennessee, North Carolina, Arizona, Oregon, California, Arkansas, and Utah, in decreasing order. Reported output of synthetic gemstones was from four firms in North Carolina, New York, California, and Arizona, in decreasing order of production. There was notable production of freshwater pearl in Tennessee, turquoise in Arizona, and beryl in North Carolina and Utah. Major uses were jewelry, carvings, and gem and mineral collections.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production:[2] Natural[3] | 43.6 | 25.0 | 14.3 | 16.1 | 16.6 |
| Synthetic | 24.0 | 21.6 | 24.2 | 47.5 | [4]50 |
| Imports for consumption | 7,240 | 8,380 | 9,250 | 10,700 | 12,900 |
| Exports, including reexports[5] | 2,660 | 2,760 | 2,980 | 3,610 | 4,080 |
| Consumption, apparent[6] | 4,650 | 5,670 | 6,310 | 7,150 | 8,890 |
| 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[7] as a percent of apparent consumption | 98 | 99 | 99 | 99 | 99 |

**Recycling:** Insignificant.

**Import Sources (1996-99 by value):** Israel, 38%; India, 21%; Belgium, 20%; and other, 21%. Diamond imports accounted for 93% of the total value of gem imports.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Diamonds, unworked or sawn | 7102.31.0000 | Free. |
| Diamond, ½ carat or less | 7102.39.0010 | Free. |
| Diamond, cut, more than ½ carat | 7102.39.0050 | Free. |
| Precious stones, unworked | 7103.10.2000 | Free. |
| Precious stones, simply sawn | 7103.10.4000 | 10.5% ad val. |
| Rubies, cut | 7103.91.0010 | Free. |
| Sapphires, cut | 7103.91.0020 | Free. |
| Emeralds, cut | 7103.91.0030 | Free. |
| Other precious, cut but not set | 7103.99.1000 | Free. |
| Other precious stones | 7103.99.5000 | 10.5% ad val. |
| Imitation precious stones | 7018.10.2000 | Free. |
| Synthetic cut, but not set | 7104.90.1000 | Free. |
| Pearls, natural | 7101.10.0000 | Free. |
| Pearls, cultured | 7101.21.0000 | Free. |
| Pearls, imitation, not strung | 7018.10.1000 | 4.0% ad val. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** The National Defense Stockpile (NDS) does not contain an inventory of gemstones. However, portions of the industrial diamond inventory are of near-gem or gem quality. Additionally, the beryl and quartz inventories contain some gem-quality materials that could be used by the gem industry. The U.S. Department of Defense is currently selling some NDS materials that may be gemstone quality.

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# GEMSTONES

**Events, Trends, and Issues:** Canada's first commercial diamond mine, the Ekati Mine, completed its first full year in 1999, with production of 2.5 million carats valued at $422 million. During the first 6 months of 2000, Ekati production was another 1.35 million carats of diamond. Canada's second commercial diamond mine, the Diavik project, is expected to come on-stream in 2003 with production of 6 to 8 million carats per year worth about $65 per carat.

The Kelsey Lake Diamond Mine, which straddles the Colorado-Wyoming State line, began production again in September 2000. Kelsey Lake is now owned by McKenzie Bay International, Ltd., a Canadian mining company, and is operated by McKenzie's local subsidiary, Great Western Diamond Co. Kelsey Lake is the United States' only commercial producing diamond mine.

In 2000, the U.S. gemstone market is expected to be about $8.9 billion, accounting for at least one-third of world demand. The United States is expected to dominate global gemstone consumption during the next decade. Synthetic gemstones will gain a larger share of domestic jewelry sales.

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

| | Mine production | | Reserves and reserve base[9] |
|---|---|---|---|
| | **1999** | **2000[e]** | |
| United States | ([10]) | ([10]) | World reserves and reserve base of gem diamond are substantial. No reserves or reserve base data are available for other gemstones. |
| Angola | 1,080 | 1,080 | |
| Australia | 13,400 | 14,000 | |
| Botswana | 15,000 | 15,000 | |
| Brazil | 300 | 300 | |
| Canada | 2,000 | 2,300 | |
| Central African Republic | 400 | 400 | |
| China | 230 | 230 | |
| Congo (Kinshasa) | 3,500 | 3,500 | |
| Ghana | 649 | 650 | |
| Namibia | 2,000 | 2,000 | |
| Russia | 11,500 | 11,500 | |
| South Africa | 4,000 | 4,000 | |
| Venezuela | 100 | 100 | |
| Other countries | 1,440 | 1,440 | |
| World total | 55,600 | 56,500 | |

**World Resources:** Natural gem-quality diamonds are among the world's rarest mineral materials. Most diamond-bearing ore bodies have a diamond content that ranges from less than 1 carat per ton to only about 6 carats per ton. The major gem diamond reserves are in southern Africa, western Australia, Canada, and Russia. Estimation of a reserve base is difficult because of the changing economic evaluation of near-gem materials and recent discoveries in 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]Estimated by rounding the 1999 synthetic production figure, because the 2000 synthetic production figure was withheld; synthetic production in 2000 was at least as high as that of 1999.
[5]Reexports account for more than 90% of the totals.
[6]If reexports were not considered, apparent consumption would be significantly greater.
[7]Defined as imports - exports and reexports + adjustments for Government and industry stock changes.
[8]Data in thousands of carats of gem diamond.
[9]See Appendix C for definitions.
[10]Less than ½ unit.

# GERMANIUM

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

**Domestic Production and Use:** The value of domestic refinery production of germanium, based upon the 2000 producer price, was about $22 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 2000. The domestic industry consisted of three germanium refineries, one each in New York, Oklahoma, and Pennsylvania, and two base metal mining operations, one in Tennessee and the other in Alaska. Both of the mining companies supplied domestic and export markets with germanium-bearing materials generated from the mining of zinc ores. The major end uses for germanium, worldwide, were estimated to be almost the same as for 1999: fiber-optic systems, 50%; polymerization catalysts, 20%; infrared optics, 15%; electronics/solar electrical applications, 10%; and other uses (phosphors, metallurgy, and chemotherapy), 5%.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, refinery[e] | 18,000 | 20,000 | 22,000 | 20,000 | 19,000 |
| Total imports[1] | 27,500 | 23,700 | 14,600 | 12,400 | 10,000 |
| Exports | NA | NA | NA | NA | NA |
| Consumption[e] | 25,000 | 28,000 | 28,000 | 28,000 | 28,000 |
| Price, producer, yearend, dollars per kilogram: | | | | | |
| Zone refined | 2,000 | 1,475 | 1,700 | 1,400 | 1,150 |
| Dioxide, electronic grade | l,300 | 950 | 1,100 | 900 | 750 |
| Stocks, producer, yearend | NA | NA | NA | NA | NA |
| Employment, plant,[2] number[e] | 120 | 115 | 100 | 85 | 85 |
| Net import reliance[3] as a percent of apparent consumption | NA | NA | NA | NA | NA |

**Recycling:** More than half of the metal used during the manufacture of most electronic and optical devices is routinely recycled as new scrap. Worldwide, about 25% of the total germanium consumed was produced from recycled materials. As a result of the low unit use of germanium in various devices, little germanium returns as old scrap.

**Import Sources (1996-99):**[4] Russia, 33%; Belgium, 24%; China, 19%; United Kingdom, 8%; and other, 16%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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—9-30-00**[5]

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Germanium | 48,561 | 750 | 48,561 | 8,000 | 2,017 |

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# GERMANIUM

**Events, Trends, and Issues:** World refinery production of germanium remained steady in 2000. The recycling of scrap continued to be a significant factor. The only releases from national government stockpiles were from the United States. Lack of world demand for satellite applications continued, as major projects remained stalled. This lack of demand was offset by increased consumption in fiber optics and polyethylene terephthalate (PET) bottles. More than one-half of total world demand was from the fiber optics sector.

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

**World Refinery Production, Reserves, and Reserve Base:**

| | Refinery production[e] | | Reserves[6] | Reserve base[6] |
|---|---|---|---|---|
| | 1999 | 2000 | | |
| United States | 20,000 | 19,000 | 450,000 | 500,000 |
| Other countries | 38,000 | 39,000 | NA | NA |
| World total (rounded) | 58,000 | 58,000 | 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.

**Substitutes:** Less expensive silicon can be substituted for germanium in certain electronic applications. Certain bimetallic compounds of gallium, indium, selenium, and tellurium can also be substituted for germanium. Germanium is more reliable than competing materials in some high-frequency and high-power electronics applications and is more economical as a substrate for some light-emitting diode applications. In infrared guidance systems, zinc selenide and germanium glass substitute for germanium metal but at the expense of performance.

[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]Total imports from republics of the former Soviet Union (Estonia, Russia, and Ukraine) accounted for 38% of the 1996-99 imports.
[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 60 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 92% of the gold produced in the United States. The value of mine production in 2000 was about $3 billion. Commercial-grade refined gold came from about two dozen producers. A few dozen companies, out of several thousand companies and artisans, dominated the fabrication of gold into commercial products. U.S. jewelry manufacturing was heavily concentrated in the New York, NY, and Providence, RI, areas with lesser concentrations in California, Florida, and Texas. Estimated uses were: jewelry and arts, 85%; electrical and electronics, 7%; dental, 3%; and other, 5%.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production: Mine | 326 | 362 | 366 | 341 | 330 |
| Refinery: Primary | ([2]) | 270 | 277 | 265 | 265 |
| Secondary (new and old scrap) | ([2]) | 100 | 163 | 143 | 140 |
| Imports[3] | 159 | 209 | 278 | 221 | 240 |
| Exports[3] | 471 | 477 | 522 | 523 | 720 |
| Consumption, reported | ([2]) | 137 | 219 | 245 | 250 |
| Stocks, yearend, Treasury[4] | 8,140 | 8,140 | 8,130 | 8,170 | 8,140 |
| Price, dollars per ounce[5] | 389 | 332 | 295 | 280 | 280 |
| Employment, mine and mill, number[e] | 16,900 | 16,300 | 13,400 | 10,300 | 9,800 |
| Net import reliance[6] as a percent of apparent consumption | E | E | E | E | E |

**Recycling:** 140 metric tons of new and old scrap, equal to 56% of reported consumption, was recycled in 2000.

**Import Sources (1996-99):**[3] Canada, 43%; Brazil, 13%; Australia, 8%; Peru, 7%; and other, 29%.

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

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

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

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# GOLD

**Events, Trends, and Issues:** Domestic gold mine production in 2000 was estimated at below the level of 1999, but high enough to maintain the United States' position as the world's second largest gold-producing nation, after South Africa. Domestic output continued to be dominated by Nevada and California, where combined production accounted for nearly 80% of the U.S. total. Between July 1999 and June 2000, nine gold mines were closed, and two were reopened in the United States. During this 12-month period, the average output per mine increased, companies merged, and the size of gold mining operations increased. Most of the larger companies were successfully replacing annual production with new reserves, but smaller companies were finding this more difficult. Estimates by an industry association indicate that worldwide gold exploration expenditures decreased for the third consecutive year, with 1997 marking the peak of exploration spending for the 1990's. The expenditures of U.S. gold producers continued to fall in 2000, owing to the low price of gold.

During the first 8 months of the year, the Engelhard Corporation's daily price of gold ranged from a low of about $272 per troy ounce, in May, to a high of almost $314, in February. For most of the year, this price was below $280, the average price for 1999. The traditional role of gold as a store of value was not able to lift the price out of its low trading range. In 2000, the Swiss National Bank embarked on selling 1,300 tons of gold (half its reserves), and the UK government continued its drive to sell 415 tons of gold from British gold reserves. Concerns about central bank gold sales, prospects for more consolidation within the gold-mining sector, and lack of investor interest kept gold prices depressed.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[7] | Reserve base[7] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 341 | 330 | 5,600 | 6,000 |
| Australia | 303 | 300 | 4,000 | 4,700 |
| Canada | 158 | 150 | 1,500 | 3,500 |
| China[e] | 170 | 170 | NA | NA |
| Indonesia | 130 | 120 | 1,800 | 2,800 |
| Peru | 128 | 140 | 200 | 650 |
| Russia | 104 | 105 | 3,000 | 3,500 |
| South Africa | 449 | 440 | 19,000 | 40,000 |
| Other countries | 735 | 665 | 13,000 | 16,000 |
| World total (may be rounded) | 2,540 | 2,445 | [8]48,000 | [8]77,000 |

Of an estimated 130,000 tons of all gold ever mined, about 15% is thought to have been lost, used in dissipative industrial uses, or otherwise unrecoverable or unaccounted for. Of the remaining 110,000 tons, an estimated 33,300 tons are official stocks held by central banks and about 77,200 tons is privately held as coin, bullion, and jewelry.

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

**Substitutes:** Base metals clad with gold alloys are widely used in electrical/electronic and jewelry products 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. NA Not available.
[1]Metric ton (1,000 kilograms) = 32,150.7 troy ounces.
[2]Survey response not sufficient for publication.
[3]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: 373.0 (1996),142.8 (1997), 309.9 (1998), 302.7 (1999), and 362.7 (2000, estimated).

[4]Includes gold in Exchange Stabilization Fund. Stocks were valued at the official price of $42.22 per troy ounce.
[5]Englehard Corporation's average gold price quotation for the year.
[6]Defined as imports - exports + adjustments for Government and industry stock changes.
[7]See Appendix C for definitions.
[8]Excludes China and some other countries for which reliable data were not available.

# GRAPHITE (NATURAL)

(Data in thousand metric tons, unless otherwise noted)

**World Production and Use:** Although natural graphite was not produced domestically in 2000, it was consumed by approximately 200 firms primarily in the Northeastern and Great Lakes regions. The major uses of natural graphite remained the same as those of 1999 as refractory applications led the way in use categories with 44%; brake linings was second with 19%; lubricants 5%, dressings and molds in foundry operations, 4%; and other uses making up the remaining 28%.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000**[e] |
|---|---|---|---|---|---|
| Production, mine | — | — | — | — | — |
| Imports for consumption | 53 | 58 | 62 | 56 | 58 |
| Exports | 26 | 40 | 28 | 29 | 30 |
| Consumption, apparent | 27 | 18 | 34 | 26 | 28 |
| Price, imports (average dollars per ton at foreign ports): | | | | | |
| Flake | 699 | 622 | 514 | 540 | 550 |
| Lump and chip (Sri Lankan) | 675 | 1,010 | 1,200 | 1100 | 1150 |
| Amorphous (Mexican) | 134 | 153 | 192 | 225 | 230 |
| Stocks, yearend | NA | NA | NA | NA | NA |
| Net import reliance[1] as a percent 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 in particular led the way in recycling of graphite products. Primary recycling of refractory articles is growing with the recycled market being principally in less demanding service conditions, such as safety linings and thermal insulation.

Recent research on the technical feasibility of recovering high-quality flake graphite from steelmaking kish, by the former Bureau of Mines research staff, may further boost graphite recycling efforts.[5] The current (2000) low prices, however, stand in the way of increased recycling efforts. Information on the quantity and monetary value of recycled graphite is not available.

**Import Sources (1996-99):** China, 33%; Mexico, 23%; Canada, 22%; Brazil 9%; and other, 13%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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—9-30-00**[2]

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Sri Lanka, amorphous lump | 4.84 | — | 4.84 | 3.42 | 3.42 |
| Madagascar, crystalline flake | 3.85 | 5.50 | 3.85 | — | 3.35 |

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# GRAPHITE (NATURAL)

**Events, Trends, and Issues:** Graphite was near to supply-demand balance in 2000. Demand was met largely by imports of flake from Canada, China, and Madagascar; lump and chip from Sri Lanka; and amorphous graphite from China and Mexico. Graphite electrode consumption in steelmaking has been decreasing since the late 1980's because of increased efficiency by the iron and steel producers. Use of natural graphite in lubrication applications is also decreasing because of changes in requirements for lubricant compositions and in processing technologies. Advances in graphite thermal technology and acid-leaching techniques, which enable the production of higher purity graphite powders, will find new application areas in high-technology fields for graphite. Such innovative refining techniques have enabled the use of improved graphite in friction materials, electronics, foils, and special lubrication applications.[6] Flexible graphite product lines, such as graphoil (a thin graphite cloth), will probably be the fastest growing market. Industry trends, common to advances in graphite technology and market, include higher purity and consistency in specifications for high-tech applications. Production of higher purity graphite, using newly developed thermal processing techniques, for such applications as advanced carbon-graphite composites will continue to be the trend.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[4] | Reserve base[4] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | — | — | — | 1,000 |
| Brazil | 60 | 65 | 360 | 1,000 |
| China | 280 | 300 | 4,800 | 310,000 |
| India | 145 | 150 | 360 | 620 |
| Madagascar | 12 | 15 | 940 | 960 |
| Mexico | 44 | 45 | 3,100 | 3,100 |
| Other countries | 143 | 145 | 5,100 | 44,000 |
| World total (may be rounded) | 685 | 720 | 15,000 | 360,000 |

**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 operations. Molybdenum disulfide competes as a dry lubricant but is more sensitive to oxidizing conditions.

[e]Estimated. NA Not available.
[1]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.
[2]See Appendix B for definitions.
[3]Less than ½ unit.
[4]See Appendix C for definitions.
[5]Laverty, P.D., Nicks, L.J., and Walters, L.A., 1994, Recovery of flake graphite from steelmaking kish: U.S. Bureau of Mines Report of Investigations 9512, 23 p.
[6]Hand, G.P., 1997, Outlook for graphite and graphite technology: Mining Engineering, v. 49, no. 2, February, p. 34-36.

# GYPSUM

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** In 2000, crude gypsum output exceeded 25 million tons and was valued at $175 million. The top producing States were, in descending order, Oklahoma, California, Iowa, Texas, Nevada, Michigan, and New Mexico, which together accounted for 75% of total output. Overall, 35 companies produced gypsum at 61 mines in 20 States, and 10 companies calcined gypsum at 64 plants in 28 States. Most of domestic consumption, which totaled about 39.9 million tons, was accounted for by manufacturers of wallboard and plaster products. More than 5.5 million tons for cement production, about 4 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. Capacity at operating wallboard plants in the United States was 31.6 billion square feet per year, and sales were more than 31 billion square feet, representing capacity utilization of about 98%.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: Crude | 17,500 | 18,600 | 19,000 | 22,400 | 25,000 |
| Synthetic[1] | 2,500 | 2,700 | 3,000 | 5,200 | 6,300 |
| Calcined[2] | 17,000 | 17,200 | 19,400 | 22,300 | 24,500 |
| Wallboard products (million square feet) | 23,700 | 24,400 | 26,900 | 31,600 | 35,000 |
| Imports, crude, including anhydrite | 8,050 | 8,420 | 8,680 | 9,340 | 8,750 |
| Exports, crude, not ground or calcined | 136 | 174 | 166 | 112 | 156 |
| Consumption, apparent[3] | 27,900 | 29,500 | 30,500 | 36,800 | 39,900 |
| Price: Average crude, f.o.b. mine, dollars per ton | 7.10 | 7.11 | 6.92 | 6.99 | 7.00 |
| Average calcined, f.o.b. plant, dollars per ton | 16.88 | 17.58 | 17.02 | 17.07 | 17.10 |
| Stocks, producer, crude, yearend | 1,200 | 1,200 | 1,500 | 1,500 | 1,500 |
| Employment, mine and calcining plant, number[e] | 6,300 | 6,000 | 6,000 | 6,000 | 6,000 |
| Net import reliance[4] as a percent of apparent consumption | 29 | 28 | 28 | 25 | 22 |

**Recycling:** Only a small amount of gypsum wallboard is recycled.

**Import Sources (1996-99):** Canada, 67%; Mexico, 24%; Spain, 8%; and other, 1%.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Gypsum; anhydrite | 2520.10.0000 | Free. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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# GYPSUM

**Events, Trends, and Issues:** Construction of new homes, commercial buildings, and office space continued to stimulate wallboard demand and boosted domestic consumption of gypsum. Some forecasts indicate that gypsum demand in North American markets will remain high for the next few years. This demand, however, will depend 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. Federal funding that was authorized in 1998 for road building and repair through 2003 will continue to spur gypsum consumption in the cement industry. Several large wallboard plants under construction and designed to use only synthetic gypsum will accelerate substitution significantly as they become operational within the next 2 years.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[5] | Reserve base[5] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 22,400 | 25,000 | 700,000 | Large |
| Australia | 2,100 | 2,100 | | |
| Canada | 9,470 | 9,500 | 450,000 | Large |
| China | 9,000 | 9,000 | | |
| Egypt | 1,500 | 1,500 | | |
| France | 4,500 | 4,500 | | |
| India | 2,200 | 2,200 | | |
| Iran | 9,750 | 9,750 | | |
| Italy | 1,300 | 1,300 | Reserves and reserve base are large in major producing countries, but data are not available. | |
| Japan | 5,500 | 5,500 | | |
| Mexico | 7,000 | 7,100 | | |
| Poland | 1,000 | 1,000 | | |
| Spain | 7,500 | 7,500 | | |
| Thailand | 5,000 | 5,000 | | |
| United Kingdom | 1,800 | 1,800 | | |
| Other countries | 16,980 | 17,000 | | |
| World total (rounded) | 107,000 | 110,000 | Large | Large |

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

**Substitutes:** Other construction materials may be substituted for gypsum, especially cement, lime, lumber, masonry, and steel. Gypsum has no practical substitute in the manufacturing of portland cement. Synthetic gypsum generated by various industrial processes is becoming more important as a substitute for mined gypsum in wallboard manufacturing, cement production, and agricultural applications.

[e]Estimated.
[1]Only synthetic reported as sold or used.
[2]From domestic crude.
[3]Defined as crude + total reported synthetic use + net import reliance.
[4]Defined as imports - exports + adjustments for industry stock changes.
[5]See Appendix C for definitions.

# HELIUM

(Data in million cubic meters of contained helium gas,[1] unless otherwise noted)

**Domestic Production and Use:** During 2000, the estimated value of Grade-A helium (99.995% or better) extracted by private industry was about $215 million. There are 13 private industry plants (5 in Kansas, 4 in Oklahoma, and 4 in Texas) that extract helium from natural gas and produce only a crude helium product that varies from 50% to 80% helium. There are six private industry plants (two in Colorado, and one each in Oklahoma, Texas, Utah, and Wyoming) that extract helium from natural gas and produce an intermediate process stream of crude helium (about 70% helium) and continue processing the stream to produce a Grade-A helium product. There are five private industry plants (four in Kansas and one in Texas) that accept a crude helium product from other producers and the Bureau of Land Management (BLM) pipeline and purify this to a Grade-A helium product. The estimated 2000 domestic consumption of 95 million cubic meters (3.4 billion cubic feet) was used for cryogenic applications, 24%; for pressurizing and purging, 20%; for welding cover gas, 18%; for controlled atmospheres, 16%; leak detection, 6%; breathing mixtures, 3%; and other, 13%.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Helium extracted from natural gas[2] | 103 | 116 | 112 | 114 | 117 |
| Withdrawn from storage[3] | (8.3) | (9.3) | (0.7) | 3 | 8 |
| Grade-A helium sales | 95 | 107 | 112 | 117 | 125 |
| Imports for consumption | — | — | — | — | — |
| Exports[4] | 22.8 | 29.5 | 27.8 | 26.8 | 29.3 |
| Consumption, apparent[4] | 67.1 | 77.4 | 83.5 | 93.2 | 95 |
| Employment, plant, number[e] | 631 | 605 | 531 | 500 | 500 |
| Net import reliance[5] as a percent of apparent consumption | E | E | E | E | E |

Price: The Government price for helium contained in crude helium was $1.785 per cubic meter ($49.50 per thousand cubic feet) in fiscal year (FY) 2000. The price for the government-owned helium is mandated by Public Law 104-273. Private industry's estimated price range for Grade-A gaseous helium was about $1.51-$1.80 per cubic meter ($42- $50 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 (1996-99):** None.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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 Helium Privatization Act of 1996 (Public Law 104-273), the BLM operates the Federal Helium Program, including a helium storage system. Because the BLM can no longer supply Federal agencies with Grade-A helium, private firms that sell Grade-A helium to the Federal agencies are now required to purchase a like amount of crude helium (in-kind) from the BLM. During FY 2000, BLM's Amarillo Field Office, Helium Operations (AMFO) accepted more than 25.1 million cubic meters (906 million cubic feet) of private helium for storage and redelivered nearly 46.9 million cubic meters (1,690 million cubic feet). Also in 2000, privately owned companies purchased nearly 6.43 million cubic meters (232 million cubic feet) of in-kind crude helium. As of September 30, 2000, 124 million cubic meters (4.5 billion cubic feet) of helium was owned by private firms, which is the largest amount to date.

**Stockpile Status—9-30-00**

| **Material** | **Uncommitted inventory** | **Committed inventory** | **Authorized for disposal** | **Disposal plan FY 2000** | **Disposals FY 2000** |
|---|---|---|---|---|---|
| Helium | 828.4 | 16.6 | 828.4 | 6.43 | 7.0 |

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# HELIUM

**Events, Trends, and Issues:** During 2000, merger and acquisition activity involving companies such as BOC Gases, Inc., Air Products and Chemicals Inc., and Air Liquide did not materialize. Helium exports increased significantly in 2000 due to cutbacks in Algerian helium production. There were also capacity expansions made at some of the purification plants along the BLM pipeline. The AMFO continued crude helium sales, operation of the pipeline and storage field, and collection of helium royalties and fees.

**World Production, Reserves, and Reserve Base:**

| | Production | | Reserves[7] | Reserve base[7] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 114 | 117 | 6,000 | [8]11,000 |
| Algeria | 16 | 16 | NA | 2,000 |
| Canada | NA | NA | NA | 2,000 |
| China | NA | NA | NA | 1,100 |
| Poland | 1 | 1 | 40 | 280 |
| Former Soviet Union[9] | 4 | 4 | 1,700 | 6,700 |
| Other countries | NA | NA | NA | 2,800 |
| World total (rounded) | 135 | 140 | NA | 26,000 |

**World Resources:** The identified helium resources of the United States were estimated to be about 11.1 billion cubic meters (400 billion cubic feet) as of January 1, 1999. This includes 0.97 billion cubic meters (35 billion cubic feet) of helium stored in the Cliffside Field, 6.0 billion cubic meters (215 billion cubic feet) of helium in helium-rich natural gas (0.30% helium or more), and 4.1 billion cubic meters (148 billion cubic feet) in helium-lean natural gas (less than 0.30% helium). The Hugoton (Kansas, Texas, and Oklahoma), Panhandle West, Panoma, and Riley Ridge Fields are currently depleting gasfields and contain an estimated 4.4 billion cubic meters (159 billion cubic feet) of helium. Future supplies will probably come from known helium-rich natural gas with little fuel value and from helium-lean resources.

Helium resources of the world exclusive of the United States were estimated to be about 15 billion cubic meters (540 billion cubic feet). The locations and volumes of the principal deposits, in billion cubic meters, are the former Soviet Union, 7; Algeria, 2; Canada, 2; China, 1; Poland, 0.3. As of December 31, 2000, AMFO had analyzed nearly 21,000 gas samples from 26 countries and the United States in a program to identify world helium resources.

**Substitutes:** There is no substance that can be substituted for helium if temperatures below -429° F are required. Argon can be substituted for helium in welding, and hydrogen can be substituted for helium in some lighter-than-air applications in which the flammable nature of hydrogen is not objectionable. Hydrogen is also being investigated as a substitute for helium in deep-sea diving applications below 1,000 feet.

[e]Estimated. E Net exporter. NA Not available.
[1]Measured at 101.325 kilopascals absolute (14.696 psia) and 15° C, 27.737 cubic meters of helium = 1 Mcf of helium at 70° F and 14.7 psia.
[2]Helium content of both Grade-A and crude helium (consisting of approximately 70% helium and 30% nitrogen).
[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]Chief, Helium Resources Division, Bureau of Land Management, Amarillo Field Office, Helium Operations, Amarillo, TX.
[7]See Appendix C for definitions.
[8]All domestic measured and indicated helium resources in the United States.
[9]As constituted before December 1991.

# INDIUM

(Data in metric tons, unless otherwise noted)

**Domestic Production and Use:** Indium was not recovered from ores in the United States in 2000. Domestically produced standard grade indium was derived from the upgrading of lower grade imported indium metal. Two companies, one each in New York and Rhode Island, were the major producers of indium metal and indium products in 2000. Several firms produced high-purity indium shapes, alloys, and compounds. Thin-film coatings, which are used in applications such as liquid crystal displays (LCD's) and electroluminescent lamps, continued to be the largest end use. Indium semiconductor compounds were used in infrared detectors, high-speed transistors, and high-efficiency photovoltaic devices. The estimated distribution of uses in 2000 was about the same as in 1999, with a slight increase in semiconductors and stable consumption in other sectors: coatings, 49%; solders and alloys, 33%; electrical components and semiconductors, 14%; and research and other, 4%. The estimated value of primary indium metal consumed in 2000, based upon the annual average price, was more than $10 million.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production, refinery | — | — | — | — | — |
| Imports for consumption | 33.2 | 85.5 | 75 | 77 | 70 |
| Exports | NA | NA | NA | NA | NA |
| Consumption[e] | 45 | 50 | 50 | 52 | 55 |
| Price, annual average, dollars per kilogram (99.97% indium) | 370 | 309 | 296 | 303 | 188 |
| Stocks, producer, yearend | NA | NA | NA | NA | NA |
| Employment, number | NA | NA | NA | NA | NA |
| Net import reliance[1] as a percent of estimated consumption[e] | NA | 100 | 100 | 100 | 100 |

**Recycling:** Small quantities of old scrap were recycled. Recycling of new scrap, the scrap from fabrication of indium products, is becoming more significant. Recycling occurred previously when the price of indium was relatively very high and/or increasing rapidly. Now it has become an important part of foreign production, but it was significant in the United States only in 1996.

**Import Sources (1996-99):** Canada, 45%; China, 22%; Russia, 12%; France, 9%; and other, 12%.

| **Tariff:** **Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Unwrought, waste and scrap | 8112.91.3000 | Free. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** The last indium held in the National Defense Stockpile was sold in December 1998.

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# INDIUM

**Events, Trends, and Issues:** Estimated domestic indium consumption increased modestly to about 55 tons in 2000. After 3 years of relative stability, the price of indium dropped considerably in 2000. Expanding LCD manufacture in Asia was more than matched by adequate supply and greater efficiency in processing. Despite a strong increase in LCD production, the ready availability of low-priced indium from China forced world prices down. The long range outlook for the indium market remains promising despite current and near term market fluctuations.

**World Refinery Production, Reserves, and Reserve Base:**

| | Refinery production[e] | | Reserves[2] | Reserve base[2] |
|---|---|---|---|---|
| | 1999 | 2000 | | |
| United States | — | — | 300 | 600 |
| Belgium | 35 | 35 | ([3]) | ([3]) |
| Canada | 35 | 35 | 700 | 2,000 |
| China | 40 | 40 | 400 | 1,000 |
| France | 43 | 43 | ([3]) | ([3]) |
| Japan | 25 | 30 | 100 | 150 |
| Peru | 4 | 4 | 100 | 150 |
| Russia | 15 | 15 | 200 | 300 |
| Other countries | 20 | 20 | 800 | 1,500 |
| World total (may be rounded) | 215 | 220 | 2,600 | 5,700 |

**World Resources:** Indium occurs predominantly in solid solution in sphalerite, a sulfide ore of zinc. Significant quantities of indium also are contained in ores of copper, lead, and tin, but there is not enough information to formulate reliable estimates of indium resources, and most of these deposits are subeconomic for indium. Indium is recovered almost exclusively as a byproduct of zinc. Estimates of the average indium content of the Earth's crust range from 50 to 200 parts per billion. The average indium content of zinc deposits ranges from less than 1 part per million to 100 parts per million. The highest known concentrations of indium occur in vein or replacement sulfide deposits, usually associated with tin-bearing minerals. However, this type of deposit is usually difficult to process economically.

**Substitutes:** Gallium arsenide can substitute for indium phosphide in solar cells and semiconductor applications. Silver-zinc oxide or tin oxide are lower cost substitutes for indium-tin oxide in transparent conductive coatings for glass. Hafnium can replace indium alloys for use in nuclear reactor control rods.

[e]Estimated. NA Not available.
[1]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.
[2]Estimate based on the indium content of zinc ores. See Appendix C for definitions.
[3]Reserves for European countries are included in “Other countries.”

# IODINE

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

**Domestic Production and Use:** Iodine produced in 2000 from three companies operating in Oklahoma accounted for 100% of the elemental iodine value estimated at $21 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 and a plant in Woodard, OK. A third company continued production at Vici, OK, for domestic use and export to Germany. Of the consumers that participate in the annual survey, 26 plants reported consumption of iodine in 1999. Major consumers were located in the Eastern United States. Prices of crude iodine in drums, published for November, ranged between $19 and $21 per kilogram. Imports of iodine through September averaged $14.42 per kilogram.

Establishing an accurate end-use pattern for iodine was difficult because intermediate iodine compounds were marketed before reaching their final end uses. Estimated world consumption of iodine was 19,000 metric tons.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production | 1,270 | 1,320 | 1,490 | 1,620 | 1,440 |
| Imports for consumption, crude content | 4,860 | 6,380 | 5,960 | 5,430 | 4,700 |
| Exports | 2,410 | 2,760 | 2,790 | 1,130 | 1,450 |
| Shipments from Government stockpile excesses | — | 204 | 291 | 221 | 104 |
| Consumption: | | | | | |
| Apparent | 3,700 | 5,140 | 4,950 | 5,650 | 4,690 |
| Reported | 3,920 | 4,500 | 4,100 | 4,540 | NA |
| Price, average c.i.f. value, dollars per kilogram, crude | 12.90 | 14.66 | 16.45 | 16.15 | 14.42 |
| Stocks, producer, yearend | NA | NA | NA | NA | NA |
| Employment, number | 40 | 40 | 40 | 40 | 30 |
| Net import reliance[1] as a percent of apparent consumption | 66 | 65 | 70 | 62 | 69 |

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

**Import Sources (1996-99):** Chile, 64%; Japan, 27%; and Russia, 9%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Iodine, crude | 2801.20.0000 | Free. |
| Iodide, calcium or of copper | 2827.60.1000 | Free. |
| Iodide, potassium | 2827.60.2000 | 2.8% ad val. |
| Iodides and iodide oxides, other | 2827.60.5000 | 4.2% ad val. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:**

**Stockpile Status—9-30-00[2]**

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Stockpile-grade | 1,782 | 14 | 1,782 | 454 | 9 |

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# IODINE

**Events, Trends, and Issues:** Chile was the largest producer of iodine in the world; Japan was the second largest producer. Production was primarily from underground brines associated with natural gas production. Six companies operated 17 plants with a total capacity of 9,000 tons per year. Production capacity of the plants was dependent upon the availability of brines with high concentrations of iodine.

Three scientists, one from Japan and two from the United States, shared the Nobel Prize in Chemistry for making plastics conduct electricity using polyacetylene with iodine. Conducting polymers are being used as antistatic coatings and corrosion inhibitors; one of the polymers is used in the radar-absorbing screen coating of Stealth bombers.

A Canadian company began construction of a plant to produce iodine from nitrate deposits in the Atacama Desert of Chile. The plant is planned to be on stream in 2001.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[3] | Reserve base[3] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 1,620 | 1,440 | 250,000 | 550,000 |
| Azerbaijan | 300 | 300 | 170,000 | 340,000 |
| Chile | 9,720 | 9,800 | 9,000,000 | 18,000,000 |
| China | 500 | 500 | 400,000 | 400,000 |
| Indonesia | 70 | 70 | 100,000 | 200,000 |
| Japan | 6,750 | 6,760 | 4,900,000 | 7,000,000 |
| Russia | 120 | 120 | 120,000 | 240,000 |
| Turkmenistan | 150 | 150 | 170,000 | 350,000 |
| World total (rounded) | 19,300 | 19,100 | [4]15,000,000 | [4]27,000,000 |

**World Resources:** In addition to the fields listed in the reserve base, seawater contains 0.05 part per million iodine, or approximately 34 million tons. Seaweeds of the Laminaria family are able to extract and accumulate up to 0.45% iodine on a dry basis. Although not as economical as the production of iodine as a byproduct of gas, oil, and nitrate, the seaweed industry represented a major source of iodine prior to 1959 and is a large resource.

**Substitutes:** Bromine and chlorine could be substituted for most of the biocide, ink, and colorant uses of iodine, although they are usually considered less desirable than iodine. Antibiotics and mercurochrome also substitute for iodine as biocides. Salt crystals and finely divided carbon may be used for cloud seeding. There are no substitutes for iodine in some catalytic, nutritional, pharmaceutical, animal feed, 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.
[4]Sum excludes countries for which data were not available.

# IRON ORE[1]

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

**Domestic Production and Use:** The value of usable ore shipped from mines in Minnesota, Michigan, and six other States in 2000 was estimated at $1.7 billion. Twelve iron ore production complexes with 12 mines, 10 concentration plants, and 10 pelletizing plants were in operation during the year. The mines included 11 open pits and 1 underground operation. Virtually all ore was concentrated before shipment. Nine mines operated by five companies accounted for 99% of production. The United States produced 6% of the world's iron ore and consumed about 8%.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, usable | 62.1 | 63.0 | 62.9 | 57.8 | 61.0 |
| Shipments | 62.2 | 62.8 | 63.2 | 60.7 | 61.0 |
| Imports for consumption | 18.4 | 18.6 | 16.9 | 14.3 | 18.0 |
| Exports | 6.3 | 6.3 | 6.0 | 6.1 | 6.2 |
| Consumption: Reported (ore and total agglomerate)[3] | 79.6 | 79.5 | 78.2 | 75.1 | 76.0 |
| Apparent | 72.0 | 73.0 | 71.1 | 70.1 | 75.2 |
| Price,[4] U.S. dollars per metric ton | 28.07 | 29.60 | 31.14 | 25.52 | 26.00 |
| Stocks, mine, dock, and consuming plant, yearend, excluding byproduct ore | 25.7 | 27.9 | 30.6 | 26.4 | 24.0 |
| Employment, mine, concentrating and pelletizing plant, quarterly average, number | 7,580 | 7,450 | 7,290 | 6,820 | 6,600 |
| Net import reliance[5] as a percent of apparent consumption (iron in ore) | 14 | 14 | 13 | 18 | 19 |

**Recycling:** None.

**Import Sources (1996-99):** Canada, 52%; Brazil, 32%; Venezuela, 8%; Australia, 4%; and other, 4%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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:** Worldwide, nearly all iron ore is used in steelmaking; in the United States, steelmaking accounts for about 98% of iron ore consumption. Iron ore production and consumption are concentrated in a few countries. In 2000, iron ore was produced in about 50 countries; the 7 largest of these producing countries accounted for 77% of the world total and no other country had as much as a 5% share.

The majority of U.S. iron ore trade involves Canada. Since 1990, about 52% of U.S. imports originated in Canada, and 99% of U.S. exports were shipped there. The reasons for this are ownership and proximity. Canadian steel mills have partial ownership in three of the nine iron ore operations that produce 99% of U.S. ore. One U.S. steelmaker and one merchant iron ore company own part of one of the three Canadian iron ore producers. The proximity of the producers and consumers of iron ore in the two countries, in particular in the Great Lakes region, means lower shipping costs.

From 1995 through 1999, the United States ranked sixth in iron ore production with 6% of the world total and third in pig iron production with 9% of the world total. Although world pig iron production levels have changed little over the past 5 years, production by area during that period has changed considerably.

Domestic iron ore production and consumption levels exceeded those of 1999. Pig iron and steel production also rose. Steel demand in the United States was significantly higher than in 1999, but much of that demand was satisfied by steel imports. Net imports of steel mill products were about 30 million metric tons, a 16% increase over that of 1999.

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# IRON ORE

Internationally, the major event in the iron ore industry was the acquisition of North Ltd. by Rio Tinto. By this acquisition, Rio Tinto moved from third to second place among the world's leading iron ore producers. Cia. Vale do Rio Doce of Brazil, which continued to be the world's largest producer, made an acquisition of its own, purchasing the majority ownership of S/A Mineração da Trindade (SAMITRI). SAMITRI mines in the Brazilian State of Minas Gerais. Rio Tinto now owns a majority position in Robe River Iron Associates in Western Australia and in the Iron Ore Company of Canada in Canada, which between them have a production capacity of 45 million metric tons per year. Rio also gained the majority ownership of the West Angelas deposit in Western Australia. Production at the deposit is expected to begin in 2002 at a rate of 7 million tons per year, rising to 20 million tons per year several years afterward.[6]

Domestically, the major event was the announcement by LTV Steel Company, Inc., a subsidiary of The LTV Corporation, of its intention to close permanently the operations of LTV Steel Mining Company. Despite investments of millions of dollars spent on the operation to increase productivity, declining ore quality and obsolete pelletizing furnaces made the operation the least productive taconite producer on the Mesabi Range.[7]

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

| | Mine production | | Crude ore | | Iron content | |
|---|---|---|---|---|---|---|
| | **1999** | **2000**[e] | **Reserves** | **Reserve base** | **Reserves** | **Reserve base** |
| United States | 58 | 61 | 10,000 | 23,000 | 3,000 | 7,000 |
| Australia | 155 | 158 | 18,000 | 40,000 | 11,000 | 25,000 |
| Brazil | 190 | 190 | 7,600 | 17,000 | 4,800 | 11,000 |
| Canada | 34 | 34 | 1,700 | 3,900 | 1,100 | 2,500 |
| China | 209 | 215 | 25,000 | 50,000 | 7,800 | 15,000 |
| India | 68 | 68 | 2,800 | 6,200 | 1,800 | 3,900 |
| Kazakhstan | 9 | 10 | 8,300 | 19,000 | 4,500 | 10,000 |
| Mauritania | 12 | 12 | 700 | 1,500 | 400 | 1,000 |
| Russia | 81 | 80 | 20,000 | 45,000 | 11,000 | 25,000 |
| South Africa | 30 | 30 | 1,000 | 2,300 | 650 | 1,500 |
| Sweden | 19 | 19 | 3,500 | 7,800 | 2,200 | 5,000 |
| Ukraine | 48 | 50 | 22,000 | 50,000 | 12,000 | 28,000 |
| Other countries | 82 | 80 | 17,000 | 38,000 | 10,000 | 23,000 |
| World total (may be rounded) | 994 | 1,010 | 140,000 | 300,000 | 71,000 | 160,000 |

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

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

[e]Estimated.
[1]See also Iron and Steel and Iron and Steel Scrap.
[2]Agglomerates, concentrates, direct-shipping ore, and byproduct ore for consumption.
[3]Includes weight of lime, flue dust, and other additives used in producing sinter for blast furnaces. Consumption data are not entirely comparable to those of 1987 and earlier years owing to changes in data collection.
[4]Calculated from value of ore at mines.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]Kirk, W. S., 2000, Rio Tinto acquires North: Skillings Mining Review, v. 89, no. 30, October 23, p. 4-7.
[7]Kirk, W. S., 2000, Iron ore in March 2000: U.S. Geological Survey Mineral Industry Surveys, June, 7 p.
[8]See Appendix C for definitions.

# IRON AND STEEL[1]

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

**Domestic Production and Use:** The iron and steel industry and ferrous foundries produced goods valued at about $73 billion. The steel industry consisted of about 105 companies that produced raw steel at about 144 locations, with combined raw steel production capability of about 128 million tons. Indiana accounted for about 23% of total raw steel production, followed by Ohio, 16%, and Pennsylvania, 7%. Pig iron was produced by 13 companies operating integrated steel mills, with about 35 blast furnaces in continuous operation. The distribution of steel shipments was estimated as follows: warehouses and steel service centers, 21%; transportation (predominantly for automotive production), 14%; construction, 13%; cans and containers, 3%; and others, 49%. Ferrous foundries, numbering about 1,100, continued to be importers of pig iron into the United States, mainly from Brazil, Russia, and South Africa.

| **Salient Statistics—United States:**[1] | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Pig iron production[2] | 49.4 | 49.6 | 48.2 | 46.3 | 50.6 |
| Steel production: | 95.5 | 98.5 | 98.6 | 97.4 | 106 |
| Basic oxygen furnaces, percent | 57.4 | 56.2 | 54.9 | 53.7 | 53.8 |
| Electric arc furnaces, percent | 42.6 | 43.8 | 45.1 | 46.3 | 46.2 |
| Continuously cast steel, percent | 93.2 | 94.7 | 95.5 | 95.9 | 96.1 |
| Shipments: | | | | | |
| Steel mill products | 91.5 | 96.0 | 92.9 | 96.3 | 105 |
| Steel castings[3] | 1.2 | 1.2 | 1.3 | [e]1.3 | 1.3 |
| Iron castings[3] | 9.8 | 9.6 | 9.8 | [e]9.8 | 9.8 |
| Imports of steel mill products | 26.5 | 28.3 | 37.7 | 32.4 | 36.8 |
| Exports of steel mill products | 4.6 | 5.5 | 5.0 | 4.9 | 6.0 |
| Apparent steel consumption[4] | 108 | 114 | 118 | 116 | 126 |
| Producer price index for steel mill products (1982=100)[5] | 115.6 | 116.4 | 113.8 | 105.3 | 111.0 |
| Steel mill product stocks at service centers yearend[6] | 6.3 | 6.6 | 7.7 | 7.7 | 8.2 |
| Total employment, average, number[7] | | | | | |
| Blast furnaces and steel mills | 168,000 | 163,000 | 160,000 | [e]160,000 | 160,000 |
| Iron and steel foundries | 129,000 | 130,000 | 132,000 | [e]132,000 | 132,000 |
| Net import reliance[8] as a percent of apparent consumption | 15 | 15 | 22 | 17 | 17 |

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

**Import Sources (1996-99):** European Union, 21%; Canada, 14%; Japan, 10%; Mexico, 9%; and other, 46%.

| **Tariff:**[9] **Item** | **Number** | **Normal Trade Relations[10] 12/31/00** | **Mexico 12/31/00** |
|---|---|---|---|
| Pig iron | 7201.10.0000 | Free | Free. |
| Carbon steel: | | | |
| Semifinished | 7207.12.0050 | 1.7% | 1.2%. |
| Structural shapes | 7216.33.0090 | 0.4% | 0.2%. |
| Bars, hot-rolled | 7213.20.0000 | 0.8% | 0.5%. |
| Sheets, hot-rolled | 7208.39.0030 | 2% | 1.4%. |
| Hot-rolled, pickled | 7208.27.0060 | 2% | 1.5%. |
| Cold-rolled | 7209.18.2550 | 1.3% | 0.9%. |
| Galvanized | 7210.49.0090 | 2.6% | 1.9%. |
| Stainless steel: | | | |
| Semifinished | 7218.91.0015 | 2.1% | 1.5%. |
| | 7218.99.0015 | 2.1% | 1.5%. |
| Bars, cold-finished | 7222.20.0075 | 4.2% | 3.1%. |
| Pipe and tube | 7304.41.3045 | 3.0% | Free. |
| Cold-rolled sheets | 7219.33.0035 | 4% | 3%. |

**Depletion Allowance:** Not applicable.

**Government Stockpile:** None.

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# IRON AND STEEL

**Events, Trends, and Issues:** During the first 8 months of 2000, monthly pig iron and raw steel production fluctuated near 4.7 million tons and 9.6 million tons, respectively. Production totals during this period increased 23% for pig iron and 15% for steel from those of 1999. Shipments of steel mill products during the first 6 months of 2000 were up 15% compared with those of 1999. However, raw steel production was trending downward during the second half of 2000.

Domestic steel prices declined significantly during 1998 and 1999, allegedly because of dumping of subsidized, low-priced steel products onto the U.S. market by foreign producers, and then reversed during the first half of 2000. As of the end of the third quarter 2000, industry market prices were up from those of 1999 for hot-rolled sheet, 16%; cold-rolled sheet, 32%; and structural beams, 8%. The industry appealed to the Government for vigorous enforcement of trade laws in response to the alleged dumping, and received support from the U.S. Department of Commerce in the form of antidumping duty margins against several countries. Later, the International Trade Commission ruled against the industry claiming that the industry did not suffer irreparable damage from the extra imports in 1998. An American Institute for International Steel study, which claimed that U.S. consumers incurred as much as $151 billion in costs over the past 40 years from governmental trade protection and subsidy aid to the industry, also opposed the position of the U.S. steel industry.

Members of the Auto Steel Partnership have been meeting with auto manufacturers to discuss future materials requirements. The Ultra-Light Steel Auto Body (ULSAB) program successfully developed the steel-intensive body-in-white that is as much as 36% lighter than existing comparable vehicles. Currently, 33 steel companies and Porsche Engineering are conducting research to establish a new standard for steel auto body design in the ULSAB-Advanced Vehicle Concepts program.

**World Production:**

| | Pig iron | | Raw steel | |
|---|---|---|---|---|
| | 1999 | 2000[e] | 1999 | 2000[e] |
| United States | 46.3 | 50.6 | 97.4 | 106 |
| Brazil | 25.1 | 27.2 | 25.0 | 27.3 |
| China | 125 | 129 | 124 | 123 |
| European Union | 93.1 | 97.2 | [e]157 | 167 |
| Japan | 74.5 | 80.1 | 94.2 | 104.8 |
| Korea, Republic of | 23.3 | 24.5 | 41.0 | 43.4 |
| Russia | 40.0 | 44.8 | 49.8 | 57.3 |
| Ukraine | 21.9 | 24.1 | 26.8 | 30.1 |
| Other countries | 91.9 | 93.8 | 171 | 174 |
| World total (may be rounded) | 541 | 571 | 786 | 833 |

**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 property advantage. Iron and steel compete with lighter materials, such as aluminum and plastics, in the motor vehicle industry; aluminum, concrete, and wood in construction; and aluminum, glass, paper, and plastics in containers.

[e]Estimated.
[1]Production and shipments data source is the American Iron and Steel Institute; see also Iron Ore and Iron and Steel Scrap.
[2]More than 95% of iron made is transported molten to steelmaking furnaces located at the same site.
[3]U.S. Department of Commerce, Census Bureau.
[4]Defined as steel shipments + imports - exports + adjustments for industry stock changes + adjustment for imports of semifinished steel products.
[5]Bureau of Labor Statistics.
[6]Steel Service Center Institute.
[7]Bureau of Labor Statistics. Blast furnaces and steel mills: SIC 3312; Iron and steel foundries: SIC 3320.
[8]Defined as imports - exports + adjustments for Government and industry stock changes.
[9]All tariff percentages are ad valorem.
[10]No tariff for Canada, Israel, and certain Caribbean and Andean nations for items shown.

# IRON AND STEEL SCRAP[1]

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

**Domestic Production and Use:** Total value of domestic purchases (receipts of ferrous scrap by all domestic consumers from brokers, dealers, and other outside sources) and exports was estimated at $6.6 billion in 2000, up about 23% from that of 1999. Manufacturers of pig iron, raw steel, and steel castings accounted for nearly 80% 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 20% to produce cast iron and steel products, such as motor blocks, pipe, and machinery parts. Relatively small quantities of scrap were used for producing ferroalloys, for the precipitation of copper, and by the chemical industry; these uses totaled less than 1 million tons.

Raw steel production in 2000 was an estimated 106 million tons, up nearly 8% from that of 1999. Net shipments of steel mill products were estimated at about 105 million tons compared with 93 million tons for 1999. The domestic ferrous castings industry shipped an estimated 11 million tons of all types of iron castings in 2000 and an estimated 1.4 million tons of steel castings, including investment castings.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: Home scrap | 20 | 20 | 20 | 19 | 22 |
| Purchased scrap[2] | 57 | 59 | 56 | 53 | 40 |
| Imports for consumption[3] | 2.9 | 3 | 3 | 4 | 5 |
| Exports[3] | 9.1 | 9 | 6 | 6 | 6 |
| Consumption, reported | 71 | 73 | 73 | 71 | 68 |
| Price, average, dollars per metric ton delivered: | | | | | |
| No. 1 Heavy Melting composite price, Iron Age | | | | | |
| Average: Pittsburgh, Philadelphia, Chicago | 126.02 | 125.80 | 104.07 | 90.98 | 95 |
| Stocks, consumer, yearend | 5.2 | 5.5 | 5.2 | 4.8 | 4.7 |
| Employment, dealers, brokers, processors, number[4] | 37,000 | 37,000 | 37,000 | 37,000 | 37,000 |
| Net import reliance[5] as a percent of apparent consumption | E | E | E | E | E |

**Recycling:** All iron and steel scrap is recycled material that is a vital raw material for the production of new steel and cast iron products. The steel and foundry industries in the United States have been structured to recycle scrap, and, as a result, are highly dependent upon scrap. The steel industry in North America has been recycling steel scrap for over 200 years. The automotive recycling industry alone recycles nearly 13 million vehicles annually through more than 200 car shredders to supply more than 14 million tons of shredded steel scrap to the steel industry for recycling. More than 12,000 vehicle dismantlers throughout North America resell parts. In the United States alone, an estimated 68 million tons of steel was recycled in steel mills and foundries in 2000. 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 31% home scrap (recirculating scrap from current operations), 25% prompt scrap (produced in steel-product manufacturing plants), and 44% obsolete (old) scrap.

**Import Sources (1996-99):** Canada, 65%; United Kingdom, 14%; Netherlands, 4%; Mexico, 3%; and other, 14%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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.

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# IRON AND STEEL SCRAP

**Events, Trends, and Issues:** The domestic scrap market, particularly obsolete scrap, recovered in early 2000. Generally, prices increased as much as 14% for No. 1 Heavy Melting scrap, and then declined slightly as the year progressed. The recovery was attributed to the decline of alleged unfair dumping of foreign steel products to the detriment of the domestic steel industry, the continuing robust domestic economy and its demand for steel products and ferrous scrap, and the recovery of the Asian steel industry. As scrap demand and prices increased during the year, supplies of scrap as well as other raw materials, such as imported pig iron and direct-reduced and hot-briquetted iron, increased to satisfy demand. Eventually, prices began to decline and by September had stabilized, suggesting that supply and demand may have reached balance. The industry expected little, if any, additional price decline during the remainder of the year. A softening of prices was reflected in an overall decline of 25% in purchased scrap production for the year. Foreign demand for scrap increased, especially in Asia, where it reached levels as high as those that preceded the financial crisis of 1998. Competing in the foreign scrap market was difficult because Ukraine and Russia shipped relatively low-priced steel to Asia and because of the strong U.S. dollar.

Ferrous scrap prices were lower, on average, during 2000 than in 1999. 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 $95 per metric ton in 2000. As reported by Iron Age Scrap Price Bulletin, the average price for nickel-bearing stainless steel scrap delivered to purchasers in Pittsburgh was about $761 per metric ton in 2000, which was significantly higher than the 1999 average price of $609 per metric ton. Exports of ferrous scrap increased slightly from 5.5 million tons during 1999 to about 6.2 million tons in 2000. Export scrap value increased from $738 million in 1999 to an estimated $1.07 billion in 2000.

In the United States, the primary source of obsolete steel scrap is the automobile. The recycling rate for automobiles for the 5-year period 1995-99 was about 95%. The recycling rates for appliances and steel cans for the past 5 years overall were about 76% and 58%, respectively. Recycling rates for construction materials for 1999 were about 95% for plates and beams and 45% 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 increase.

**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 2000 as a substitute for iron and steel scrap.

[e]Estimated. E Net exporter.

[1]See also Iron Ore and Iron and Steel.

[2]Receipts - shipments by consumers + exports - imports.

[3]Includes used rails for rerolling and other uses, and ships, boats, and other vessels for scrapping.

[4]Estimated, based on 1992 Census of Wholesale Trade.

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

# IRON AND STEEL SLAG

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** Ferrous slags are valuable coproducts of iron- and steelmaking. In 2000, about 19 million tons of domestic iron and steel slags, valued at about $153 million[1] (f.o.b.), were consumed. Of this, iron or blast furnace slag accounted for about 57% of the tonnage sold, and was worth about $120 million. Steel slags, produced from open hearth,[2] basic oxygen, and electric arc furnaces accounted for the remainder. There were 15 slag-processing companies servicing either iron and steel or just steel facilities at about 100 locations, iron slags at about 30 sites in a dozen States, and steel slags at about 90 sites in about 30 States. The north-central region (Illinois, Indiana, Michigan, Ohio) was the source of about 58% of total sales of domestic slag. The major uses of iron slag were for road bases, 29%; asphaltic aggregates 19%; cement and concrete applications, 18%; and fill, 9%. Steel slags were mainly used for road bases, 30%; asphaltic aggregates, 27%; and fill 13%. About 84% of iron and steel slag shipments was by truck, generally to customers within approximately 80 kilometers of the plant. Rail and waterway transport accounted for about 6% and 5% of shipments, respectively. These included destinations farther afield.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, marketed[3] | 20,500 | 18,900 | 18,400 | 19,000 | 19,000 |
| Imports for consumption | 346 | 663 | 700 | 920 | 1,200 |
| Exports | 3 | 9 | 10 | 12 | 20 |
| Consumption, apparent[4] | 20,800 | 19,600 | 19,000 | 19,900 | 20,200 |
| Price average value, dollars per ton, f.o.b. plant | 6.90 | 7.70 | 8.00 | 8.50 | 8.50 |
| Stocks, yearend | NA | NA | NA | NA | NA |
| Employment, number[e] | 2,500 | 2,500 | 2,700 | 2,750 | 2,750 |
| Net import reliance[5] as a percent of reported consumption | 2 | 3 | 4 | 5 | 6 |

**Recycling:** No longer regarded largely as waste, ferrous slags are viewed as valuable byproducts of iron- and steelmaking, and are among the most voluminous of recycled materials. Apart from the large outside markets for slag in the construction sector, some iron and steel slags are used internally—being recycled 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 (1996-99):** Year-to-year import data for ferrous slags show great variations in both tonnages and unit values; many of the data contain unresolved discrepancies. Slag was imported from 1996 to 1999 mainly from Canada and South Africa; prior sources were mainly Canada and Japan. Data, for 2000 only: Germany, 27%; Brazil, 24%; Canada,18%; Italy, 14%; other, 17%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Granulated slag | 2618.00.0000 | Free. |
| Basic slag | 3103.20.0000 | Free. |
| Ferrous scale | 2619.00.9000 | Free. |
| Slag, dross, scalings, from manufacture of iron and steel | 2619.00.3000 | Free. |

**Depletion Allowance:** Not applicable.

**Government Stockpile:** None.

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# IRON AND STEEL SLAG

**Events, Trends, and Issues:** Sales of iron and steel slags depend, to a large degree, on the price and availability of natural aggregates, which are slag's main competitor in the construction sector. There has been increasing demand for granulated blast furnace slag (as a pozzolan or cement additive) in the United States; such use is common overseas. This material makes up the bulk of slag imports. The long-term availability of iron slag in the United States will probably decline as existing blast furnaces are shut down; no new blast furnaces are under construction or planned. This may lead to an increase in imports to compensate for the domestic decline.

Iron and steel slags have been proposed for regulation under various waste classifications by Federal and State agencies. Citing slag's widespread marketability and chemical inertness, the industry has thus far succeeded at keeping iron and steel slags exempt from such regulation. No new government regulation is pending.

**World Mine Production, Reserves, and Reserve Base:** Not strictly applicable because slag is not a mining product, per se. Production data for the world are unavailable, but it may be estimated that current annual world iron and steel slag output is on the order of 250 to 275 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 fly ash, are pozzolan substitutes in blended cements and concrete. Fly ash represents the bulk of the substitutes, with about 2 million tons of the total 9 million tons used going into cement manufacture, either as raw feed or cement additive.

[e]Estimated. NA Not available.

[1]The reported value of $153 million (obtained from annual survey of processors) represents the quantities sold rather than processed, and excludes the value of any entrained metal that may be recovered during slag processing and returned to the iron and, especially, steel furnaces. Value data for such recovered metal were unavailable.

[2]Sales of open hearth furnace steel slag were from stockpiles; there was no domestic open hearth steel production in 2000.

[3]Data for actual production of marketable slag are unavailable, and the data shown are for sales, largely from stockpiles. Production may be estimated as equivalent to 25% to 30% of crude (pig) iron production and 10% to 15% of crude steel output.

[4]Defined as production + imports - exports.

[5]Defined as imports - exports. Data are unavailable to allow adjustments for changes in stocks.

# KYANITE AND RELATED MINERALS

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** One firm in Virginia with integrated mining and processing operations produced kyanite from hard-rock open pit mines. One 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, 50% to 60% was estimated to have been used in iron and steel making and the remainder in the manufacture of chemicals, glass, nonferrous metals, and other materials.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production: | | | | | |
| Mine | W | W | [e]90 | [e]90 | 90 |
| Synthetic mullite | W | W | [e]39 | [e]39 | 39 |
| Imports for consumption (andalusite) | 11 | 8 | 10 | 6 | 5 |
| Exports[e] | 35 | 35 | 35 | 35 | 35 |
| Shipments from Government stockpile excesses | — | 1 | — | — | — |
| Consumption, apparent | W | W | [e]104 | [e]100 | 99 |
| Price, average, dollars per metric ton: | | | | | |
| U.S. kyanite, raw | 154 | 154 | 157 | 158 | 165 |
| U.S. kyanite, calcined | 262 | 262 | 267 | 268 | 279 |
| Andalusite, Transvaal, South Africa, 57.5% $Al_2O_3$ | 190 | 190 | 190 | 200 | 180 |
| Andalusite, Transvaal, South Africa, 59.5% $Al_2O_3$ | 230 | 230 | 230 | 225 | 210 |
| 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 percent of apparent consumption | E | E | E | E | E |

**Recycling:** Insignificant.

**Import Sources (1996-99):** South Africa, 100%.

| **Tariff:** Item | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Andalusite, kyanite, and sillimanite | 2508.50.0000 | Free. |
| Mullite | 2508.60.0000 | Free. |

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

**Government Stockpile:**

**Stockpile Status—9-30-00[2]**

| **Material** | **Uncommitted inventory** | **Committed inventory** | **Authorized for disposal** | **Disposal plan FY 2000** | **Disposals FY 2000** |
|---|---|---|---|---|---|
| Kyanite, lump | 0.1 | — | 0.1 | — | — |

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# KYANITE AND RELATED MINERALS

**Events, Trends, and Issues:** Refractories are used in the manufacture of many materials, including aluminum and other nonferrous metals, cement, chemicals, glass, iron and steel, petrochemicals, and others. Manufacturing process technology has advanced in most of these industries; refractory suppliers have been developing products that offer superior performance and increased longevity and that require less frequent replacement and maintenance.

The iron and steel industry has been the largest user of refractories. In Japan, for example, some 70% of refractory demand comes from the steel industry. Japan is considered to be the world's leader in refractories technology.[3] According to the International Iron and Steel Institute, most of its 63 member countries, including China, the European Union, Japan, Republic of Korea, North America, Russia, and South America, were projected to show growth in steel consumption in 2000 compared with that of 1999. The Institute estimated that world steel consumption will be 5.8% higher in 2000 than in 1999.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves and reserve base[4] |
|---|---|---|---|
| | 1999 | 2000[e] | |
| United States | [e]90 | 90 | Large in the United States and South Africa; may be large in other countries. |
| France | 65 | 65 | |
| India | 17 | 15 | |
| South Africa | 130 | 150 | |
| Other countries | 11 | 10 | |
| World total | 313 | 330 | |

**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 Mountain area and in Idaho. Other resources are in aluminous gneiss in southern California. These resources are not economical to mine at present, but some may be eventually. 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. W Withheld to avoid disclosing company proprietary data.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix B for definitions.
[3]Pearson, Karine, 2000, The Chinese invasion: Industrial Minerals, no. 389, February, p. 28-29.
[4]See Appendix C for definitions.

# LEAD

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

**Domestic Production and Use:** The value of recoverable mined lead in 2000, based on the average U.S. producer price, was $432 million. Seven lead mines in Missouri plus lead-producing mines in Alaska, Idaho, and Montana yielded most of the total. Primary lead was processed at two smelter-refineries in Missouri and at a smelter in Montana. Of the 27 plants that produced secondary lead, 15 had annual capacities of 15,000 tons or more and accounted for more than 98% of secondary production. Lead was consumed at about 150 manufacturing plants. The transportation industries were the principal users of lead, consuming 76% of it for batteries, fuel tanks, solder, seals, bearings, and wheel weights. Electrical, electronic, communications uses (including batteries), ammunition, television glass, construction (including radiation shielding), and protective coatings accounted for approximately 22% of consumption. The balance was used in ballast and counterweights, ceramics and crystal glass, tubes and containers, type metal, foil, wire, and specialized chemicals.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production: Mine, lead in concentrates | 436 | 459 | 493 | 520 | 480 |
| Primary refinery | 326 | 343 | 337 | 350 | 350 |
| Secondary refinery, old scrap | 1,030 | 1,040 | 1,060 | 1,060 | 1,020 |
| Imports for consumption, lead in concentrates | 7 | 18 | 33 | 12 | 35 |
| Exports, lead in concentrates | 60 | 42 | 72 | 94 | 90 |
| Imports for consumption, refined metal, wrought and unwrought | 278 | 272 | 275 | 323 | 400 |
| Exports, refined metal, wrought and unwrought | 61 | 53 | 40 | 37 | 25 |
| Shipments from Government stockpile excesses, metal | 39 | 26 | 50 | 61 | 54 |
| Consumption: Reported | 1,540 | 1,620 | 1,630 | 1,680 | 1,730 |
| Apparent | 1,630 | 1,610 | 1,690 | 1,760 | 1,790 |
| Price, average, cents per pound: | | | | | |
| North American Producer | 48.8 | 46.5 | 45.3 | 43.7 | 44 |
| London Metal Exchange | 35.1 | 28.3 | 24.0 | 22.8 | 21 |
| Stocks, metal, producers, consumers, yearend | 80 | 101 | 89 | 92 | 100 |
| Employment: Mine and mill (peak), number | 1,200 | 1,200 | 1,200 | 1,100 | 1,100 |
| Primary smelter, refineries | 500 | 450 | 450 | 450 | 450 |
| Secondary smelters, refineries | 1,800 | 1,800 | 1,800 | 1,700 | 1,700 |
| Net import reliance[1] as a percent of apparent consumption | 17 | 14 | 18 | 20 | 24 |

**Recycling:** About 1.1 million tons of secondary lead was produced, an amount equivalent to 66% of domestic lead consumption. Nearly all of it was recovered from old (post-consumer) scrap. About 1 million tons (equivalent to 61% of domestic lead consumption) was recovered from used batteries alone.

**Import Sources (1996-99):** Lead in concentrates: Peru, 32%; Canada, 17%; Australia, 13%; Mexico, 6%; and other, 32%. Metal, wrought and unwrought: Canada, 67%; Mexico, 20%; Peru, 4%; Australia, 2%; and other, 7%. Total lead content: Canada, 65%; Mexico, 19%; Peru, 5%; Australia, 3%; and other, 8%.

| **Tariff: Item** | **Number** | **Normal Trade Relations[2] 12/31/00** |
|---|---|---|
| Unwrought (refined) | 7801.10.0000 | 2.5% ad val. |

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

**Government Stockpile:**

**Stockpile Status—9-30-00[3]**

| **Material** | **Uncommitted inventory** | **Committed inventory** | **Authorized for disposal** | **Disposal plan FY 2000** | **Disposals FY 2000** |
|---|---|---|---|---|---|
| Lead | 205 | 23 | 205 | 54 | 47 |

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# LEAD

**Events, Trends, and Issues:** During 2000, the price for lead decreased in the U.S. and world markets. The average North American Producer and London Metal Exchange (LME) prices for the first 9 months of the year were 0.4% and 10.8%, respectively, below the averages for the previous year. Worldwide demand for lead rose in 2000, mainly owing to further growth in the Asian market, particularly in China and Thailand. Total output of refined lead worldwide increased in 2000 with about 60% being derived from the recovery and recycling of secondary materials. The supply and demand for lead in the industrialized countries of the world were expected to remain in close balance in 2000, according to a report issued by the International Lead and Zinc Study Group at its 45th Session in London, England, in October.

U.S. mine production declined by about 8%, mainly as a result of production decreases implemented by one major producer during the year, and secondary refinery production declined by about 4%. U.S. apparent consumption of lead remained near the level of the previous year, as the lack of temperature extremes in most of the heavily populated regions of the country reduced the rate of automotive-type battery failures and the consequent rate of demand for replacement batteries. However, demand for industrial-type stationary and traction batteries continued to grow.

A major U.S. secondary lead producer and automotive battery manufacturer completed its acquisition of another major U.S. secondary lead producer and battery manufacturer at the end of September. The latter company supplies a significant portion of industrial batteries to the North American market, and is also a leading supplier of automotive batteries for both the original equipment and replacement battery markets. The purchase was completed about 18 months after negotiations were terminated on the purchase of the latter company by another major U.S. secondary lead producer. As a result of the purchase, several initiatives were begun involving closure and consolidation of facilities that would effectively restructure the newly formed company.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[4] | Reserve base[4] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 520 | 480 | 6,700 | 20,000 |
| Australia | 681 | 630 | 15,000 | 28,000 |
| Canada | 161 | 140 | 1,800 | 11,000 |
| China | 501 | 560 | 9,000 | 30,000 |
| Kazakhstan | 34 | 30 | 2,000 | 2,000 |
| Mexico | 120 | 140 | 1,000 | 2,000 |
| Morocco | 87 | 90 | 500 | 1,000 |
| Peru | 273 | 270 | 2,000 | 3,000 |
| South Africa | 80 | 80 | 2,000 | 3,000 |
| Sweden | 115 | 120 | 500 | 1,000 |
| Other countries | 447 | 440 | 23,000 | 33,000 |
| World total (may be rounded) | 3,020 | 2,980 | 64,000 | 130,000 |

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

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

[e]Estimated.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]No tariff for Canada and Mexico for item shown.
[3]See Appendix B for definitions.
[4]See Appendix C for definitions.

# LIME[1]

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

**Domestic Production and Use:** In 2000, quicklime and hydrate producers at 117 plants in 37 States and Puerto Rico sold or used 20.1 million tons (22.2 million short tons) of lime valued at about $1.2 billion, an increase of about 500,000 tons (551,000 short tons) and an increase of about $20 million from 1999 levels. Five companies, operating 39 lime plants and 6 hydrating plants, accounted for about 68% of the total output. Principal producing States, each with production over 1 million tons, were Alabama, Kentucky, Missouri, Ohio, Pennsylvania, and Texas. These six States produced about 11.2 million tons (12.3 million short tons) or 56% of the total output. Major markets for lime were steel, flue gas desulfurization, mining, construction, pulp and paper, precipitated calcium carbonate, and water treatment.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production[3] | 19,200 | 19,700 | 20,100 | 19,600 | 20,100 |
| Imports for consumption | 262 | 274 | 231 | 152 | 221 |
| Exports | 50 | 80 | 56 | 59 | 72 |
| Consumption, apparent[4] | 19,400 | 19,900 | 20,300 | 19,700 | 20,300 |
| Quicklime average value, dollars per ton at plant | 56.68 | 57.80 | 57.60 | 57.20 | 56.60 |
| Hydrate average value, dollars per ton at plant | 79.64 | 80.20 | 78.90 | 79.70 | 76.00 |
| Stocks, yearend | NA | NA | NA | NA | NA |
| Employment, mine and plant, number | 5,600 | 5,600 | 5,600 | 5,600 | 5,600 |
| Net import reliance[5] as a percent of apparent consumption | 1 | 1 | 1 | ([6]) | 1 |

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

**Import Sources (1996-99):** Canada, 89%; Mexico, 10%; and other 1%.

| **Tariff:** **Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| 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:** 14% for limestone produced and used for lime production (Domestic and foreign).

**Government Stockpile:** None.

**Events, Trends, and Issues:** Graymont Ltd., the Canadian parent company of Continental Lime Inc. and others, reorganized and renamed its lime subsidiaries into the following: Graymont Western US Inc., Graymont Western Canada Inc., Graymont Dolime (OH) Inc., Graymont (PA) Inc., Graymont (QC) Inc., and Graymont (NB) Inc. Graymont produces lime in six U.S. States and five Canadian Provinces (Graymont Ltd., 2000, Related companies, accessed July 11, 2000, at URL http://www.graymont.com/related.htm).

Baker Refractories, headquartered in York, PA, and Wülfrath Refractories GmbH, headquartered in Hilden, Germany, signed an agreement to merge. Wülfrath is part of the Lhoist Group, which is a major lime and stone producer in Europe and North America. Baker is the leading producer of refractory dolomite in North America, and produces refractory products from plants in the United States, the United Kingdom, and at a joint-venture operation in Mexico.[7]

Despite a surge in steel imports in 2000 similar to what occurred in 1998, domestic production reached an estimated 106 million tons for the year. This was an increase of about 8% over 1998 production levels. This increase in steel production was expected to help lime sales to the steel market recover from the downturn experienced in 1998. Lime sales for iron and steel manufacturing were expected to reach 6.1 to 6.2 million tons. The high level of imports is still a major issue to domestic steel companies. Production is expected to decrease in 2001, owing to the high levels of imports and the large inventories that have accumulated, which will affect lime sales to the steel industry.

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# LIME

The rise in petroleum and natural gas prices affected lime producers in varying degrees. All were affected to some extent by the increase in diesel prices, which increased operating costs of mining equipment and shipping costs. Producers that operate vertical kilns were also affected by higher kiln fuel prices because most vertical shaft kilns burn fuels such as natural gas. Because of low inventories and rising demand, natural gas wellhead prices increased by 110% between December 1999 and September 2000, and further increases were expected during the peak winter season.

The most common fuel used to produce lime in the United States is coal. Emissions generated in the combustion of coal and other fuels make the lime industry subject to regulation under the Clean Air Act. Of immediate concern to the lime industry are the costs and obligations expected for additional monitoring, reporting, and control of particulate matter and hazardous air pollutants such as hydrogen chloride. Of longer term concern, but with potentially greater impacts, are the international discussions on the reduction of greenhouse gas emissions, particularly carbon dioxide.

**World Lime Production and Limestone Reserves and Reserve Base:**

| | Production | | Reserves and reserve base[8] |
|---|---|---|---|
| | 1999 | 2000[e] | |
| United States | 19,600 | 20,100 | Adequate for all countries listed. |
| Belgium | 1,750 | 1,700 | |
| Brazil | 5,700 | 5,700 | |
| Canada | 2,580 | 2,600 | |
| China | 21,500 | 22,000 | |
| France | 2,400 | 2,400 | |
| Germany | 7,600 | 7,600 | |
| Italy[9] | 3,500 | 3,500 | |
| Japan (quicklime only) | 7,750 | 7,700 | |
| Mexico | 6,600 | 6,600 | |
| Poland | 2,500 | 2,500 | |
| Romania | 1,700 | 1,700 | |
| Russia | 7,000 | 7,000 | |
| South Africa (sales) | 1,500 | 1,500 | |
| United Kingdom | 2,500 | 2,500 | |
| Other countries | 21,700 | 22,000 | |
| World total (rounded) | 116,000 | 117,000 | |

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

**Substitutes:** Limestone is a substitute for lime in many applications, such as agriculture, fluxing, and sulfur removal. Limestone 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 pH control, and magnesium oxide is a substitute for lime 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]See Appendix A for conversion to short tons.
[3]Sold or used by producers.
[4]Stocks data are not available; stock changes are assumed to be zero for apparent consumption and net import reliance calculations.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]Less than ½ unit.
[7]Industrial Minerals, 2000, Refractory dolomite consolidation: Industrial Minerals, no. 397, October, p. 8-9.
[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 largest lithium chemical producer in the world; Argentina, China, Russia, and the United States were large producers also. Australia, Canada, and Zimbabwe were major producers of lithium ore concentrates. The United States remained the leading consumer of lithium minerals and compounds and the leading producer of value-added lithium materials. Because only one company produced lithium compounds from domestic resources, reported production and value of production data cannot be published. Estimation of value for the lithium mineral compounds produced in the United States is extremely difficult because of the large number of compounds used in a wide variety of end uses and the great variability of the prices for the different compounds.

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

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production | W | W | W | W | W |
| Imports for consumption | 884 | 975 | 2,590 | 2,640 | 3,000 |
| Exports | 2,310 | 2,200 | 1,400 | 1,330 | 1,400 |
| Consumption: | | | | | |
| Apparent | W | W | W | W | W |
| Estimated | 2,700 | 2,800 | 2,800 | 2,800 | 2,800 |
| Price, yearend, dollars per kilogram: | | | | | |
| Lithium carbonate | 4.34 | 4.47 | 4.47 | 4.47 | 4.47 |
| Lithium hydroxide, monohydrate | 5.51 | 5.74 | 5.74 | 5.74 | 5.74 |
| Employment, mine and mill, number[e] | 230 | 230 | 100 | 100 | 100 |
| Net import reliance[1] as a percent of apparent consumption | E | E | E | <50% | >50% |

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

**Import Sources (1996-99):** Chile, 78%; Argentina, 18%; and other, 4%.

| **Tariff: Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Other alkali metals | 2805.19.0000 | 5.5% ad val. |
| Lithium oxide and hydroxide | 2825.20.0000 | 3.7% ad val. |
| Lithium carbonate: | | |
| U.S.P. grade | 2836.91.0010 | 3.7% ad val. |
| Other | 2836.91.0050 | 3.7% ad val. |

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

**Government Stockpile:** None.

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# LITHIUM

**Events, Trends, and Issues:** The only active lithium carbonate plant remaining in the United States was at a brine operation in Nevada. Subsurface brines have become the dominant raw material for lithium carbonate production worldwide because of lower production costs as compared to the costs for hard rock ores. Two brine operations in Chile dominate the world market; a facility at a brine deposit in Argentina produced lithium chloride and resumed limited lithium carbonate production after suspending operations in 1999. Most of the lithium minerals mined in the world were consumed as ore concentrates rather than feedstock for lithium carbonate and other lithium compounds.

Two companies produced a large array of downstream lithium compounds in the United States from domestic or South American lithium carbonate; and a U.S. recycling company produced a small quantity of lithium carbonate from solutions recovered during the recycling of lithium batteries. In new developments, a pilot-scale operation in Quebec increased its lithium carbonate production from ore and considered adding lithium chloride capacity, and a Chinese joint venture was developing a lithium-rich salt lake in Tibet.

When a Chilean fertilizer producer entered the lithium carbonate market in 1997, it cut prices by about 50% to establish market share and to increase total demand, especially in new uses. Higher cost facilities closed, but markets have stayed steady. Prices increased by about 10% at the end of 1999 and again in 2000, although U.S. list prices have not reflected any changes since 1997.

Interest in lithium batteries for electric vehicles (EV's) continued; large-scale acceptance, however, of battery-powered EV's was not expanding significantly. Other rechargeable lithium batteries were growing in popularity for powering portable computers and telephones, video cameras, and cordless tools. Nonrechargeable lithium batteries were used in calculators, cameras, computers, electronic games, and watches.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[2] | Reserve base[2] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | W | W | 38,000 | 410,000 |
| Argentina[e] | 200 | 200 | NA | NA |
| Australia[e] | 2,200 | 2,000 | 150,000 | 160,000 |
| Bolivia | — | — | — | 5,400,000 |
| Brazil | 32 | 30 | 910 | NA |
| Canada | 710 | 710 | 180,000 | 360,000 |
| Chile | 5,300 | 5,500 | 3,000,000 | 3,000,000 |
| China | 2,300 | 2,000 | NA | NA |
| Portugal | 140 | 140 | NA | NA |
| Russia[e] | 2,000 | 1,800 | NA | NA |
| Zimbabwe | 700 | 700 | 23,000 | 27,000 |
| World total (may be rounded) | [3]14,000 | [3]13,000 | [4]3,400,000 | [5]9,400,000 |

**World Resources:** The identified lithium resources total 760,000 tons in the United States and more than 12 million tons in other countries.

**Substitutes:** Substitutes for lithium compounds are possible in manufactured glass, ceramics, greases, and batteries. Examples are sodic and potassic fluxes in ceramics and glass manufacture; calcium and aluminum soaps as substitutes for stearates in greases; and zinc, magnesium, calcium, and mercury 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 glass, polymer, or boron fibers in engineering resins.

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix C for definitions.
[3]Excludes U.S. production.
[4]Excludes Argentina, China, Namibia, Portugal, and Russia.
[5]Excludes Argentina, Brazil, China, Namibia, Portugal, and Russia.

# 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 63% of U.S. magnesium compounds production. Magnesium oxide and other compounds were recovered from seawater by four companies in California, Delaware, and Florida; from well brines by three companies in Michigan; and from lake brines by two companies in Utah. Magnesite was mined by one company in Nevada, brucite was mined by one company in Texas, and olivine was mined by two companies in North Carolina and Washington. About 65% of the magnesium compounds consumed in the United States was used for refractories. The remaining 35% was consumed in agricultural, chemical, construction, environmental, and industrial applications.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production | 389 | 402 | 374 | 395 | 400 |
| Imports for consumption | 240 | 259 | 344 | 321 | 380 |
| Exports | 66 | 56 | 49 | 52 | 50 |
| Consumption, apparent | 563 | 605 | 669 | 664 | 730 |
| Stocks, producer, yearend | NA | NA | NA | NA | NA |
| Employment, plant, number[e] | 600 | 600 | 600 | 550 | 550 |
| Net import reliance[2] as a percent of apparent consumption | 31 | 34 | 44 | 41 | 45 |

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

**Import Sources (1996-99):** China, 64%; Canada, 9%; Australia, 7%; Austria, 4%; and other, 16%.

| **Tariff:**[3] **Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| 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.

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# MAGNESIUM COMPOUNDS

**Events, Trends, and Issues:** China continued to be the principal source for U.S. caustic-calcined and dead-burned magnesia imports. Despite the export licensing requirements imposed by the Chinese Government, magnesia exports from China to the United States continued to rise. For 2000, the Chinese export quota for magnesite was 1.6 million tons and the license fee was about $43 per ton. Because of falling magnesite prices, many of the Chinese producers gathered to form two separate export syndicates. The producers expect to be able to control prices and export volumes more easily through these syndicates.

The U.S. magnesite producer increased its annual caustic-calcined magnesia capacity by 20,000 tons to 140,000 tons in August. The capacity increase was in response to growing demand in the wastewater treatment market. The State of Utah was investigating a proposal to modify the salinity levels in the Great Salt Lake. A railroad causeway in the lake has been acting as a dam and creating essentially two separate bodies of water with different salinity levels. The proposal to deepen a breach in the causeway, allowing for greater water flow between the two bodies, thereby equalizing the salinity levels could adversely affect companies that recover magnesium chloride from the higher salinity portion of the Great Salt Lake.

**World Mine Production, Reserves, and Reserve Base:**

| | Magnesite production | | Magnesite reserves and reserve base[4] | |
|---|---|---|---|---|
| | 1999 | 2000[e] | Reserves | Reserve base |
| United States | W | W | 10,000 | 15,000 |
| Australia | 56 | 60 | NA | NA |
| Austria | 187 | 190 | 15,000 | 20,000 |
| Brazil | 89 | 90 | 45,000 | 65,000 |
| China[e] | 706 | 700 | 750,000 | 1,000,000 |
| Greece | 187 | 190 | 30,000 | 30,000 |
| India | 104 | 100 | 30,000 | 45,000 |
| Korea, North[e] | 288 | 300 | 450,000 | 750,000 |
| Russia[e] | 259 | 250 | 650,000 | 730,000 |
| Slovakia[e] | 245 | 250 | 20,000 | 30,000 |
| Spain | 144 | 150 | 10,000 | 30,000 |
| Turkey | 721 | 700 | 65,000 | 160,000 |
| Other countries | 102 | 100 | 430,000 | 490,000 |
| World total (may be rounded) | [5]3,090 | [5]3,100 | 2,500,000 | 3,400,000 |

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

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

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

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

# MAGNESIUM METAL[1]

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** Two companies in Utah and Washington produced primary magnesium in 2000. An electrolytic process was used at the plant in Utah to recover magnesium from lake brines, and a thermic process was used to recover magnesium from dolomite in Washington. Structural uses of magnesium (castings and wrought products) were the largest end use for magnesium, accounting for 45% of domestic primary metal use. Magnesium was a constituent of aluminum-base alloys that were used for packaging, transportation, and other applications, which accounted for 44% of total domestic consumption. Desulfurization of iron and steel accounted for 7% of U.S. consumption of primary metal; reducing agent in nonferrous metals production, 1%; and other uses, 3%.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| U.S. primary production capacity, yearend | 145 | 145 | 145 | 80 | 83 |
| Production: Primary | 133 | 125 | 106 | W | W |
| Secondary (new and old scrap) | 71 | 78 | 76 | 87 | 90 |
| Imports for consumption | 47 | 65 | 83 | 91 | 90 |
| Exports | 41 | 41 | 35 | 29 | 20 |
| Consumption: Reported, primary | 102 | 100 | 103 | 131 | 130 |
| Apparent | 162 | 185 | 185 | 179 | 175 |
| Price, yearend: | | | | | |
| Metals Week, U.S. spot Western, dollars per pound, average | 1.75 | 1.65 | 1.57 | 1.48 | 1.35 |
| Metal Bulletin, free market, dollars per metric ton, average | 2,525 | 2,525 | 1,975 | 2,500 | 1,950 |
| Stocks, producer and consumer, yearend | 26 | 21 | 22 | W | W |
| Employment, number[e] | 1,400 | 1,400 | 800 | 800 | 800 |
| Net import reliance[2] as a percent of apparent consumption | E | 16 | 25 | 38 | 40 |

**Recycling:** In 2000, about 34,000 tons of the secondary production was recovered from old scrap.

**Import Sources (1996-99):** Canada, 47%; Russia, 21%; China, 15%; Israel, 8%; and other, 9%.

| **Tariff:** Item | Number | Normal Trade Relations[3] 12/31/00 |
|---|---|---|
| Unwrought metal | 8104.11.0000 | 8.0% ad val. |
| Unwrought alloys | 8104.19.0000 | 6.5% ad val. |
| Wrought metal | 8104.90.0000 | 14.8¢/kg on Mg content + 3.5% ad val. |

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

**Government Stockpile:** None.

**Events, Trends, and Issues:** At the request of one of the U.S. producers, the U.S. International Trade Commission (ITC) began an investigation regarding antidumping and countervailing duties on pure magnesium from China, Israel, and Russia. The following duties were finalized during 2000: countervailing for pure and alloy magnesium from Canada, 1.38% ad valorem for calendar year 1998, and the antidumping duty for pure magnesium from Canada for August 1, 1998, to July 31, 1999, at 0% ad valorem. The International Trade Administration also determined that because the largest Canadian producer had not sold commercial quantities of magnesium into the United States in a 3-consecutive-year period, it did not qualify for revocation of the antidumping duty. The ITC revoked the antidumping duty order established in 1995 on magnesium imported from Russia. After an investigation that began in June 1999, the European Commission recommended an antidumping duty on imports of magnesium from China of 63.4%; a significant increase from the 31.7% that is currently in effect.

A new plant in Quebec, Canada, that will produce magnesium from asbestos tailings is scheduled to begin commercial production in the first quarter of 2001. The Israeli magnesium producer is in the process of increasing production at its Sdom facility to 30,000 tons of magnesium metal and 24,000 tons of magnesium alloys in 2000, and the company is proceeding with the construction of its direct-chill caster for producing magnesium T-bar ingot. The 5,000-ton-per-year primary magnesium plant in Serbia, which had been shut down because of bombing in the area by North Atlantic Treaty Organization forces reportedly restarted production at the end of 1999. Although small quantities of magnesium were produced in 2000, it is uncertain whether commercial quantities of magnesium will be produced again. In China,

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# MAGNESIUM METAL

several magnesium producers in the Shanxi Province have temporarily closed because of pollution problems; other Chinese magnesium producers, however, continued to expand production at some plants.

A preliminary feasibility study on the proposed magnesium plant in the Netherlands was completed. The study was for a combined 15,000-ton-per-year magnesium smelter, a diecasting plant, and a recycling plant. With the projected sale of excess chlorine generated at the plant, the operating cost for the plant is estimated to be about 60 cents per pound of magnesium. A decision on plant construction is expected by the end of 2001.

In March, a feasibility study on the construction of a new magnesium plant in Stanwell, Queensland, Australia, which estimates that the capital cost for a 96,000-ton-per-year plant would be $759 million and that the operating cost would be between 58.1 and 63.8 cents per pound, was completed. A separate firm that plans to construct a magnesium plant in Australia began trial mining of its magnesite deposit in South Australia and selected Port Pirie as the site for its proposed 52,500-ton-per-year magnesium plant. Initial investment in the plant is expected to begin in 2001 with commercial production scheduled for 2004. A Canadian firm expects to complete a feasibility study on its planned 90,000-ton-per-year magnesium project by the end of 2000.

For the new 2001 models, North American auto manufacturers are expecting to average between 3.9 and 4.1 kilograms (8.5 and 9 pounds) of magnesium components per vehicle, a 12.5% increase from the 2000 average. Most of the increase will result from the use of existing part applications in new models. The principal magnesium components are instrument panel support beams, engine cam covers, four-wheel-drive transfer cases, steering column and pedal bracket supports, and steering wheel armatures.

The U.S. Environmental Protection Agency (EPA) is planning to collect information on sulfur hexafluoride ($SF_6$) emissions from companies that produce or cast magnesium. The data collection is part of the EPA's $SF_6$ Emission Reduction Partnership for the Magnesium Industry, which is one of the agency's voluntary programs that contributes to the overall reduction of greenhouse gas emissions. $SF_6$ has a global warming potential of 23,900 times that of carbon dioxide, and although the principal source of $SF_6$ emissions is leaks in older electrical power transmission systems, $SF_6$ is also used as a cover gas when melting magnesium.

**World Primary Production, Reserves, and Reserve Base:**

| | Primary production | |
|---|---|---|
| | 1999 | 2000[e] |
| United States | W | W |
| Brazil | 9 | 9 |
| Canada[5] | 71 | 75 |
| China | [e]83 | 80 |
| France | 14 | 14 |
| Israel | 25 | 25 |
| Kazakhstan | [e]10 | 10 |
| Norway | 28 | 30 |
| Russia | [e]35 | 40 |
| Serbia and Montenegro | 1 | 1 |
| Ukraine | [e]1 | — |
| World total[6] | 277 | 284 |

**Reserves and reserve base[4]**

Domestic magnesium metal production is derived from natural brines and dolomite, and 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 where salinity is high.

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

[e]Estimated. E Net exporter. W Withheld to avoid disclosing company proprietary data.
[1]See also Magnesium Compounds.
[2]Defined as imports - exports + adjustments for Government and industry stock changes. Because of proprietary data constraints, stock changes are not included.
[3]No tariff for Canada and Israel for items shown.
[4]See Appendix C for definitions.
[5]Includes secondary.
[6]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 2000. Manganese ore was consumed mainly by about 15 firms with plants principally in the Eastern United States and the Midwestern United States. The majority of ore consumption was related to steel production, directly in pig iron manufacture and indirectly through upgrading ore to ferroalloys and metal. Additional quantities of ore were used for such nonmetallurgical purposes as production of dry cell batteries, as an ingredient in plant fertilizers and animal feed, and as a colorant for brick. Manganese ferroalloys were produced at one smelter. Leading identifiable end uses of manganese were in products for construction, machinery, and transportation, which were estimated to be 26%, 13%, and 12%, respectively, of total manganese demand. Most of the rest went to a variety of other iron and steel applications. Value of domestic consumption was estimated from foreign trade data to be about $460 million.

| Salient Statistics—United States:[1] | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, mine[2] | — | — | — | — | — |
| Imports for consumption: | | | | | |
| Manganese ore | 478 | 355 | 332 | 460 | 445 |
| Ferromanganese | 374 | 304 | 339 | 312 | 330 |
| Silicomanganese[3] | 323 | 306 | 346 | 301 | 390 |
| Exports: | | | | | |
| Manganese ore | 32 | 84 | 8 | 4 | 8 |
| Ferromanganese | 10 | 12 | 14 | 12 | 9 |
| Shipments from Government stockpile excesses:[4] | | | | | |
| Manganese ore | 128 | 115 | 97 | 76 | 61 |
| Ferromanganese | (2) | 31 | 37 | 35 | 28 |
| Consumption, reported:[5] | | | | | |
| Manganese ore[6] | 478 | 510 | 499 | 479 | 500 |
| Ferromanganese | 326 | 337 | 290 | 281 | 310 |
| Consumption, apparent, manganese[7] | 776 | 643 | 776 | 719 | 795 |
| Price, average value, 46% to 48% Mn metallurgical ore, dollars per mtu cont. Mn, c.i.f. U.S. ports | 2.55 | 2.44 | 2.40 | 2.26 | 2.39 |
| Stocks, producer and consumer, yearend: | | | | | |
| Manganese ore[6] | 319 | 241 | 163 | 172 | 240 |
| Ferromanganese | 27 | 21 | 26 | 40 | 45 |
| Net import reliance[8] as a percent 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 (1996-99):** Manganese ore: Gabon, 59%; Australia, 13%; Mexico, 11%; South Africa, 10%; and other, 7%. Ferromanganese: South Africa, 40%; France, 26%; Mexico, 8%; Australia, 7%; and other, 19%. Manganese contained in all manganese imports: South Africa, 29%; Gabon, 17%; Australia, 14%; France, 11%; and other, 29%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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 | 8111.00.4500 | 14% ad val. |

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

**Government Stockpile:** In addition to the data tabulated, the stockpile contained additional uncommitted inventories of nonstockpile-grade ore, all of which was authorized for disposal, as follows, in tons: natural battery, 16,800, and metallurgical, 331,000.

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# MANGANESE

### Stockpile Status—9-30-00[9]

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Battery: | | | | | |
| Natural ore | 90 | 1 | 90 | 27 | 6 |
| Synthetic dioxide | 3 | — | 3 | 3 | — |
| Chemical ore | 137 | 4 | 137 | 36 | 7 |
| Metallurgical ore | 547 | 111 | 547 | 227 | 40 |
| Ferromanganese: | | | | | |
| High-carbon | 817 | 43 | 627 | 45 | 45 |
| Electrolytic metal | 6 | 0.1 | 6 | 2 | 0.1 |

**Events, Trends, and Issues:** A projected global increase in ore production was being led by increases in output in South Africa and Ukraine. The price of ore increased for the first time in 4 years, and increases in year-average prices were likely for ferroalloys. In the United States, prices for ferroalloys rose or were steady until August but then weakened. Citing low prices, one of the two domestic producers of manganese metal announced that its production would be suspended by yearend. Manganese is an essential element for people, animals, and plants, but it can be harmful in excessive amounts. Thus, manganese can be an industrial poison, but generally is not a hazard.

**World Mine Production, Reserves, and Reserve Base (metal content):**[10]

| | Mine production 1999 | Mine production 2000[e] | Reserves[11] | Reserve base[11] |
|---|---|---|---|---|
| United States | — | — | — | — |
| Australia | 926 | 875 | 26,000 | 72,000 |
| Brazil | [e]641 | 660 | 18,000 | 51,000 |
| China | [e]1,100 | 1,100 | 40,000 | 100,000 |
| Gabon | [e]966 | 1,000 | 20,000 | 160,000 |
| India | [e]570 | 580 | 34,000 | 50,000 |
| Mexico | 169 | 180 | 4,000 | 9,000 |
| South Africa | [e]1,340 | 1,500 | 370,000 | 4,000,000 |
| Ukraine | [e]675 | 900 | 135,000 | 520,000 |
| Other countries | [e]607 | 655 | Small | Small |
| World total (rounded) | [e]6,990 | 7,450 | 660,000 | 5,000,000 |

**World Resources:** Land-based resources are large but irregularly distributed; those of the United States are very low grade and have potentially high extraction costs. South Africa and the former Soviet Union (FSU) account for more than 80% of the world's identified resources; South Africa accounts for more than 80% of the total exclusive of China and the FSU. Some of the data for reserves and reserve base have been revised from those previously published.

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

[e]Estimated.
[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. Data in parentheses denote increases in inventory.
[5]Total manganese consumption cannot be approximated from consumption of manganese ore and ferromanganese because of the use of ore in making manganese ferroalloys and metal.
[6]Exclusive of that at iron and steel plants.
[7]Thousand tons, manganese content; based on estimates of average content for all significant components except imports, for which content is reported.
[8]Defined as imports - exports + adjustments for Government and industry stock changes.
[9]See Appendix B for definitions.
[10]Thousand tons, manganese content.
[11]See Appendix C for definitions.

# MERCURY

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

**Domestic Production and Use:** Recovery of mercury from obsolete or wornout items remains the primary source of domestic mercury production. Several companies in the eastern and central United States recovered mercury from a variety of secondary sources, such as batteries, chlor-alkali wastewater sludges, dental amalgams, electrical apparatus, fluorescent light tubes, and measuring instruments. Domestic mine production of mercury was limited to a very small quantity of byproduct production from fewer than 10 gold mines in California, Nevada, and Utah. The value of mercury used in the United States was estimated at approximately $1 million. It was estimated that approximately 35% of the mercury consumed domestically was used in the manufacture of chlorine and caustic soda and 30% for electrical and electronic applications. The remaining 35% was used for applications such as measuring and control instruments and dental amalgams.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: Mine | W | W | NA | NA | NA |
| Secondary, industrial | 446 | 389 | NA | NA | NA |
| Imports for consumption (gross weight) | 340 | 164 | 128 | 62 | 100 |
| Exports (gross weight) | 45 | 134 | 63 | 181 | 200 |
| Consumption, reported | 372 | 346 | NA | NA | NA |
| Price, average value, dollars per flask, free market | NA | 159.52 | 139.84 | 140.00 | 150.00 |
| Stocks, industry, yearend[2] | 446 | 203 | NA | NA | NA |
| Net import reliance[3] as a percent of apparent consumption | NA | NA | NA | NA | NA |

**Recycling:** Recycling of old scrap represented essentially all of the domestic mercury production in 2000.

**Import Sources (1996-99):** Canada, 22%; United Kingdom, 17%; Spain, 13%; Kyrgyzstan, 12%; and other, 36%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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.

**Stockpile Status—9-30-00**[4]

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Mercury | 4,435 | — | 4,435 | 690 | — |

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# MERCURY

**Events, Trends, and Issues:** Federal, State, and local jurisdictions are concerned about mercury emissions and/or the final disposition of mercury-bearing products. As a result, stringent environmental regulations are likely to continue as the major determinants of domestic mercury supply and demand. The major component of supply will remain the secondary industry, owing to the recycling of many worn out or obsolete products and various wastes to avoid deposition in landfills. Domestic primary production is expected to remain limited to byproduct production where the mercury is recovered to avoid emissions to the environment. Domestic mercury consumption will continue to decline as mercury is gradually eliminated in many products or as substitute products are developed.

Sales from the National Defense Stockpile remain suspended pending completion of an analysis of the potential environmental impact of the sales.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[5] | Reserve base[5] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | NA | NA | — | 7,000 |
| Algeria | 200 | 200 | 2,000 | 3,000 |
| Italy | — | — | — | 69,000 |
| Kyrgyzstan | 620 | 600 | 7,500 | 13,000 |
| Spain | 600 | 600 | 76,000 | 90,000 |
| Other countries | 380 | 400 | 38,000 | 61,000 |
| World total (may be rounded) | 1,800 | 1,800 | 120,000 | 240,000 |

**World Resources:** World mercury resources are estimated at nearly 600,000 tons, principally in Kyrgyzstan, Russia, Slovenia, Spain, and Ukraine. These are sufficient for another century or more, especially with declining consumption rates.

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

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]One metric ton (1,000 kilograms) = 29.0082 flasks.
[2]Consumer stocks only.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]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 110,000 metric tons in 2000. North Carolina accounted for about 50% of U.S. production. The remaining output came from Arizona, 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, paint, roofing, oil well drilling additives, and rubber products. The value of 2000 scrap mica production was estimated at $17 million. Ground mica sales in 1999 were valued at $36.7 million. There were 10 domestic producers of scrap and flake mica.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production:[2 3] Mine | 97 | 114 | 87 | 104 | 110 |
| Ground | 103 | 110 | 104 | 111 | 105 |
| Imports, mica powder and mica waste | 18 | 23 | 23 | 26 | 29 |
| Exports, mica powder and mica waste | 8 | 8 | 8 | 11 | 10 |
| Consumption, apparent[4] | 107 | 122 | 137 | 125 | 133 |
| Price, average, dollars per ton, reported: | | | | | |
| Scrap and flake | 81 | 83 | 87 | 95 | 100 |
| Ground: | | | | | |
| Wet | 1,032 | 1,080 | 909 | 849 | 1,000 |
| Dry | 182 | 176 | 179 | 192 | 200 |
| Stocks, producer, yearend[e] | 7 | NA | NA | NA | NA |
| Employment, mine, number[5] | NA | 347 | 367 | NA | NA |
| Net import reliance[6] as a percent of apparent consumption | 4 | 9 | 24 | 17 | 17 |

**Recycling:** None.

**Import Sources (1996-99):** Canada, 68%; India, 22%; Finland, 4%; Japan, 2%; and other, 4%.

| **Tariff:** Item | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Mica powder | 2525.20.0000 | Free. |
| Mica waste | 2525.30.0000 | Free. |

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

**Government Stockpile:** None.

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# MICA (NATURAL), SCRAP AND FLAKE

**Events, Trends, and Issues:** Domestic production of ground mica increased in 2000. The increase primarily resulted from increased production in Georgia and at a new operation in Arizona. Mining operators at a mine near Black Canyon, AZ, completed the initial test phase of production and development. At midyear, pilot-plant production of a wet-ground muscovite sample product for the cosmetic and paint industries was initiated. A new mica mine is under development at Bear Creek, NC. 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] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States[2] | 104 | 110 | Large | Large |
| Brazil | 2 | 2 | Large | Large |
| Canada | 17 | 17 | Large | Large |
| India | 2 | 2 | Large | Large |
| Korea, Republic of | 39 | 39 | Large | Large |
| Russia | 100 | 100 | Large | Large |
| Other countries | 40 | 30 | Large | Large |
| World total | 304 | 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, estimated at less than 500 kilograms, was produced in 2000, 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 2000, an estimated 4,300 tons of unworked mica split block and mica splittings valued at $3.2 million was consumed by 14 companies in 7 States, mainly in the East and Midwest. Most was fabricated into parts for electronic and electrical equipment. An additional estimated 1,200 tons of imported worked mica valued at $11.9 million was also consumed.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, mine[e] | ([2]) | ([2]) | ([2]) | ([2]) | ([2]) |
| Imports, plates, sheets, and strips; worked mica; split block; splittings; other > $1.00/kg | 6,330 | 5,760 | 4,380 | 4,550 | 5,470 |
| Exports, plates, sheets, and strips; worked mica; crude and rifted into sheet or splittings > $1.00/kg | 831 | 1,060 | 1,280 | 1,290 | 430 |
| Shipments from Government stockpile excesses | 1,110 | 326 | 557 | 708 | 1,500 |
| Consumption, apparent | 6,540 | 5,030 | 3,660 | 3,980 | 6,540 |
| Price, average value, dollars per kilogram, muscovite and phlogopite mica, reported: | | | | | |
| Block | 55 | 28 | 26 | 20 | 23 |
| Splittings | 1.75 | 1.69 | 1.67 | 1.67 | 1.70 |
| Stocks, fabricator and trader, yearend | NA | NA | NA | NA | NA |
| Net import reliance[3] as a percent of apparent consumption | 100 | 100 | 100 | 100 | 100 |

**Recycling:** None.

**Import Sources (1996-99):** India, 62%; Belgium, 13%; Germany, 10%; China, 5%; and other, 10%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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—9-30-00[4]

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Block: | | | | | |
| Muscovite (stained and beffer) | 51 | 207 | 51 | ([5]) | 250 |
| Phlogopite | 2 | 32 | 2 | — | 37 |
| Film, muscovite | ([2]) | ([2]) | ([2]) | ([5]) | — |
| Splittings: | | | | | |
| Muscovite | 4,168 | 1,028 | 4,168 | ([5]) | 1,065 |
| Phlogopite | 233 | 2 | 233 | ([5]) | 2 |

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# MICA (NATURAL), SHEET

**Events, Trends, and Issues:** Demand for sheet mica increased in 2000. Imports of splittings from India increased as demand for electrical equipment increased, especially transformers. Imports remained the principal source of sheet mica, and shipments from U.S. Government stockpile excesses continued to be a significant source of supply. The availability of good quality mica remained in short supply. There were no environmental problems associated with the manufacture of mica products.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production[e] | | Reserves[6] | Reserve base[6] |
|---|---|---|---|---|
| | 1999 | 2000 | | |
| United States | ([2]) | ([2]) | Very small | Small |
| India | 3,500 | 3,500 | Very large | Very large |
| Russia | 1,500 | 1,500 | Moderate | Large |
| Other countries | 200 | 200 | Moderate | Large |
| World total | 5,200 | 5,200 | Large | Large |

**World Resources:** There has been no formal evaluation of world resources of sheet mica because of the sporadic occurrence of this material. Large deposits of mica-bearing rock are known to exist in countries such as Brazil, India, and Madagascar. Limited resources of sheet mica are available in the United States. These domestic resources are uneconomic because of the high cost of hand labor required to mine and process the sheet mica.

**Substitutes:** Many materials can be substituted for mica in numerous electrical and electronic 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.
[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, except phlogopite block, is undifferentiated at 1,025 metric tons (2,260,000 pounds).
[6]See Appendix C for definitions.

# MOLYBDENUM

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

**Domestic Production and Use:** In 2000, molybdenum, valued at about $74 million (based on average oxide price), was produced by six mines. Molybdenum ore was produced at a mine in Idaho, whereas five mines in Arizona, Montana, New Mexico, and Utah recovered molybdenum as a byproduct. Three plants converted molybdenite ($MoS_2$) concentrate to molybdic oxide, from which intermediate products, such as ferromolybdenum, metal powder, and various chemicals, were produced. Iron and steel producers accounted for about 75% of the molybdenum consumed. Major end-use applications were as follows: machinery, 35%; electrical, 15%; transportation, 15%; chemicals, 10%; oil and gas industry, 10%; and others, 15%.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, mine | 54,900 | 60,900 | 53,300 | 43,000 | 32,100 |
| Imports for consumption | 13,400 | 13,200 | 14,400 | 13,800 | 13,600 |
| Exports, all primary forms | 49,600 | 62,100 | 41,700 | 27,900 | 27,400 |
| Consumption: Reported | 20,900 | 20,000 | 18,800 | 17,700 | 15,000 |
| Apparent | 21,200 | 23,000 | 24,500 | 33,100 | 21,500 |
| Price, average value, dollars per kilogram[1] | 8.30 | 9.46 | 5.90 | 5.90 | 5.90 |
| Stocks, mine and plant concentrates, product, and consumer materials | 9,900 | 11,400 | 16,200 | 12,000 | 8,700 |
| Employment, mine and plant, number | 800 | 700 | 600 | 475 | 300 |
| Net import reliance[2] as a percent of apparent consumption | E | E | E | E | E |

**Recycling:** Secondary molybdenum in the form of molybdenum metal or superalloys was recovered, but the amount was small. About 1,000 tons of molybdenum was reclaimed from spent catalysts. While molybdenum is not recovered from scrap steel, recycling of steel alloys is significant, and molybdenum content is reused. Data on the quantities of molybdenum recycled in this manner are not available.

**Import Sources (1996-99):** United Kingdom, 28%; China, 26%; Chile, 23%; Canada, 14%; and other, 9%.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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 | 8102.91.1000 | 13.9¢/kg + 1.9% ad val. |
| Waste and scrap | 8102.91.5000 | Free. |
| Wrought | 8102.92.3000 | 6.6% ad val. |
| Wire | 8102.93.0000 | 4.4% ad val. |
| Other | 8102.99.0000 | 3.7% ad val. |

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

**Government Stockpile:** None.

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# MOLYBDENUM

**Events, Trends, and Issues:** U.S. mine output of molybdenum in 2000 decreased 26% from that of 1999, to the lowest level since 1983. U.S. imports for consumption and exports were about the same as those of 1999. U.S. reported consumption and inventories were about 15% and 28%, respectively, below those of 1999.

Prices of concentrates and molybdenum products moderated toward the end of the year. The domestic price for technical-grade molybdic oxide averaged $5.90 per kilogram of contained molybdenum during 2000; prices averaged the same as in 1999. Mine capacity utilization was 45%. Two mines, in Arizona and New Mexico, that had produced molybdenum in the past, recovered no molybdenum in 2000.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[3] | Reserve base[3] |
|---|---|---|---|---|
| | 1999 | 2000[e] | (thousand metric tons) | |
| United States | 43,000 | 32,100 | 2,700 | 5,400 |
| Armenia | 2,500 | 2,500 | 20 | 30 |
| Canada | 5,930 | 6,000 | 450 | 910 |
| Chile | 27,300 | 27,000 | 1,100 | 2,500 |
| China | 27,900 | 28,000 | 500 | 1,000 |
| Iran | 600 | 600 | 50 | 140 |
| Kazakhstan | 110 | 100 | 130 | 200 |
| Mexico | 6,000 | 6,000 | 90 | 230 |
| Mongolia | 1,750 | 1,800 | 30 | 50 |
| Peru | 4,400 | 4,500 | 140 | 230 |
| Russia | 2,400 | 2,500 | 240 | 360 |
| Uzbekistan | 500 | 500 | 60 | 150 |
| Other countries | — | — | — | 590 |
| World total (rounded) | 122,000 | 112,000 | 5,500 | 12,000 |

**World Resources:** Identified resources amount to about 5.5 million metric tons of molybdenum in the United States and more than 12 million metric tons in the world. Molybdenum occurs as the principal metal sulfide in large low-grade porphyry molybdenum deposits and as a subsidiary metal sulfide in low-grade porphyry copper deposits. Resources of molybdenum are adequate to supply world needs for the foreseeable future.

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

[e]Estimated. E Net exporter.
[1]Major producer price per kilogram of molybdenum contained in technical-grade molybdic oxide.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions.

# NICKEL

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

**Domestic Production and Use:** The only nickel smelter in the United States—a ferronickel operation near Riddle, OR—closed in April 1998 because of low nickel prices. The adjoining mine on Nickel Mountain has been idle since 1996. Limited amounts of byproduct nickel are recovered from copper and palladium-platinum ores mined in the western United States. On a monthly or annual basis, 154 facilities reported nickel consumption. The principal consuming State was Pennsylvania, followed by West Virginia, Illinois, and Ohio. Approximately 43% of the primary nickel consumed went into stainless and alloy steel production, 34% into nonferrous alloys and superalloys, 13% into electroplating, and 10% into other uses. Ultimate end uses were as follows: transportation, 29%; chemical industry, 13%; electrical equipment, 11%; construction, 8%; fabricated metal products, 7%; petroleum, 7%; household appliances, 6%; machinery, 6%; and other, 13%. Estimated value of apparent primary consumption was $1.0 billion.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: Mine | 1,330 | — | — | — | — |
| Plant | 15,100 | 16,000 | 4,290 | — | — |
| Shipments of purchased scrap:[1] | 84,900 | 97,600 | 89,700 | 93,000 | 124,000 |
| Imports: Ore | 15,000 | 17,600 | 1,420 | — | — |
| Primary | 142,000 | 147,000 | 148,000 | 139,000 | 166,000 |
| Secondary | 8,060 | 11,000 | 8,500 | 9,480 | 12,600 |
| Exports: Primary | 13,100 | 16,400 | 8,440 | 7,430 | 7,920 |
| Secondary | 33,600 | 40,200 | 35,100 | 31,400 | 48,200 |
| Consumption: Reported, primary | 118,000 | 120,000 | 114,000 | 115,000 | 119,000 |
| Reported, secondary | 59,300 | 68,400 | 63,100 | 71,000 | 88,100 |
| Apparent, primary | 146,000 | 154,000 | 149,000 | 140,000 | 158,000 |
| Price, average annual, London Metal Exchange: | | | | | |
| Cash, dollars per metric ton | 7,501 | 6,927 | 4,630 | 6,011 | 8,613 |
| Cash, dollars per pound | 3.402 | 3.142 | 2.100 | 2.727 | 3.907 |
| Stocks: Government, yearend | 15,900 | 8,530 | 2,600 | — | — |
| Consumer, yearend | 13,500 | 16,100 | 15,800 | 9,790 | 10,600 |
| Producer, yearend[2] | 13,300 | 12,600 | 13,100 | 12,700 | 12,900 |
| Employment, yearend, number: Mine | 8 | 7 | 7 | 1 | 1 |
| Smelter | 253 | 264 | 6 | 6 | 6 |
| Port facility | 23 | 22 | 1 | 1 | 1 |
| Net import reliance[3] as a percent of apparent consumption | 59 | 56 | 64 | 63 | 58 |

**Recycling:** About 88,000 tons of nickel was recovered from purchased scrap in 2000. This represented about 43% of reported consumption for the year.

**Import Sources (1996-99):** Canada, 39%; Norway, 15%; Russia, 13%; Australia, 10%; and other, 23%.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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:** On June 10, 1999, the U.S. Government sold the last of the nickel in the National Defense Stockpile. The Government held 33,800 tons of nickel in the stockpile when the sales program began on March 24, 1993. The U.S. Department of Energy is holding 6,000 tons of nickel scrap contaminated by low-level radioactivity.

**Events, Trends, and Issues:** Stainless steel accounts for two-thirds of primary nickel consumed in the world. U.S. demand for austenitic (i.e., nickel bearing) stainless steel was at an all-time high in 2000, with much of the increase being met by imports. Domestic steel producers continued to compete with importers by modernizing plants, adding new capacity, and consolidating less efficient operations. U.S. production of austenitic stainless steel exceeded 1.37 million tons in 2000, edging out the previous record of 1.36 million tons set in 1988. Imported steels accounted for 29% of total U.S. stainless steel consumption in 2000. The U.S. International Trade Commission issued several countervailing duty and antidumping rulings in 1999-2000 that temporarily slowed the surge in stainless steel imports.

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# NICKEL

World nickel demand continued to grow faster than supply in 2000, causing a gradual drawdown of stocks in warehouses approved by the London Metal Exchange (LME). Producer stock levels were relatively unchanged because mine production was at an all-time high. Resumption of economic growth in parts of East Asia and strong demand for stainless steel in the European Union and the Americas kept nickel prices from returning to the depressed levels of 1998. For the week ending December 1, 2000, the LME cash price for 99.8%-pure nickel averaged $7,488 per metric ton ($3.40 per pound). Since 1975, demand for stainless steel has grown at an average rate of 4.5% per year. This growth rate is projected to continue or accelerate over the next 20 years. Three laterite mines were commissioned in Western Australia in 1999. The nickel was being recovered onsite using advanced pressure acid leach (PAL) technology. At least three other Australian PAL projects were in varying stages of development. Competitors were considering employing PAL technology in Cuba, Indonesia, New Caledonia, and the Philippines. In Canada, development of the huge Voisey's Bay nickel-copper sulfide deposit near Nain was on hold. The project sponsor and the Provincial Government of Newfoundland and Labrador were unable to agree on critical concepts, and suspended negotiations in January 2000. Exploration crews will continue to carry out surface drilling and geophysical surveys around the deposit and in the rest of the Voisey's Bay district. Drilling crews are exploring several other promising districts in northern Canada—the Lac Rocher region southeast of James Bay, the Ungava Nickel Belt in northern Quebec, and an area in Manitoba northeast of the Thompson Nickel Belt.

Several automobile manufacturers were using nickel-metal hydride (Ni-MH) batteries to power their gasoline-electric hybrid and pure electric vehicles for the 2001 and 2002 model years. The hybrid automobile uses an electric motor to propel the vehicle in low-speed, stop-and-go city driving, and switches to an internal combustion engine for higher speeds. Some models have a regenerative braking system that recovers part of the vehicle's kinetic energy and converts it to electrical energy for later reuse by the motor. Japanese manufacturers of Ni-MH batteries consumed an estimated 22,000 tons of nickel in 1999.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[4] | Reserve base[4] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | — | — | 43,000 | 2,500,000 |
| Australia | 126,000 | 168,000 | 11,000,000 | 18,000,000 |
| Botswana | 25,800 | 24,200 | 880,000 | 1,400,000 |
| Brazil | 43,784 | 43,900 | 670,000 | 6,000,000 |
| Canada | 188,218 | 194,000 | 6,600,000 | 15,000,000 |
| China | 50,100 | 51,900 | 3,700,000 | 7,900,000 |
| Colombia | 39,300 | 55,500 | 920,000 | 1,200,000 |
| Cuba | 64,407 | 68,700 | 5,700,000 | 23,000,000 |
| Dominican Republic | 39,500 | 44,700 | 670,000 | 1,300,000 |
| Greece | 16,050 | 20,900 | 450,000 | 900,000 |
| Indonesia | 89,100 | 93,500 | 3,200,000 | 13,000,000 |
| New Caledonia | 110,062 | 120,000 | 4,500,000 | 15,000,000 |
| Philippines | 8,450 | 20,700 | 410,000 | 11,000,000 |
| Russia | 260,000 | 265,000 | 6,600,000 | 7,300,000 |
| South Africa | 35,802 | 32,800 | 2,500,000 | 12,000,000 |
| Venezuela | — | 3,200 | 610,000 | 610,000 |
| Zimbabwe | 11,164 | 9,900 | 240,000 | 260,000 |
| Other countries | 12,400 | 9,300 | 450,000 | 12,000,000 |
| World total (rounded) | 1,120,000 | 1,230,000 | 49,000,000 | 150,000,000 |

**World Resources:** Identified land-based resources averaging 1% nickel or greater contain at least 130 million tons of nickel; about 60% is in laterites, and 40% is in sulfide deposits. In addition, extensive deep-sea resources of nickel are in manganese crusts and nodules covering large areas of the ocean floor, particularly in the Pacific Ocean.

**Substitutes:** With few exceptions, substitutes for nickel would result in increased cost or some 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-based superalloys in some highly corrosive chemical environments.

[e]Estimated.
[1]Scrap receipts - shipments by consumers + exports - imports + adjustments for consumer stock changes.
[2]Stocks of producers, agents, and dealers held only in the United States.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]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 24 companies at 39 plants in the United States during 2000. High natural gas prices led to extended shutdowns at some plants during the year, and, as a result, U.S. ammonia producers operated significantly below rated capacity. Fifty-seven percent of total U.S. ammonia production capacity was centered in Louisiana, Oklahoma, and Texas because of their large reserves of natural gas, the dominant domestic feedstock. The United States remained the world's second largest ammonia producer and consumer following China. Urea, ammonium phosphates, ammonium nitrate, nitric acid, and ammonium sulfate were the major derivatives of ammonia in the United States, in descending order of importance.

Approximately 88% of U.S. apparent domestic ammonia consumption was for fertilizer use, including anhydrous ammonia for direct application, urea, ammonium nitrates, ammonium phosphates, and other nitrogen compounds. Ammonia was also used to produce plastics, synthetic fibers and resins, explosives, and numerous other chemical compounds.

| Salient Statistics—United States:[1] | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production[2] | 13,400 | 13,300 | 13,800 | 12,900 | 13,000 |
| Imports for consumption | 3,390 | 3,530 | 3,460 | 3,890 | 4,000 |
| Exports | 435 | 395 | 614 | 562 | 500 |
| Consumption, apparent | 16,400 | 15,800 | 17,100 | 16,300 | 16,500 |
| Stocks, producer, yearend | 881 | 1,530 | [3]1,050 | [3]996 | 1,000 |
| Price, dollars per ton, average, f.o.b. Gulf Coast[3] | 190 | 173 | 121 | 109 | 170 |
| Employment, plant, number[e] | 2,500 | 2,500 | 2,500 | 2,200 | 2,000 |
| Net import reliance[4] as a percent of apparent consumption | 19 | 16 | 19 | 21 | 21 |

**Recycling:** None.

**Import Sources (1996-99):** Trinidad and Tobago, 56%; Canada, 34%; Mexico, 5%; Venezuela, 1%; and other, 4%. In addition, the United States imports significant quantities of ammonia from Russia and Ukraine, but the U.S. Census Bureau quantity data are suppressed, so these data are not included in the calculation of import sources.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Ammonia, anhydrous | 2814.10.0000 | Free. |
| Ammonia, aqueous | 2814.20.0000 | 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:** Escalating natural gas prices led to a corresponding increase in ammonia prices at the beginning of the year. Between mid-February and the beginning of May, U.S. Gulf Coast ammonia prices rose by about $60 per short ton to reach $176 per short ton; the price continued to climb and reached more than $200 per short ton by mid-October. The high cost of natural gas feedstock pushed production costs at some U.S. ammonia plants higher than the ammonia selling price. As a result, some plants, or parts of plants, were closed during part of the year, mostly during the summer months. In June and July portions of plants in Cherokee, AL, Pollack, LA, Yazoo City, MS, and Verdigris, OK, were closed. A 364,000-ton-per-year plant in Geismar, LA, was closed in July, and the company planned to scrap the facility because ammonia did not fit with its core business. A May explosion at an ammonia plant in Donaldsonville, LA, and a July explosion at a plant in Lawrence, KS, idled parts of these faciltities for the rest of the year.

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# NITROGEN (FIXED)—AMMONIA

New ammonia capacity came on-stream in Argentina, Egypt, Indonesia, Malaysia, Saudi Arabia, and Venezuela in 2000; one plant in the Netherlands closed. In addition to the new capacity already under construction, plans for new ammonia plants in Algeria, Australia, Egypt, Oman, and Trinidad and Tobago were announced.

In May, the U.S. Department of Commerce reached a suspension agreement with the Ministry of Trade of the Russian Federation regarding ammonium nitrate. Under terms of the agreement, Russia can continue to export specific quotas of ammonium nitrate to the United States, and a minimum price for the U.S. imports was set. The suspension agreement avoids the imposition of a dumping duty of 253.98% ad valorem on imports of ammonium nitrate from Russia. In October, U.S. ammonium nitrate producers filed an antidumping petition with the International Trade Commission claiming that because of the suspension agreement with Russia, ammonium nitrate importers were shifting to material from Ukraine, and this material was injuring U.S. producers.

The President signed Public Law 106-286 granting permanent normal trade relations to China, which paves the way for China to join the World Trade Organization (WTO). The WTO accession agreement includes a separately negotiated fertilizer trade agreement. This fertilizer agreement establishes a tariff rate quota for urea and diammonium phosphate and expands the channels that can be used to import fertilizers into China. This could provide additional markets for U.S. fertilizer producers and would eliminate China's moratorium on imports of urea, which has been in effect since 1997.

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

**World Ammonia Production, Reserves, and Reserve Base:**

| | Plant production | | Reserves and reserve base[5] |
|---|---|---|---|
| | 1999 | 2000[e] | |
| United States | 12,900 | 13,000 | Available atmospheric nitrogen and sources of natural gas for production of ammonia are considered adequate for all listed countries. |
| Canada | 4,140 | 4,200 | |
| China | 28,400 | 28,000 | |
| Egypt | 1,410 | 1,500 | |
| France | 1,570 | 1,500 | |
| Germany | 2,410 | 2,500 | |
| India | 10,400 | 9,200 | |
| Indonesia | 3,700 | 4,100 | |
| Netherlands | 2,430 | 2,400 | |
| Pakistan | 2,000 | 2,000 | |
| Russia | 7,630 | 6,000 | |
| Saudi Arabia | 1,400 | 1,600 | |
| Trinidad and Tobago | 2,720 | 2,300 | |
| Ukraine | 3,710 | 3,300 | |
| Other countries | 22,900 | 22,400 | |
| World total (rounded) | 108,000 | 104,000 | |

**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 demand.

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

[e]Estimated.
[1]U.S. Department of Commerce (DOC) data unless otherwise noted.
[2]Annual and preliminary data as reported in Current Industrial Reports MA325B and MQ325B (DOC).
[3]Source: Green Markets.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.

# PEAT

(Data in thousand metric tons, unless otherwise noted)[1]

**Domestic Production and Use:** The estimated f.o.b. plant value of marketable peat production in the contiguous United States was estimated at $19.7 million in 2000. Peat output in Alaska was valued at $190,000, according to the Alaska Department of Natural Resources. Peat was harvested and processed by about 60 producers in 20 of the contiguous States and by several producers in Alaska. Florida, Michigan, and Minnesota were the largest producing States, in order of quantity produced. Reed-sedge peat accounted for about 81% of the total volume, followed by sphagnum moss, 8%; hypnum moss, 6%; and humus, the remaining 5%. Approximately 95% of domestic peat was sold for horticultural use, including general soil improvement, potting soils, earthworm culture, nursery business, and golf course maintenance and construction. Other applications included seed inoculants, vegetable cultivation and mushroom culture, mixed fertilizers, and packing for flowers and plants. In the industrial sector, peat was used as an oil absorbent, an efficient filtration medium for the removal of waterborne contaminants in mine waste streams and municipal storm drainage.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production | 549 | 661 | 685 | 731 | 727 |
| Commercial sales | 640 | 753 | 791 | 834 | 759 |
| Imports for consumption | 667 | 754 | 761 | 752 | 800 |
| Exports | 19 | 22 | 30 | 40 | 40 |
| Consumption, apparent[2] | 1,240 | 1,310 | 1,430 | 1,580 | 1,510 |
| Price, average value, f.o.b. mine, dollars per ton | 28.90 | 23.23 | 24.26 | 26.48 | 27.09 |
| Stocks, producer, yearend | 342 | 421 | 408 | 272 | 250 |
| Employment, mine and plant, number[e] | 800 | 800 | 800 | 800 | 800 |
| Net import reliance[3] as a percent of apparent consumption | 56 | 50 | 52 | 54 | 52 |

**Recycling:** None.

**Import Sources (1996-99):** Canada, 99%, other, 1%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Peat | 2703.00.0000 | Free. |

**Depletion Allowance:** 5% (Domestic and foreign).

**Government Stockpile:** None.

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# PEAT

**Events, Trends, and Issues:** In 2000, domestic production was estimated to have remained about the same as in 1999, while consumption and sales decreased slightly. Domestic peat production and use has been trending upward over the past decade, owing to increasing demand for horticultural usage. Peat has become an essential requirement in horticulture worldwide, and the percentage of world production used for horticulture versus energy has been increasing each year. Sphagnum moss, which comprises less than 10% of domestic production, is the type of peat preferred by consumers in North America; the United States is the largest market for Canadian sphagnum peat moss, accounting for more than 50% of domestic demand since 1993.

A major U.S. peat producer purchased the worldwide distribution rights for horticultural and peat products manufactured by the largest peat producer in Western Europe. The company previously had acquired the brand name and distribution rights for the United Kingdom and Ireland. Another U.S. company was expanding its soil blending facility in Florida; sphagnum peat is imported from its subsidiary company in Quebec for use at the plant.

Demand for peat is expected to continue growing at a steady rate in the near future, with the percentage of peat being imported from Canada increasing concurrently. Soil blending companies that import peat from Canada stand to benefit from growing demand for high-quality sphagnum moss. The outlook for the domestic peat producers will be governed by several variables, chiefly, the ability to permit new bogs, the level of Canadian competition, and growth and competition from composted yard wastes.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[4] | Reserve base[4] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 731 | 727 | 15,000 | 6,400,000 |
| Belarus | [e]2,000 | 2,000 | ([5]) | ([5]) |
| Canada | 1,310 | 1,500 | 22,000 | 30,000,000 |
| Estonia | [e]923 | 1,000 | ([5]) | ([5]) |
| Finland | [e]7,400 | 7,400 | 64,000 | 6,400,000 |
| Germany | [e]2,980 | 3,000 | 42,000 | 450,000 |
| Ireland | 5,600 | 6,000 | 160,000 | 820,000 |
| Latvia | 683 | 700 | ([5]) | ([5]) |
| Lithuania | 300 | 300 | ([5]) | ([5]) |
| Russia | [e]2,000 | 2,000 | ([5]) | ([5]) |
| Sweden | 1,050 | 1,100 | ([5]) | ([5]) |
| Ukraine | [e]1,000 | 1,000 | ([5]) | ([5]) |
| United Kingdom | [e]500 | 500 | ([5]) | ([5]) |
| Other countries | 730 | 750 | 4,900,000 | 160,000,000 |
| World total (rounded) | 27,000 | 28,000 | 5,200,000 | 200,000,000 |

**World Resources:** U.S. resources of peat were estimated at more than 110 billion tons, with more than 50% located in Alaska. World resources of peat were estimated to be 2 trillion tons, of which the former Soviet Union has about 770 billion tons and Canada about 510 billion tons.

**Substitutes:** Natural organic materials may be composted and compete in certain 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 2000 was $21.9 million. Crude ore production came from 11 mines operated by 9 companies in 7 Western States. New Mexico continued to be the major producing State. Processed ore was expanded at 61 plants in 31 States. The principal end uses were building construction products, 72%; horticultural aggregate,10%; filter aid, 8%; fillers, 7%; and other, 3%.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production[1] | 684 | 706 | 685 | 711 | 675 |
| Imports for consumption[e] | 125 | 135 | 150 | 144 | 170 |
| Exports[e] | 38 | 38 | 42 | 47 | 50 |
| Consumption, apparent | 771 | 803 | 793 | 808 | 795 |
| Price, average value, dollars per ton, f.o.b. mine | 28.25 | 33.04 | 31.91 | 33.40 | 32.44 |
| Stocks, producer, yearend | NA | NA | NA | NA | NA |
| Employment, mine and mill | 125 | 135 | 140 | 150 | 150 |
| Net import reliance[2] as a percent of apparent consumption | 11 | 12 | 14 | 12 | 15 |

**Recycling:** Not available.

**Import Sources (1996-99):** Greece, 100%.

| **Tariff:** Item | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Mineral substances, not specifically provided for | 2530.10.0000 | Free. |

**Depletion Allowance:** 10% (Domestic and foreign).

**Government Stockpile:** None.

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# PERLITE

**Events, Trends, and Issues:** Imports of perlite increased 18% compared with those of 1999. Sales of domestic perlite decreased about 5% compared to those of 1999. Domestic perlite continued to encounter transportation cost disadvantages in some areas of the Eastern United States compared with Greek imports. However, U.S. perlite exports to Canada partially offset imports into the Eastern United States.

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

New uses of perlite are being researched, which may increase domestic consumption.

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

| | Production | | Reserves[3] | Reserve base[3] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 711 | 675 | 50,000 | 200,000 |
| Greece | 500 | 500 | 50,000 | 300,000 |
| Japan | 200 | 200 | ([4]) | ([4]) |
| Turkey | 130 | 130 | ([4]) | ([4]) |
| Other countries | 310 | 300 | 600,000 | 1,500,000 |
| World total (may be rounded) | 1,850 | 1,800 | 700,000 | 2,000,000 |

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

**Substitutes:** Alternate 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 10 firms in 4 States, and upgraded into an estimated 39.7 million tons of marketable product valued at $1 billion, f.o.b. mine. Florida and North Carolina accounted for 85% of total domestic output, with the remainder produced in Idaho and Utah. More than 90% of the U.S. phosphate rock ore produced was used to manufacture wet-process phosphoric acid and superphosphoric acid, which were used as intermediates in the manufacture of granular and liquid ammonium phosphate fertilizers and animal feed supplements. More than 50% of the wet-process phosphoric acid produced was exported in the form of upgraded granular diammonium and monoammonium phosphate fertilizer, triple superphosphate fertilizer, and merchant grade phosphoric acid. Phosphate rock mined by two companies in Idaho was consumed as feedstock for elemental phosphorus production at two wholly owned electric furnace facilities. Elemental phosphorus was used to produce high-purity phosphoric acid and phosphorus compounds, which were used in a variety of industrial applications.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production[1] | 45,400 | 45,900 | 44,200 | 40,600 | 39,700 |
| Sold or used by producers | 43,500 | 42,100 | 43,700 | 41,600 | 37,800 |
| Imports for consumption | 1,800 | 1,830 | 1,760 | 2,170 | 1,900 |
| Exports | 1,570 | 335 | 378 | 272 | 250 |
| Consumption[2] | 43,700 | 43,600 | 45,000 | 43,500 | 39,500 |
| Price, average value, dollars per ton, f.o.b. mine[3] | 23.40 | 24.40 | 25.46 | 30.56 | 26.16 |
| Stocks, producer, yearend | 6,390 | 7,910 | 7,920 | 6,920 | 8,000 |
| Employment, mine and beneficiation plant, number[e] | 6,500 | 6,500 | 6,500 | 6,500 | 6,000 |
| Net import reliance[4] as a percent of apparent consumption | — | — | 3 | 7 | 1 |

**Recycling:** None.

**Import Sources (1996-99):** Morocco, 99%; and other, 1%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Natural calcium phosphates: | | |
| Unground | 2510.10.0000 | Free. |
| Ground | 2510.20.0000 | Free. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

**Events, Trends, and Issues:** In 2000, domestic phosphate rock production decreased slightly, however, consumption for fertilizer production dropped substantially. Producers in Florida and North Carolina were affected by lower export sales and prices, which was the result of the opening of new phosphoric acid and diammonium phosphate (DAP) plants in Asia. One mine in Florida closed permanently in August owing to market conditions and the company began using phosphate rock imported from Morocco at its fertilizer plant. Since mid-1999, four mines have closed in Florida as part of corporate restructuring programs and depletion of reserves. Overall, production in the Florida-North Carolina region was below 90% of rated annual capacity. Mine production in Idaho and Utah was higher than in 1999.

Production of DAP, the major phosphate fertilizer, was lower than last year because the export market, which is the driving force of U.S. production, remained weak. The largest producer of processed phosphates temporarily closed some facilities in late 1999, and made additional closures in July 2000. This reduced its DAP production capacity by more than 50%. The company reopened some of the plants in September. Exports of DAP to India were down substantially owing to several new plants in the region that commenced production and Indian Government subsidy programs. Although the facilities in both India and Australia experienced various problems that kept output lower than expected, it did not benefit U.S. companies greatly. China has emerged as the important market for domestic DAP. The China National Chemicals and Import and Export Corporation (Sinochem), signed a 2-year extension to the existing DAP purchase agreement.

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# PHOSPHATE ROCK

A new mine and fertilizer plant has been proposed to be built in northeastern Utah. The company would obtain ore from a deposit near Vernal and would process it at a plant near Bonanza. The major products would be animal feed supplements and fertilizers. The firm plans to process ore at the mine site using a European method that would not require clay settling ponds or phosphogypsum stacks. The byproduct phosphogypsum would be free of impurities and would be used to manufacture wallboard. The company was in the process of obtaining financing for the project.

The two elemental phosphorus producers entered into a joint-venture agreement to manufacture and market phosphorus chemicals. The new company also will produce purified phosphoric acid in Soda Springs, ID, in a partnership with a fertilizer manufacturer. This would result in reduced production of elemental phosphorus at its Pocatello, ID, facility, which will assist in bringing the plant into compliance with environmental regulations.

World demand for phosphate fertilizers will continue to expand in relation to increased world population and food requirements, with the largest growth occurring in developing nations. The United States remains the world's largest producer of phosphate rock and processed phosphates and the leading supplier of DAP. However, increased foreign competition has removed a significant portion from U.S. sales. Domestic fertilizer consumption should increase slightly as total acreage planted for the major crops is projected to increase. The current market conditions will likely prevail until the full impact of new plants in Asia is determined and how quickly domestic manufacturers can increase sales in other regions. Phosphate rock production is likely to continue to decline in Florida, as companies adjust production to meet demand and prolong reserves. Several replacement mines are planned, but have to undergo permitting procedures that can take several years.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[5] | Reserve base[5] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 40,600 | 39,700 | 1,000,000 | 4,000,000 |
| Brazil | 4,100 | 4,300 | 330,000 | 370,000 |
| China | 25,100 | 26,000 | 500,000 | 1,200,000 |
| Israel | 4,100 | 3,800 | 180,000 | 180,000 |
| Jordan | 6,000 | 6,000 | 900,000 | 1,700,000 |
| Morocco and Western Sahara | 24,000 | 21,000 | 5,700,000 | 21,000,000 |
| Russia | 11,100 | 11,000 | 150,000 | 1,000,000 |
| Senegal | 1,800 | 1,800 | 50,000 | 160,000 |
| South Africa | 2,900 | 2,600 | 1,500,000 | 2,500,000 |
| Syria | 2,100 | 2,400 | 60,000 | 100,000 |
| Togo | 1,700 | 1,500 | 30,000 | 60,000 |
| Tunisia | 8,000 | 8,000 | 100,000 | 600,000 |
| Other countries | 9,500 | 11,200 | 1,200,000 | 4,000,000 |
| World total (rounded) | 141,000 | 139,000 | 12,000,000 | 37,000,000 |

**World Resources:** 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]Marketable.
[2]Defined as sold or used plus imports minus exports.
[3]Marketable phosphate rock, weighted value, all grades, domestic and export.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]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 Mine is the only primary platinum-group metals (PGM) producer in the United States. The mine, located near Nye, MT, processed more than 400,000 metric tons of ore and recovered more than 13,000 kilograms of palladium and platinum in 2000. Small quantities of PGM were also recovered as byproducts of copper refining by two companies in Texas and Utah. Automobile catalysts continued to be the largest demand sector for PGM. In the United States, more than 110,000 kilograms of PGM were used by the automotive industry in the manufacture of catalysts. Oxidation catalysts are also used in other air-pollution-abatement processes to remove organic vapors, odors, or carbon monoxide. Chemical uses include catalysts for organic synthesis; for example, in hydrogenation, dehydrogenation, and isomerization. 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. The primary medical use of PGM is in cancer chemotherapy. Other medical uses include platinum-iridium alloys in prosthetic and biomedical devices.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Mine production:[1] Platinum | 1,840 | 2,610 | 3,240 | 2,920 | 3,050 |
| Palladium | 6,100 | 8,400 | 10,600 | 9,800 | 10,000 |
| Imports for consumption: | | | | | |
| Platinum | 75,800 | 77,300 | 96,700 | 129,000 | 72,000 |
| Palladium | 146,000 | 148,000 | 176,000 | 189,000 | 147,000 |
| Rhodium | 9,650 | 14,400 | 13,500 | 10,500 | 19,900 |
| Ruthenium | 15,600 | 11,500 | 8,880 | 11,400 | 16,600 |
| Iridium | 1,810 | 1,860 | 1,950 | 2,270 | 2,640 |
| Osmium | NA | 54 | 71 | 23 | 46 |
| Exports: | | | | | |
| Platinum | 12,700 | 23,000 | 14,300 | 19,400 | 32,572 |
| Palladium | 26,700 | 43,800 | 36,700 | 44,000 | 54,900 |
| Rhodium | 187 | 282 | 811 | 114 | 764 |
| Price,[2] dollars per troy ounce: | | | | | |
| Platinum | 398.07 | 396.59 | 374.61 | 378.94 | 390.94 |
| Palladium | 130.39 | 184.14 | 289.76 | 363.20 | 590.00 |
| Rhodium | 308.30 | 298.00 | 619.83 | 904.35 | 1,800.00 |
| Employment, mine, number | 500 | 550 | 620 | 815 | 820 |
| Net import reliance as a percent of apparent consumption:[e] | | | | | |
| Platinum | NA | NA | 94 | 96 | 83 |
| Palladium | NA | NA | 90 | 92 | 89 |

**Recycling:** An estimated 70 metric tons of PGM were recovered from new and old scrap in 1999.

**Import Sources (1996-99):** Platinum: South Africa, 56%; United Kingdom,11%; Russia, 10%; Germany, 5%; and other, 18%. Palladium: Russia, 51%; South Africa, 18%; United Kingdom, 8%; Belgium, 7%; and other, 16%.

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

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

**Government Stockpile:**

**Stockpile Status—9-30-00[3]**

| **Material** | **Uncommitted inventory** | **Committed inventory** | **Authorized for disposal** | **Disposal plan FY 2000** | **Disposals FY 2000** |
|---|---|---|---|---|---|
| Platinum | 6,745 | — | 6,745 | 3,888 | 3,904 |
| Palladium | 26,191 | 673 | 26,190 | — | 8,006 |
| Iridium | 784 | — | 2.18 | — | — |

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# PLATINUM-GROUP METALS

**Events, Trends, and Issues:** The lone U.S. primary PGM producer experienced a number of operating setbacks at its Stillwater Mine that prevented it from reaching its target production rate of 3,000 metric tons per day. The setbacks were caused by difficulties associated with a lack of sufficiently developed working faces, increased dilution resulting from narrower ore width, and lower mine productivity. The operator of the Stillwater Mine expects to expand production to a minimum of 16,300 kilograms of palladium and platinum by the end of 2001.

As of April 30, 2000, the East Boulder and Stillwater Mines had proven and probable reserves of 36.3 million metric tons at a grade of 22.1 grams per ton containing 799,360 kilograms of recoverable palladium and platinum. With the ongoing expansion project that will increase the Stillwater Mine's capacity to 3,000 tons of ore per day and construction of the 2,000-ton-per-day East Boulder Project, these reserves equate to 20 years of production with both projects producing at capacity. The proven and probable reserves are contained in a 4,500-meter-long deposit along the J-M Reef, in southern Montana. The average palladium to platinum ratio in the deposit is about 3:1.

The price of palladium rose sharply in 1999 from $337 per troy ounce at the beginning of January to a record high of $454 per ounce at the end of the year. In the first 6 months of 2000, new highs of more than $700 per ounce were reached. Platinum prices rose more slowly but began to increase at the end of 1999 and have continued to increase through the first half of 2000.

The world's largest platinum producer plans to increase its annual production by 75% during the next 6 years. The increase, from 62,200 kilograms in 1999 to more than 100,000 kilograms in 2006, will be produced from a number of new mines, as well as the expansion of mines in South Africa's Bushveld complex.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | | | PGM | |
|---|---|---|---|---|---|---|
| | Platinum | | Palladium | | Reserves[4] | Reserve base[4] |
| | 1999 | 2000[e] | 1999 | 2000[e] | | |
| United States | 2,920 | 3,050 | 9,800 | 10,000 | 800,000 | 890,000 |
| Canada | 5,442 | 5,500 | 8,592 | 8,800 | 310,000 | 390,000 |
| Russia | 27,000 | 26,000 | 85,000 | 86,000 | 6,200,000 | 6,600,000 |
| South Africa | 131,000 | 140,000 | 63,600 | 65,000 | 63,000,000 | 70,000,000 |
| Other countries | 2,600 | 3,450 | 7,000 | 7,200 | 700,000 | 850,000 |
| World total (rounded) | 169,000 | 178,000 | 174,000 | 177,000 | 71,000,000 | 79,000,000 |

**World Resources:** World resources of PGM in mineral concentrations currently or potentially economic to mine are estimated to total more than 100 million kilograms. The largest reserves are located in the Bushveld Complex in South Africa. In 2000, there were 10 producing mines in the Bushveld Complex; of these, nine are producing from the Merensky Reef and UG2 Chromite Layer, and one is producing from the Platreef, located on the northern limb of the Complex.

**Substitutes:** Some motor vehicle manufacturers have substituted platinum for the now 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. NA Not available.
[1]Estimates from published sources.
[2]Handy & Harman quotations.
[3]See Appendix B for definitions.
[4]See Appendix C for definitions.

# POTASH

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

**Domestic Production and Use:** In 2000, the value of production of marketable potash, f.o.b. mine, was about $300 million, owing to increased sales over 1999 with level or declining prices. Domestic potash production was from Michigan, New Mexico, and Utah. The majority of the production was from southeastern New Mexico, where two companies operated three mines. New Mexico potash ores, both sylvinite and langbeinite, were beneficiated by flotation, heavy media separation, dissolution-recrystallization, or combinations of these processes, and provided more than 70% of the U.S. total producer sales.

In Utah, with three potash operations, one company brought underground potash to the surface by solution mining. The potash was recovered from the brine by solar evaporation to crystals and flotation. Another Utah company collected subsurface brines from an interior basin for solar evaporation to crystals and flotation. The third Utah company collected lake brines for solar evaporation to crystals, flotation, and dissolution-recrystallization. In Michigan, a company used deep well solution mining and mechanical evaporation to recrystallization to produce finished product.

The fertilizer industry used about 90% of the U.S. potash sales, and the chemical industry used about 10%. More than 50% of the potash was produced as potassium chloride (muriate of potash). Potassium sulfate (sulfate of potash) and potassium magnesium sulfate (sulfate of potash-magnesia), required by certain crops and soils, were also sold.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production, marketable | 1,390 | 1,400 | [1]1,300 | [1]1,200 | [1]1,300 |
| Imports for consumption | 4,940 | 5,490 | 4,780 | 4,470 | 4,300 |
| Exports | 481 | 466 | 480 | 460 | 470 |
| Consumption, apparent | 5,890 | 6,500 | [2]5,600 | [2]5,100 | [2]5,000 |
| Price, dollars per metric ton of $K_2O$, average, muriate, f.o.b. mine[3] | 133 | 140 | 145 | 145 | 155 |
| Employment, number: Mine | 880 | 850 | 730 | 660 | 610 |
| Employment, number: Mill | 810 | 800 | 780 | 725 | 665 |
| Net import reliance[4] as a percent of apparent consumption | 77 | [5]80 | [5]80 | [5]80 | [5]70 |

**Recycling:** None.

**Import Sources (1996-99):** Canada, 93%; Russia, 5%; Belarus, 1%; and other, 1%.

| **Tariff:** Item | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Crude salts, sylvinite, etc. | 3104.10.0000 | Free. |
| Potassium chloride | 3104.20.0000 | Free. |
| Potassium sulfate | 3104.30.0000 | Free. |
| Potassium nitrate | 2834.21.0000 | Free. |
| Potassium-sodium nitrate mixtures | 3105.90.0010 | Free. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

**Events, Trends, and Issues:** The world's largest potash producers operated at reduced capacity for another year owing to potential oversupply. The Canadian potash industry operated for the first half of the year at about 70% of capacity which was an increase from the first half of 1999. Production declined slightly the second half of the year. Producers extended some summer turnarounds and employee vacations in North America to maintain stocks at reasonable levels. Potash producers in the former Soviet Union continued operating at reduced capacity while many other producers around the world operated at normal capacity. Belarus, Germany, and Russia faced marginally increasing demand in their home markets. The 1997 Asian economic problems placed subdued downward pressure on foodstuff trade. The effect diminished as most countries were recovering from the problems. Asian consumers continued purchasing potash, although not in significant amounts from U.S. producers, to maintain local food production and to reduce imports of food. Grain prices were still relatively low in grain producing and exporting countries. These low prices were particularly troublesome in the United States where excellent harvests occurred despite droughts, floods, and reduced potash applications.

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# POTASH

The Boulby potash mine on the east coast of England returned to normal production in 2000 after reduced production owing to underground flooding in the first half of 1999. In France, after the Marie-Louise refinery closed at the end of July 1999, the last potash refinery was the Amélie mill, which is expected to close in 2004 because the Marie-Louise and Amélie Mines will be exhausted of minable reserves.

Annual production capacity and annual production in Chile have grown by the addition of new, smaller operations. Brazil seems to have brought production at its one mine up to the attainable capacity limit of the mill.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[6] | Reserve base[6] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | [1]1,200 | [1]1,300 | 100,000 | 300,000 |
| Azerbaijan | [e]5 | 5 | NA | NA |
| Belarus | 3,600 | 3,800 | 800,000 | 1,000,000 |
| Brazil | 350 | 350 | 50,000 | 600,000 |
| Canada | 8,329 | 9,200 | 4,400,000 | 9,700,000 |
| Chile | 22 | 22 | 10,000 | 50,000 |
| China | 125 | 125 | 320,000 | 320,000 |
| France | 300 | 300 | 1,200 | NA |
| Germany | 3,600 | 3,400 | 710,000 | 850,000 |
| Israel | 1,750 | 1,750 | [7]40,000 | [7]580,000 |
| Jordan | 1,100 | 1,100 | [7]40,000 | [7]580,000 |
| Russia | 4,200 | 3,600 | 1,800,000 | 2,200,000 |
| Spain | 550 | 450 | 20,000 | 35,000 |
| Ukraine | 35 | 35 | 25,000 | 30,000 |
| United Kingdom | 500 | 650 | 22,000 | 30,000 |
| Other countries | — | — | 50,000 | 140,000 |
| World total (may be rounded) | 25,700 | 26,500 | 8,400,000 | 17,000,000 |

**World Resources:** Estimated domestic potash resources total about 6 billion tons. Most of this lies at depths between 6,000 and 10,000 feet in a 1,200-square-mile 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 4,000 feet. An unknown, but large potash resource lies about 7,000 feet under central Michigan. The U.S. reserve figure above contains approximately 62 million tons of reserves in central Michigan. Estimated world resources total about 250 billion tons. The potash deposits in the former Soviet Union contain large amounts of carnallite; it is not clear if this can be mined in a free market, competitive economy. Large resources, about 10 billion tons and mostly carnallite, occur in Thailand.

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

[e]Estimated. NA Not available.
[1]Rounded to the nearest 0.1 million tons to protect proprietary data.
[2]Rounded to the nearest 0.2 million tons to protect 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 protect proprietary data.
[6]See Appendix C for definitions.
[7]Total reserves and reserve base in the Dead Sea are equally divided between Israel and Jordan.

# 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 2000 was $28 million. Domestic output came from 15 producers in 6 States. The principal producing States were California, Idaho, New Mexico, and Oregon, with combined production accounting for about 94% of the national total. The remaining production was from Arizona and Kansas. About 66% of the pumice was consumed for building blocks, and the remaining 34% was used in abrasives, concrete, stone-washing laundries, and other applications.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, mine[1] | 612 | 577 | 583 | 643 | 749 |
| Imports for consumption | 215 | 265 | 286 | 354 | 390 |
| Exports[e] | 13 | 12 | 22 | 23 | 25 |
| Consumption, apparent | 814 | 830 | 847 | 974 | 1,110 |
| Price, average value, dollars per ton, f.o.b. mine or mill | 24.19 | 27.90 | 21.59 | 27.69 | 37.38 |
| Stocks, yearend | NA | NA | NA | NA | NA |
| Employment, mine and mill, number | 70 | 70 | 75 | 85 | 85 |
| Net import reliance[2] as a percent of apparent consumption | 25 | 30 | 31 | 34 | 33 |

**Recycling:** Not available.

**Import Sources (1996-99):** Greece, 88%; Turkey, 5%; Ecuador, 3%; Italy, 3%; and other, 1%.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Crude or in irregular pieces, including crushed pumice | 2513.11.0000 | Free. |
| Other | 2513.19.0000 | Free. |

**Depletion Allowance:** 5% (Domestic and foreign).

**Government Stockpile:** None.

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# PUMICE AND PUMICITE

**Events, Trends, and Issues:** The amount of pumice and pumicite sold or used in 2000 increased about 16% when compared with that of 1999. Imports increased over 10% compared with those of 1999 as more Greek pumice was brought into the eastern half of the United States. Total consumption reached a record level since pumice and pumicite data were first published separately from volcanic cinder in 1978. Consumption increased because of increased demand from lightweight-block and lightweight-concrete producers. Stone-washing laundry use of pumice continued to decline in 2000.

The average price of pumice and pumicite increased significantly from 1999 to 2000 because of the inclusion of data from a newer operation and higher reported values from several traditional suppliers.

It is estimated that in 2001 domestic mine production of pumice and pumicite will be about 750,000 tons, with U.S. apparent consumption at approximately 1,100,000 tons. Imports, mainly from Greece, continue to maintain markets in the East Coast and Gulf Coast States of the United States.

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

All domestic mining of pumice in 2000 was by open pit methods, and generally occurred in relatively 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 geographical area.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[3] | Reserve base[3] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States[1] | 643 | 749 | Large | Large |
| Chile | 600 | 650 | NA | NA |
| France | 460 | 500 | NA | NA |
| Germany | 600 | 600 | NA | NA |
| Greece | 1,700 | 1,700 | NA | NA |
| Italy | 4,600 | 4,600 | NA | NA |
| Spain | 600 | 600 | NA | NA |
| Turkey | 600 | 600 | NA | NA |
| Other countries | 1,800 | 1,800 | NA | NA |
| World total (rounded) | 11,600 | 11,800 | NA | NA |

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

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

[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:** Domestic production of cultured quartz crystal in 2000 remained near 1999 levels. Lascas[1] mining and processing in Arkansas was stopped at the end of 1997, but three U.S. firms continued to produce cultured quartz crystals by using imported and stockpiled lascas as feed material. Electronic applications accounted for most industrial uses of quartz crystal; other uses included special optical applications.

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

**Salient Statistics—United States:** Production of cultured quartz crystals was estimated to be about 200 metric tons. 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 were about 90 tons, and imports were about 25 tons in 2000. The average value of exports and imports was $282,000 per ton and $423,000 per ton, respectively. Other salient statistics were not available.

**Recycling:** None.

**Import Sources (1996-99):** The United States is 100% import reliant. Brazil, Germany, and Madagascar are reportedly the major sources for lascas. Other possible sources of lascas include China, South Africa, and Venezuela.

**Tariff:**

| Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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. |
| Piezo-electric quartz | 7104.10.00.00 | 3% ad val. |

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

**Government Stockpile:**

**Stockpile Status—9-30-00[2]**

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Quartz crystal | 105 | ([3]) | — | — | — |

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# QUARTZ CRYSTAL (INDUSTRIAL)

**Events, Trends, and Issues:** Trends indicate that demand for quartz crystal devices should continue to grow, and consequently, quartz crystal production should remain strong well into the future. Growth of the consumer electronics market (for products such as personal computers, electronic games, and cellular telephones), particularly in the United States, will continue to promote domestic production. The growing global electronics market may require additional production capacity worldwide.

**World Mine Production, Reserves, and Reserve Base:** This information is unavailable, but the global reserve base for lascas is thought to be large.

**World Resources:** Limited resources of natural quartz crystal suitable for direct electronic or optical use are available throughout the world. World dependence on these resources will continue to decline because of the increased acceptance of cultured quartz crystal as an alternative material; however, use of cultured quartz crystal will mean an increased dependence on lascas for growing cultured quartz.

**Substitutes:** Quartz crystal is the best material for frequency-control oscillators and frequency filters in electronic circuits. Other materials, such as dipotassium tartrate, are usable only in specific applications, such as oscillators and filters.

[1]Lascas is a nonelectronic-grade quartz used as a feedstock for growing cultured quartz crystal and for production of fused quartz.
[2]See Appendix B for definitions.
[3]Less than ½ unit.

# RARE EARTHS[1]

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

**Domestic Production and Use:** Rare earths were mined by one company in 2000. Bastnasite, a rare-earth fluocarbonate mineral, was mined as a primary product by a firm in Mountain Pass, CA. The United States was a leading producer and processor of rare earths and continued to be a major exporter and consumer of rare-earth products. Domestic ore production was valued at an estimated $14 million. Refined rare-earth products were produced primarily by three companies with operations in Phoenix, AZ; Freeport, TX; and Chattanooga, TN. The estimated value of refined rare earths consumed in the United States was more than $700 million. The approximate distribution in 1999 by end use was as follows: automotive catalytic converters, 60%; glass polishing and ceramics, 11%; permanent magnets, 8%; petroleum refining catalysts, 7%; metallurgical additives and alloys, 6%; rare-earth phosphors for lighting, televisions, computer monitors, radar, and X-ray intensifying film, 2%; and miscellaneous, 6%.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: | | | | | |
| Bastnasite concentrates | [2]20,400 | [e]10,000 | [e]5,000 | [e]5,000 | 5,000 |
| Imports:[3] Thorium ore (monazite) | 56 | 11 | — | — | — |
| Rare-earth metals, alloys | 429 | 529 | 953 | 1,780 | 2,370 |
| Cerium compounds | 3,180 | 1,810 | 4,940 | 3,990 | 4,300 |
| Mixed REO's | 879 | 974 | 2,530 | 5,980 | 2,290 |
| Rare-earth chlorides | 1,070 | 1,450 | 1,680 | 1,530 | 1,030 |
| Rare-earth oxides, compounds | 10,300 | 7,070 | 3,720 | 7,760 | 11,800 |
| Ferrocerium, alloys | 107 | 121 | 117 | 120 | 128 |
| Exports:[3] Rare-earth metals, alloys | 250 | 991 | 724 | 1,600 | 1,830 |
| Cerium compounds | 6,100 | 5,890 | 4,640 | 3,960 | 3,870 |
| Other rare-earth compounds | 2,210 | 1,660 | 1,630 | 1,690 | 1,590 |
| Ferrocerium, alloys | 4,410 | 3,830 | 2,450 | 2,360 | 1,830 |
| Consumption, apparent[4] | W | 19,400 | 11,500 | 11,500 | 17,900 |
| Price, dollars per kilogram, yearend: | | | | | |
| Bastnasite concentrate, REO basis | 2.87 | 2.87 | 2.87 | 2.87 | 2.87 |
| Monazite concentrate, REO basis | 0.48 | 0.73 | 0.73 | 0.73 | 0.73 |
| Mischmetal, metal basis, metric ton quantity[5] | 7-11 | 8-12 | 6-8 | 5-7 | 5-7 |
| Stocks, producer and processor, yearend | W | W | W | W | W |
| Employment, mine and mill, number | NA | 327 | 183 | 102 | 100 |
| Net import reliance[4] as a percent of apparent consumption | 18 | E | 56 | 70 | 72 |

**Recycling:** Small quantities, mostly permanent magnet scrap.

**Import Sources (1996-99):** Monazite: Australia, 67%; France, 33%; Rare-earth metals, compounds, etc.: China, 71%; France, 23%; Japan, 3%; United Kingdom, 1%; and other, 2%.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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 REO's except cerium oxide | 2846.90.2010 | Free. |
| Mixtures of rare-earth chlorides, except cerium chloride | 2846.90.2050 | Free. |
| Rare-earth compounds, individual REO's (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); bastnasite and xenotime, 14% (Domestic and foreign).

**Government Stockpile:** None.

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# RARE EARTHS

**Events, Trends, and Issues:** Domestic demand for rare earths in 2000 was higher than that of 1999. U.S. imports of rare earths remained at high levels in most trade categories as a result of the temporary closure of the rare-earth separation plant at Mountain Pass, CA. The plant is expected to resume separation operations. The mine continued to produce bastnasite concentrates and cerium concentrates. The trend is for continued increased use of the rare earths in many applications, especially automotive catalytic converters, permanent magnets, and rechargeable batteries.

Researchers at the U.S. Department of Energy's Ames Laboratory developed a new group of rare-earth-containing alloys that boost the cooling performance of cryocoolers.[6] The erbium-based alloys can absorb 25% to 175% more heat than the lead regenerators presently used in many cryocoolers. Cryocoolers are refrigeration devices that cool scientific equipment, magnetic resonance imaging scanners, medical fertility and anthropomorphic storage systems, and defense equipment components.

The *4th International Conference on f-elements* was held in Madrid, Spain, during September 17-21, 2000. The *4th International Conference on Rare Earth Development and Applications* is scheduled for June 15-20, 2001, in Beijing, China. The conference, *Rare Earths—2001* is planned for September 22-26, 2001, in Sao Paolo, Brazil.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production[e] | | Reserves[7] | Reserve base[7] |
|---|---|---|---|---|
| | 1999 | 2000 | | |
| United States | 5,000 | 5,000 | 13,000,000 | 14,000,000 |
| Australia | — | — | 5,200,000 | 5,800,000 |
| Brazil | 1,400 | 1,400 | 280,000 | 310,000 |
| Canada | — | — | 940,000 | 1,000,000 |
| China[8] | 70,000 | 70,000 | 43,000,000 | 48,000,000 |
| India | 2,700 | 2,700 | 1,100,000 | 1,300,000 |
| Malaysia | 350 | 250 | 30,000 | 35,000 |
| South Africa | — | — | 390,000 | 400,000 |
| Sri Lanka | 120 | 120 | 12,000 | 13,000 |
| Former Soviet Union[9] | 2,000 | 2,000 | 19,000,000 | 21,000,000 |
| Other countries | — | — | 21,000,000 | 21,000,000 |
| World total (rounded) | 82,000 | 81,000 | 100,000,000 | 110,000,000 |

**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 bastnasite and monazite. Bastnasite deposits in China and the United States constitute the largest percentage of the world's rare-earth economic resources, while monazite deposits in Australia, Brazil, China, India, Malaysia, South Africa, Sri Lanka, Thailand, and the United States constitute the second largest segment. Xenotime, rare-earth-bearing (ion adsorption) clays, loparite, phosphorites, apatite, eudialyte, secondary monazite, cheralite, and spent uranium solutions make up most of the remaining resources. Undiscovered resources are thought to be very large relative to expected demand.

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

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Data includes lanthanides and yttrium, but excludes most scandium. See also Scandium and Yttrium.
[2]As reported by Molycorp, Inc. employee.
[3]REO equivalent or contents of various materials were estimated. Data from U.S. Census Bureau.
[4]Monazite concentrate production was not included in the calculation of apparent domestic consumption and net import reliance. Net import reliance defined as imports - exports + adjustments for Government and industry stock changes.
[5]Price range from Elements - Rare Earths, Specialty Metals and Applied Technology, Trade Tech, Denver, CO.
[6]U.S. Department of Energy, Ames Laboratory, 2000, Versatile set of alloys could enhance performance of cryocoolers, Ames, IA, Ames Laboratory, News Release, August 21, 2 p.
[7]See Appendix C for definitions.
[8]Number reported in China Rare Earth Information, Baotou, Inner Mongolia, China, v. 6, no. 2, p. 1.
[9]As constituted before December 1991.

# RHENIUM

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

**Domestic Production and Use:** During 2000, ores containing rhenium were mined by six operations. Rhenium compounds are included in molybdenum concentrates derived from porphyry copper deposits in the Southwestern United States, and rhenium is recovered as a byproduct from roasting such molybdenum concentrates. Rhenium-containing products included ammonium perrhenate, perrhenic acid, and metal powder. The major uses of rhenium were in petroleum-reforming catalysts and in high-temperature superalloys used in turbine engine components, representing about 40% and 50%, respectively, of the total demand. Rhenium was used in petroleum-reforming catalysts for the production of high-octane hydrocarbons, which are used in the production of lead-free gasoline. Bimetallic platinum-rhenium catalysts have replaced many of the monometallic catalysts. Rhenium is used in superalloys, improving the strength properties, at high temperatures (1,000° C), of nickel-based alloys. Some of the uses for rhenium alloys were in thermocouples, temperature controls, heating elements, ionization gauges, mass spectrographs, electron tubes and targets, electrical contacts, metallic coatings, vacuum tubes, crucibles, electromagnets, and semiconductors. The estimated value of rhenium consumed in 2000 was $44.4 million.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production[1] | 14,000 | 15,400 | 14,000 | 12,000 | 9,000 |
| Imports for consumption | 20,800 | 15,100 | 25,200 | 13,500 | 20,800 |
| Exports | NA | NA | NA | NA | NA |
| Consumption: Estimated | 24,100 | 17,900 | 28,600 | 32,600 | 40,000 |
| Apparent | NA | NA | NA | NA | NA |
| Price, average value, dollars per kilogram: | | | | | |
| Metal powder, 99.99% pure | 900 | 900 | 500 | 1,100 | 1,110 |
| Ammonium perrhenate, kilogram | 500 | 300 | 400 | 750 | 780 |
| Stocks, yearend, consumer, producer, dealer | NA | NA | NA | NA | NA |
| Employment, number | Small | Small | Small | Small | Small |
| Net import reliance[2] as a percent of apparent consumption | NA | NA | NA | NA | NA |

**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 (1996-99):** Chile, 59%; Germany 16%; Kazakhstan, 9%; Russia, 7%; and other, 9%.

| **Tariff:** **Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| 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 | 8112.91.0500 | Free. |
| Rhenium, (metals) unwrought; powders | 8112.91.5000 | 3% ad val. |
| Rhenium, etc., (metals) wrought; etc. | 8112.99.0000 | 4% ad val. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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# RHENIUM

**<u>Events, Trends, and Issues</u>:** During 2000, the average rhenium prices were $1,110 per kilogram for metal and $780 per kilogram for ammonium perrhenate. The supply increased by 4,300 kilograms, and the consumption increased by 7,400 kilograms. Imports of rhenium increased by about 54% in 2000 compared with those of 1999. Chile and Kazakhstan supplied the majority of the rhenium imported. The United States relied on imports for much of its supply of rhenium. The increased estimated consumption was in the areas of catalysts for petroleum refining and superalloys for turbine engines.

In 2001, U.S. consumption of rhenium has been estimated to be about 50,000 kilograms.

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 also prevents most of the rhenium from escaping into the atmosphere.

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

| | Mine production[e] | | Reserves[3] | Reserve base[3] |
|---|---|---|---|---|
| | 1999 | 2000 | | |
| United States | 12,000 | 9,000 | 390,000 | 4,500,000 |
| Armenia | 700 | 700 | 95,000 | 120,000 |
| Canada | 1,600 | 1,600 | — | 1,500,000 |
| Chile | 14,700 | 14,700 | 1,300,000 | 2,500,000 |
| Kazakhstan | 2,400 | 2,400 | 190,000 | 250,000 |
| Mexico | 5,500 | 5,300 | NA | NA |
| Peru | 4,800 | 4,800 | 45,000 | 550,000 |
| Russia | 1,100 | 1,100 | 310,000 | 400,000 |
| Uzbekistan | NA | NA | 59,000 | 400,000 |
| Other countries | 3,000 | 3,000 | 91,000 | 360,000 |
| World total (rounded) | 46,000 | 43,000 | 2,500,000 | 11,000,000 |

**<u>World Resources</u>:** 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.

**<u>Substitutes</u>:** 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.

[1]Calculated rhenium contained in $MoS_2$ concentrates. Recovered quantities are considerably less and are withheld.

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

[3]See Appendix C for definitions.

# RUBIDIUM

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

**Domestic Production and Use:** Although rubidium is not recovered from any domestically mined ores, at least one domestic company manufactured rubidium products from imported lepidolite ore. Small quantities of rubidium, usually in the form of chemical compounds, were used mainly in research and development. Rubidium also was used in electronic and medical applications.

**Salient Statistics—United States:** Salient statistics, such as production, consumption, imports, and exports, are not available. The domestic rubidium market is very small, with annual consumption probably amounting to only a few thousand kilograms. There is no active trading of the metal, and, therefore, no market price. However, several companies publish prices for rubidium and rubidium compounds. These prices remain relatively stable for several years. The per-unit price for the metal or compounds purchased from these companies varies inversely with the quantity of material purchased. For example, in 2000, one company offered 1-gram ampoules of 99.8%-grade rubidium metal at $79.70. The price for 100 grams of the same material from this company was $998.00, or $9.98 per gram.

**Recycling:** None.

**Import Sources (1996-99):** The United States is 100% import reliant. Although there is no information on the countries shipping rubidium-bearing material to the United States, Canada is thought to be the major source of this raw material.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
| --- | --- | --- |
| Alkali metals, other | 2805.19.0000 | 5.5% ad val. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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# RUBIDIUM

**<u>Events, Trends, and Issues</u>:** Rubidium and its compounds were largely the subject of laboratory study, and were of little commercial significance. No major breakthroughs or developments were anticipated that would change the production or consumption patterns. Domestic rubidium production is entirely dependent upon imported lepidolite ores. Because of the small scale of production of rubidium products, no significant environmental problems have been encountered.

**<u>World Mine Production, Reserves, and Reserve Base</u>:** Rubidium forms no known minerals in which it is the predominant metallic element. Rather, it substitutes for potassium in a number of minerals, especially those that crystallize late in the formation of pegmatites. Lepidolite, a potassium lithium mica that may contain up to 3.15% rubidium, is the principal ore of rubidium. Pollucite, the cesium aluminosilicate mineral, may contain up to 1.35% rubidium. The rubidium-bearing minerals are mined as byproducts or coproducts with other pegmatite minerals.

**<u>World Resources</u>:** World resources of rubidium have not been estimated.

**<u>Substitutes</u>:** The properties of cesium and its compounds are so similar to those of rubidium and its compounds that compounds of rubidium and cesium are used interchangeably in many applications.

# SALT

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** Domestic production of salt increased slightly in 2000, with total value estimated at $1 billion. Thirty-one companies operated 69 plants in 15 States. The estimated percentage of salt sold or used, by type, was salt in brine, 51%; rock salt, 32%; vacuum pan, 9%; and solar salt, 8%.

The chemical industry consumed about 45% of total salt sales, with salt brine representing about 91% of the type of salt used for feedstock. Chlorine and caustic soda manufacture was the main consuming sector within the chemical industry. Salt for highway deicing accounted for 31% of U.S. demand. The remaining markets for salt, in declining order, were distributors, 8%; industrial, 6%; agricultural, 4%; food, 3%; primary water treatment, 2%; and other combined with exports, 1%.

| **Salient Statistics—United States:**[1] | **1996** | **1997** | **1998** | **1999** | **2000**[e] |
|---|---|---|---|---|---|
| Production | 42,200 | 41,400 | 41,200 | 44,900 | 45,300 |
| Sold or used by producers | 42,900 | 40,600 | 40,800 | 44,400 | 45,300 |
| Imports for consumption | 10,600 | 9,160 | 8,770 | 8,870 | 8,800 |
| Exports | 869 | 748 | 731 | 892 | 800 |
| Consumption: Reported | 52,800 | 49,500 | 44,200 | 50,000 | 53,300 |
| Consumption: Apparent | 52,600 | 49,000 | 48,800 | 52,400 | 53,300 |
| Price, average value of bulk, pellets and packaged salt, dollars per ton, f.o.b. mine and plant: | | | | | |
| Vacuum and open pan salt | 120.54 | 119.61 | 114.93 | 112.49 | 111.00 |
| Solar salt | 39.97 | 38.81 | 37.56 | 52.02 | 38.00 |
| Rock salt | 22.14 | 20.50 | 21.90 | 22.55 | 21.00 |
| Salt from brine | 6.72 | 6.67 | 5.93 | 6.65 | 6.00 |
| Stocks, producer, yearend[e 2] | 1,400 | 800 | 400 | 500 | 0 |
| Employment, mine and plant, number | 4,150 | 4,150 | 4,150 | 4,100 | 4,200 |
| Net import reliance[3] as a percent of apparent consumption | 19 | 17 | 17 | 15 | 15 |

**Recycling:** None.

**Import Sources (1996-99):** Canada, 41%; Chile, 20%; Mexico, 16%; The Bahamas, 11%; and other, 12%.

| **Tariff:** **Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Iodized salt | 2501.00.0000 | Free. |

**Depletion Allowance:** 10% (Domestic and foreign).

**Government Stockpile:** None.

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# SALT

**Events, Trends, and Issues:** After a 5-year scientific assessment, the Canadian Government released for public comments its findings that road salts (calcium chloride, magnesium chloride, potassium chloride, and sodium chloride) are toxic to the environment. A final decision had not been made by yearend, but if the assessment is adopted, the government would have 2 years to develop control measures and 18 months to implement them so that road salts would not be released to the environment. Opponents to this study were hopeful that the government will realize that sodium chloride is not a toxic substance and that there are no reasonable alternative deicing agents.

A U.S. salt company brought on-stream its new vacuum pan salt facility in Baytown, TX. The plant has an annual nameplate capacity of 725,000 tons. Another domestic vacuum pan salt-producer closed its plant in Hutchinson, KS, and increased capacity at its other facilities in Lyons, KS, and Hersey, MI.

The new rock salt mine at Hampton Corners, NY, that came on-stream in late 1999 expanded production to meet the anticipated demand for rock salt for the winter of 2000-01. After a few mild winters that affected salt sales, many weather forecasters were forecasting below-normal temperatures and a more severe winter that may help alleviate the buildup of salt inventories and increase rock salt sales.

New salt projects were being developed around the world, such as new solar salt plants in Venezuela and Vietnam. After years of planning and discussion, the proposed solar salt complex in San Ignacio Lagoon in Baja, Mexico, was canceled by the Government. Environmental groups were concerned that the new project would be detrimental to whales and other marine life, however, an environmental impact study showed otherwise.

Consumption of salt in 2001 is expected to be higher than that of 2000.

**World Production, Reserves, and Reserve Base:**

| | Production | | Reserves and reserve base[4] |
|---|---|---|---|
| | 1999 | 2000[e] | |
| United States[1] | 44,900 | 45,300 | Large. Economic and subeconomic deposits of salt are substantial in principal salt-producing countries. The oceans comprise an inexhaustible supply of salt. |
| Australia | 10,000 | 9,000 | |
| Brazil | 6,900 | 7,000 | |
| Canada | 12,500 | 12,500 | |
| China | 28,100 | 30,000 | |
| France | 7,000 | 7,100 | |
| Germany | 15,700 | 15,800 | |
| India | 14,500 | 14,500 | |
| Italy | 3,600 | 3,600 | |
| Mexico | 8,500 | 8,600 | |
| Poland | 4,000 | 4,000 | |
| Russia | 2,000 | 2,000 | |
| Spain | 3,200 | 3,500 | |
| Ukraine | 2,500 | 2,500 | |
| United Kingdom | 5,800 | 5,700 | |
| Other countries | 39,800 | 38,900 | |
| World total (may be rounded) | 209,000 | 210,000 | |

**World Resources:** World resources of salt are practically unlimited. 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.
[1]Excludes Puerto Rico.
[2]Reported stock data are incomplete. For apparent consumption and net import reliance calculations, changes in annual stock totals are assumed to be the difference between salt produced and salt sold or used.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions.

# SAND AND GRAVEL (CONSTRUCTION)[1]

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

**Domestic Production and Use:** Construction sand and gravel valued at $5.7 billion was produced by an estimated 4,000 companies from 6,100 operations in 50 States. Leading States, in order of tonnage, were California, Texas, Michigan, Arizona, Ohio, Washington, and Colorado, which combined accounted for about 46% of the total output. It is estimated that about 48% of the 1.17 billion metric tons of construction sand and gravel produced in 2000 was for unspecified uses. Of the remaining total, about 41% was used as concrete aggregates; 25% for road base and coverings and road stabilization; 14% as asphaltic concrete aggregates and other bituminous mixtures; 13% as construction fill; 2% for concrete products, such as blocks, bricks, pipes, etc.; 2% for plaster and gunite sands; and the remainder 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 2000 was about 860 million tons, which represents an increase of 4.1% compared with the same period of 1999. The estimated output of crushed stone in the 48 conterminous States shipped for consumption in the first 9 months of 2000 was 1.18 billion tons, which represents an increase of 3.1% compared with the same period of 1999. Additional production information by quarter for each State, geographic region, and the United States is published by the U.S. Geological Survey in its quarterly Mineral Industry Surveys for Crushed Stone and Sand and Gravel.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production | [3]914 | 952 | 1,070 | 1,110 | 1,170 |
| Imports for consumption | 1 | 2 | 1 | 2 | 2 |
| Exports | 1 | 2 | 2 | 2 | 2 |
| Consumption, apparent | 914 | 952 | 1,070 | 1,110 | 1,170 |
| Price, average value, dollars per ton | 4.38 | 4.47 | 4.57 | 4.73 | 4.87 |
| Stocks, yearend | NA | NA | NA | NA | NA |
| Employment, quarry and mill, number[e] | 33,200 | 33,900 | 35,600 | 37,300 | 37,500 |
| Net import reliance[4] as a percent of apparent consumption | — | — | — | — | — |

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

**Import Sources (1996-99):** Canada, 71%; The Bahamas, 11%; Mexico, 8%; and other, 10%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Sand, construction | 2505.90.0000 | Free. |
| Gravel, construction | 2517.10.0000 | Free. |

**Depletion Allowance:** Common varieties, 5% (Domestic and foreign).

**Government Stockpile:** None.

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# SAND AND GRAVEL (CONSTRUCTION)

**Events, Trends, and Issues:** Construction sand and gravel output increased 5.4% in 2000. It is estimated that 2001 domestic production and U.S. apparent consumption will be about 1.2 billion tons each, a 2.6% increase. Aggregate consumption is expected to continue growing because of increased outlays for highway construction and maintenance provided by the Transportation Equity Act for the 21st Century (Public Law 105-178). The law guarantees that $165 billion will be obligated for highways and $35 billion for transit work through 2003.

The construction sand and gravel industry continued to be concerned with safety and health regulations and environmental restrictions. Shortages in urban and industrialized areas were expected to continue to increase because of local zoning regulations and land development. For these reasons, movement of sand and gravel operations away from highly populated centers is expected to continue.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves and reserve base[5] |
|---|---|---|---|
| | 1999 | 2000[e] | |
| United States | 1,110 | 1,170 | The reserves and reserve base are controlled largely by land use and/or environmental constraints. |
| Other countries | 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, their extraction is uneconomic in some cases. The most important commercial sources of sand and gravel have been river flood plains, river channels, and glacial deposits. Offshore deposits are being used presently in the United States, mostly for beach erosion control. Other countries mine offshore deposits of aggregates for onshore construction projects.

**Substitutes:** Crushed stone remains the predominant choice for construction aggregate use.

[e]Estimated. NA Not available.
[1]See also Sand and Gravel (Industrial).
[2]See Appendix A for conversion to short tons.
[3]Excludes Hawaii.
[4]Defined as imports - exports + adjustments for Government and industry stock changes; changes in stocks not available and assumed to be zero.
[5]See Appendix C for definitions.

# SAND AND GRAVEL (INDUSTRIAL)

(Data in thousand metric tons, unless otherwise noted)[1]

**Domestic Production and Use:** Industrial sand and gravel valued at about $542 million was produced by 76 companies from 136 operations in 37 States. Leading States, in order of tonnage, were Illinois, Michigan, California, Wisconsin, North Carolina, Oklahoma, Texas, and New Jersey. Combined production from these States represented 58% of the domestic total. About 38% of the U.S. tonnage was used as glassmaking sand, 22% as foundry sand, 5% as abrasive sand, 5% as hydraulic fracturing sand, and the remaining 30% for other uses.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production | 27,800 | 28,500 | 28,200 | 28,900 | 29,500 |
| Imports for consumption | 7 | 39 | 44 | 211 | 135 |
| Exports | 1,430 | 980 | 2,400 | 1,670 | 1,570 |
| Consumption, apparent | 26,400 | 27,600 | 26,200 | 27,400 | 28,000 |
| Price, average value, dollars per ton | 17.88 | 17.93 | 18.19 | 18.64 | 18.40 |
| Stocks, yearend | NA | NA | NA | NA | NA |
| Employment, quarry and mill, number[e] | 1,450 | 1,450 | 1,400 | 1,400 | 1,400 |
| Net import reliance[2] as a percent 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 amount of reused silica.

**Import Sources (1996-99):** Canada, 43%; Mexico, 39%; Australia, 13%; and other, 5%.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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.

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# SAND AND GRAVEL (INDUSTRIAL)

**Events, Trends, and Issues:** Domestic sales of industrial sand and gravel in 2000 increased by just over 2% compared to those of 1999. U.S. apparent consumption reached 28 million tons in 2000, the highest consumption since 1979. Imports dropped 36% in 2000 compared to those of 1999. Import levels in 1999 had been the highest reported in at least the past 20 years. Imports of silica are generally of two types: small-quantity shipments of very high purity silica or a few large shipments of lower grade silica that were shipped only when special circumstances were achieved (e.g., very low freight rates).

The United States was the world's largest producer and consumer of industrial sand and gravel based on estimated world production figures. It was difficult to collect definitive numbers on silica sand and gravel production in most nations because of the wide range of terminologies and specifications for silica from country to country. The United States remained a major exporter of silica sand, shipping sand to almost every region of the world. This was attributed to the high quality and advanced processing techniques of a large variety of grades of silica, meeting virtually every specification for silica sand and gravel.

It is estimated that 2001 domestic production and apparent consumption will be about 29.5 million tons and 28 million tons, respectively.

The industrial sand and gravel industry continued to be concerned with safety and health regulations and environmental restrictions in 2000. Local shortages were expected to continue to increase owing to local zoning regulations and land development alternatives. These situations are expected to continue to cause a movement of sand and gravel operations away from high-population centers.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production[e] | | Reserves and reserve base[3] |
|---|---|---|---|
| | 1999 | 2000 | |
| United States | 28,900 | 29,500 | |
| Australia | 2,500 | 2,500 | Large. Silica is abundant in the Earth's crust. The reserves and reserve base are determined mainly by the location of population centers. |
| Austria | 6,000 | 5,800 | |
| Belgium | 2,400 | 2,400 | |
| Brazil | 2,700 | 2,700 | |
| Canada | 2,000 | 2,000 | |
| France | 6,500 | 6,600 | |
| Germany | 7,000 | 6,800 | |
| India | 1,300 | 1,400 | |
| Italy | 3,000 | 3,000 | |
| Japan | 2,800 | 2,700 | |
| Mexico | 1,800 | 1,900 | |
| Netherlands | 3,000 | 3,000 | |
| Paraguay | 10,000 | 10,000 | |
| South Africa | 2,200 | 2,100 | |
| Spain | 6,000 | 6,000 | |
| United Kingdom | 4,000 | 4,000 | |
| Other countries | 15,000 | 15,000 | |
| World total (rounded) | 107,000 | 107,000 | |

**World Resources:** Sand and gravel resources of the world are sizable. However, because of their geographic distribution, environmental restrictions, and quality requirements for some uses, extraction of these resources is sometimes uneconomic. Quartz-rich sand and sandstones, the main source of industrial silica sand, occur throughout the world.

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

[e]Estimated. E Net exporter. NA Not available.
[1]See Appendix A for conversion to short tons.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions.

# SCANDIUM

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

**Domestic Production and Use:** Demand for scandium increased in 2000. Although scandium was not mined domestically in 2000, quantities sufficient to meet demand were available in domestic tailings. Principal sources were imports from Russia and Ukraine. Companies that processed scandium ores, concentrates, and low-purity compounds to produce refined scandium products were 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 1999 were aluminum alloys for sporting equipment, metallurgical research, high-intensity metal halide lamps, analytical standards, electronics, and laser research.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Price, yearend, dollars: | | | | | |
| Per kilogram, oxide, 99.0% purity | 1,400 | 1,400 | 1,100 | 900 | 700 |
| Per kilogram, oxide, 99.9% purity | 2,900 | 2,900 | 2,300 | 2,000 | 2,000 |
| Per kilogram, oxide, 99.99% purity | 4,400 | 4,400 | 3,400 | 3,000 | 3,000 |
| Per kilogram, oxide, 99.999% purity | 6,750 | 6,750 | 5,750 | 4,000 | 6,000 |
| Per gram, powder, metal[1] | 372.00 | 285.00 | 285.00 | 270.00 | 270.00 |
| Per gram, sublimed, metal[2] | 169.00 | 172.00 | 172.00 | 175.00 | 175.00 |
| Per gram, scandium bromide, 99.99% purity[3] | 80.00 | 90.00 | 90.00 | 91.80 | 91.80 |
| Per gram, scandium chloride, 99.9% purity[3] | 37.00 | 38.80 | 38.80 | 39.60 | 39.60 |
| Per gram, scandium fluoride, 99.9% purity[3] | 77.00 | 78.50 | 78.50 | 80.10 | 80.10 |
| Per gram, scandium iodide, 99.999% purity[3] | 78.00 | 148.00 | 148.00 | 151.00 | 151.00 |
| Net import reliance[4] as a percent of apparent consumption | 100 | 100 | 100 | 100 | 100 |

**Recycling:** Very minor, recovered from laser crystal rods.

**Import Sources (1996-99):** Not available.

| **Tariff:** **Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Mineral substances not elsewhere specified or included: Including scandium ores | 2530.90.0000 | 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 2000, 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 lacrosse sticks. A domestic gun manufacturer began producing high-strength, lightweight handgun frames and cylinders from scandium-aluminum alloys. Future demand is expected to be in fuel cells.

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# SCANDIUM

Scandium's use continued to increase in metal halide lighting. Scandium additions, as the metal or the iodide, mixed with other elements, were added to halide light bulbs to adjust the color to appear like natural sunlight. Demand also continued to increase for scandium-aluminum alloys. Future development is expected to occur in alloys for aerospace and specialty markets, including sports equipment. Market activity has increased since 1998, primarily to meet demand for alloying. Scandium's availability from the former Soviet Union increased substantially in 1992, after export controls were relaxed, and sales to the Western World, especially from Ukraine, have been increasing. China also continued to supply a small quantity of goods to the U.S. market.

The price of scandium materials varies greatly based on purity and quantity. The weight-to-price ratio of scandium metals and compounds was generally much higher for gram quantities than for kilogram purchases. Kilogram prices for scandium metal ingot were typically double the cost of the starting scandium compound, while higher purity distilled or sublimed metal ranged from four to six times the cost of the starting material.

**World Mine Production, Reserves, and Reserve Base:** Scandium was produced as a byproduct material in China, Kazakhstan, Ukraine, and Russia. Foreign mine production data were not available. No scandium was mined in the United States in 2000. Scandium occurs in many ores in trace amounts, but has not been found in sufficient quantities to be considered a reserve or reserve base. As a result of its low concentration, scandium has been produced exclusively as a byproduct during processing of various ores or recovered from previously processed tailings or residues.

**World Resources:** Resources of scandium are abundant, especially when considered in relation to actual and potential demand. Scandium is rarely concentrated in nature due to its lack of affinity to combine with the common ore forming anions. It is widely dispersed in the lithosphere and forms solid solutions in over 100 minerals. In the Earth's crust, scandium is primarily a trace constituent of ferromagnesium minerals. Concentrations in these minerals (amphibole-hornblende, pyroxene, and biotite) 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 rare-earth minerals, wolframite, columbite, cassiterite, beryl, garnet, muscovite, and the aluminum phosphate minerals. Recent domestic production has primarily been from the scandium-yttrium silicate mineral, thortveitite, and from byproduct leach solutions from uranium operations. Future production is expected from tantalum residues. One of the principal domestic scandium resources is the fluorite tailings from the Crystal Mountain deposit near Darby, MT. Tailings from the mined-out fluorite operations, which were generated from 1952 to 1971, contain the scandium mineral, thortveitite, and other associated scandium-enriched minerals. Resources are also contained in the tantalum residues previously processed at Muskogee, OK. Smaller resources are contained in tungsten, molybdenum, and titanium minerals from the Climax molybdenum deposit in Colorado, and in kolbeckite, varisite, and crandallite at Fairfield, UT. Other lower grade domestic resources are present in ores of aluminum, 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 a nickel and cobalt deposit in Syerston, New South Wales. China's resources are in tin, tungsten, and iron deposits in Jiangxi, Guangxi, Guangdong, Fujian, and Zhejian Provinces. Resources in Russia and Kazakhstan are in the Kola Peninsula apatites and in uranium-bearing deposits, respectively. Scandium in Madagascar is contained in pegmatites in the Befanomo area. Resources in Norway are dispersed in the thortveitite-rich pegmatites of the Iveland-Evje Region and a deposit in the northern area of Finnmark. In Ukraine, scandium is recovered as a byproduct of iron ore processing at Zheltye Voda. An occurrence of the mineral thortveitite is reported from Kobe, Japan. Undiscovered scandium resources are thought to be very large.

**Substitutes:** In applications, such as lighting and lasers, scandium is generally not subject to substitution. In metallurgical applications, titanium and aluminum high-strength alloys and carbon fiber may substitute in sporting goods, especially bicycle frames.

[e]Estimated.

[1]Less than 250 micron, 99.9% purity, 1995 through 1999 prices converted from 0.5-gram price, from Alfa Aesar, a Johnson Matthey company.

[2]Lump, sublimed dendritic 99.99% purity, from Alfa Aesar, a Johnson Matthey company.

[3]Bromide, chloride, and fluoride in crystalline or crystalline aggregate form and scandium iodide as ultradry powder from Alfa Aesar, a Johnson Matthey company.

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

# 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. Two copper refineries in Texas accounted for domestic production of primary selenium. Anode slimes from other primary electrolytic refiners were exported for processing. The estimated consumption of selenium by end use was as follows: glass manufacturing, 35%; chemicals and pigments, 20%; electronics, 13%; and other, including agriculture and metallurgy, 32%. In glass manufacturing, selenium was used to decolor container glass and other soda-lime silica glasses and to reduce solar heat transmission in architectural plate glass. Cadmium sulfoselenide red pigments, which have good heat stability, were used in ceramics and plastics. Chemical uses included rubber compounding chemicals, gun bluing, catalysts, human dietary supplements, and antidandruff shampoos. Dietary supplementation for livestock was the largest agricultural use. Combinations of bismuth and selenium were added to brasses to replace lead in plumbing applications. Selenium was added to copper, lead, and steel alloys to improve their machinability. In electronics, high-purity selenium was used primarily as a photoreceptor on the drums of plain paper copiers; but this application has reached the replacement-only stage as selenium has been supplanted by newer materials in currently manufactured copiers.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production, refinery | 379 | W | W | W | W |
| Imports for consumption, metal and dioxide | 428 | 346 | 339 | 326 | 452 |
| Exports, metal, waste and scrap | 322 | 127 | 151 | 233 | 89 |
| Consumption, apparent[1] | 564 | W | W | W | W |
| Price, dealers, average, dollars per pound, 100-pound lots, refined | 4.00 | 2.94 | 2.49 | 2.55 | 3.82 |
| Stocks, producer, refined, yearend | W | W | W | W | W |
| Employment, number | NA | NA | NA | NA | NA |
| Net import reliance[2] as a percent of apparent consumption | 38 | W | W | W | W |

**Recycling:** There was no domestic production of secondary selenium. Scrap xerographic materials were exported for recovery of the contained selenium. An estimated 70 tons of selenium metal recovered from scrap was imported in 2000.

**Import Sources (1996-99):** Philippines, 35%; Canada, 31%; Belgium, 13%; Japan, 6%; and other, 15%.

| **Tariff:** **Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Selenium metal | 2804.90.0000 | Free. |
| Selenium dioxide | 2811.29.2000 | Free. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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# SELENIUM

**Events, Trends, and Issues:** Domestic selenium consumption increased moderately when compared to that of 1999. World selenium demand and production were steady, so the oversupply situation that already existed was eased only slightly in 2000. The price of selenium rose from $2.78 per pound to $3.35 per pound during the first week of 2000. The price increase that began in 1999 continued until March 2000, when the price reached $4.30 per pound. It declined slowly to $3.95 per pound over a period of 2 months and remained steady until October, when it began to fall again. The price reached $3.25 per pound by yearend.

The use of selenium in glass remained strong. The use in copiers continued to decline, while the use in metallurgical additives increased. The use of selenium as an additive to no-lead, free-machining brasses for plumbing applications continued to increase as more stringent regulations on lead in drinking water took effect (ordinary free-machining brass contains up to 7% lead). Alloys with bismuth/selenium additions are dominating this market. Selenium reduces the quantity of bismuth needed, without adverse effects on alloy properties.

Research continued to confirm the effectiveness of dietary selenium supplementation for human cancer prevention. However, even if proven safe and effective, the dosage requirement for direct supplementation would be small, 200 to 400 micrograms per day per person; consequently, selenium demand would not change dramatically. Supplementation of fertilizer would be another way to achieve this public health benefit. Selenium already is added to fertilizer used to improve feed for livestock.

**World Refinery Production, Reserves, and Reserve Base:**

| | Refinery production | | Reserves[3] | Reserve base[3] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | W | W | 10,000 | 19,000 |
| Belgium | 200 | 200 | — | — |
| Canada | 438 | 400 | 7,000 | 15,000 |
| Chile | 49 | 50 | 19,000 | 30,000 |
| Finland | 26 | 25 | — | — |
| Germany | 100 | 100 | — | — |
| Japan | 548 | 550 | — | — |
| Peru | 21 | 20 | 2,000 | 5,000 |
| Philippines | 40 | 40 | 2,000 | 3,000 |
| Serbia and Montenegro | 10 | 10 | 1,000 | 1,000 |
| Sweden | 20 | 20 | — | — |
| Zambia | 13 | 10 | 3,000 | 6,000 |
| Other countries[4] | 12 | 10 | 27,000 | 55,000 |
| World total (rounded) | [5]1,480 | [5]1,400 | 70,000 | 130,000 |

**World Resources:** In addition to the reserve base of selenium, which is contained in identified economic copper deposits, 2.5 times this quantity of selenium was estimated to exist in copper or other metal deposits that were undeveloped, of uneconomic grade, or as yet undiscovered. Coal contains an average of 1.5 parts per million of selenium, which is about 80 times the average for copper deposits, but recovery of selenium from coal appears unlikely in the foreseeable future.

**Substitutes:** High-purity silicon has replaced selenium in high-voltage rectifiers and is the major substitute for selenium in low- and medium-voltage rectifiers. Other inorganic semiconductor materials, such as silicon, cadmium, tellurium, gallium, and arsenic, as well as organic photoconductors, substitute for selenium in photoelectric applications. Other substitutes include cerium oxide in glass manufacturing; tellurium in pigment and rubber compounding; 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.
[1]Calculated using reported shipments, imports of selenium metal, and 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, India, Kazakhstan, Russia, the United Kingdom, and Zimbabwe are known to produce refined selenium.
[5]Excludes the United States.

# 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 2000 was about $420 million. Ferrosilicon was produced by six companies in six plants, and silicon metal was produced by three companies in six plants. Two of the eight companies in the industry produced both products. Most of the ferrosilicon and silicon metal plants were east of the Mississippi River or in the Pacific Northwest. Most ferrosilicon was consumed in the ferrous foundry and steel industries, predominantly in the eastern one-half of the United States. The main consumers of silicon metal were producers of aluminum and aluminum alloys and the chemical industry. The semiconductor industry, which manufactures chips for computers from high-purity silicon, accounted for only a few percent of silicon demand.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production | 412 | 430 | 429 | 423 | 374 |
| Imports for consumption | 227 | 256 | 241 | 286 | 378 |
| Exports | 44 | 50 | 47 | 61 | 41 |
| Consumption, apparent | 594 | 628 | 616 | 643 | 715 |
| Price,[1] average, cents per pound Si: | | | | | |
| Ferrosilicon, 50% Si | 64.0 | 54.8 | 52.1 | 49.1 | 45 |
| Ferrosilicon, 75% Si | 62.2 | 48.0 | 43.1 | 40.2 | 36 |
| Silicon metal | 89.7 | 81.4 | 70.5 | 58.1 | 56 |
| Stocks, producer, yearend | 35 | 44 | 50 | 54 | 50 |
| Net import reliance[2] as a percent of apparent consumption | 31 | 32 | 30 | 34 | 48 |

**Recycling:** Insignificant.

**Import Sources (1996-99):** Norway, 29%; South Africa, 13%; Russia, 11%; Canada, 10%; and other, 37%.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Ferrosilicon, 55%-80% Si: | | |
| More than 3% Ca | 7202.21.1000 | 1.1% ad val. |
| Other | 7202.21.5000 | 1.5% ad val. |
| Ferrosilicon, 80%-90% Si | 7202.21.7500 | 1.9% ad val. |
| Ferrosilicon, more than 90% Si | 7202.21.9000 | 5.8% ad val. |
| Ferrosilicon, other: | | |
| More than 2% Mg | 7202.29.0010 | Free. |
| Other | 7202.29.0050 | Free. |
| Silicon, more than 99.99% Si | 2804.61.0000 | Free. |
| Silicon, 99.00%-99.99% Si | 2804.69.1000 | 5.3% ad val. |
| Silicon, other | 2804.69.5000 | 5.5% ad val. |

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

**Government Stockpile:** None.

**Events, Trends, and Issues:** Domestic apparent consumption of silicon for 2000 is projected as about 15% greater than the average for 1996-99. Of the 2000 total, ferrosilicon is estimated to account for 57% and silicon metal 43%, or almost the same amount as for 1999. The annual growth rate for ferrosilicon demand is expected to fall in the range of 1% to 2%, in line with long-term trends in steel production. For 2000, trends through August suggested that domestic steel production could be more than 10% greater than that for 1999. The annual growth rate for silicon metal demand has been greater than that for ferrosilicon—about 3% for silicon demand by the aluminum industry and about 8% for silicon demand by the chemical industry. Global demand by the chemical industry, principally for silicones, appears to have been recovering from effects of the recent Asian economic crisis, so a return to a growth rate of 4% or greater for silicon overall may be possible.

The decline projected for domestic production in 2000, expressed in terms of contained silicon, is concentrated in ferrosilicon, especially the 75% grade. Between September 1999 and January 2000, two domestic plants producing silicon materials were shut down, at least partly because of low prices.

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# SILICON

Through the first one-half of 2000, prices in the U.S. market for 75% ferrosilicon and silicon metal generally trended upward and then turned downward. The price quotation for 50% ferrosilicon was unchanged until it was discontinued in mid-September by the traditional source. Prices as of the end of September differed from those at the beginning of the year only by about 1%, lower for 75% ferrosilicon and higher for silicon metal. Year-average prices lower than for 1999 were projected for all forms of silicon; the largest percentage decline was for 75% ferrosilicon. At the end of September, the range in dealer import price, in cents per pound of contained silicon, was 43 to 47 for 50% ferrosilicon, 33.5 to 36 for 75% ferrosilicon, and 52 to 54 for silicon metal.

U.S. foreign trade in silicon materials in 2000, projected on the basis of data for the first 6 months of the year, showed substantial percentage changes as compared with trade in 1999, with increases for imports and decreases for exports. On an overall basis, this applied to ferrosilicon and silicon metal, giving rise to a net import reliance that approached 50%. At least for ferrosilicon, particularly the 75% grade, this could be seen as an outgrowth of removal of antidumping and countervailing duties late in 1999, a Governmental action being challenged in the courts.

**World Production, Reserves, and Reserve Base:**

| | Production[e] | | Reserves and reserve base[3] |
|---|---|---|---|
| | 1999 | 2000 | |
| United States | 423 | 374 | The reserves and reserve base in most major producing countries are ample in relation to demand. Quantitative estimates are not available. |
| Australia | 29 | 29 | |
| Brazil | 205 | 215 | |
| Canada | 66 | 65 | |
| China | 910 | 870 | |
| Egypt | 29 | 26 | |
| France | 145 | 145 | |
| Germany | 20 | 25 | |
| Iceland | 49 | 59 | |
| India | 36 | 33 | |
| Kazakhstan | 78 | 91 | |
| Macedonia | 33 | 27 | |
| Norway | 404 | 410 | |
| Poland | 47 | 47 | |
| Russia | 430 | 460 | |
| South Africa | 95 | 97 | |
| Spain | 55 | 52 | |
| Ukraine | 158 | 195 | |
| Venezuela | 37 | 42 | |
| Other countries | 103 | 115 | |
| World total (rounded) | 3,400 | 3,400 | |

Production quantities given above are combined totals of estimated content for ferrosilicon and silicon metal, as applicable. For the world, ferrosilicon accounts for about four-fifths of the total. The leading countries for ferrosilicon production were China, Norway, Russia, Ukraine, and the United States, and for silicon metal Brazil, China, France, Norway, and the United States. China was by far the largest producer of ferrosilicon and may well have been the largest producer of silicon metal. China's production of silicon metal is not included in this tabulation because data are not available.

**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:** Various metals and alloys, such as aluminum and silicomanganese, can be substituted for ferrosilicon in some applications. Germanium and gallium arsenide 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 2000, U.S. mine production of silver was about 2,100 tons with an estimated value of $338 million. Nevada was the largest producer, with more than 590 tons. Precious metal ores accounted for approximately one-half of domestic silver production; the other one-half was recovered as a byproduct from processing of copper, lead, and zinc ores. There were 22 principal refiners of commercial-grade silver with an estimated output of approximately 4,000 tons. About 30 fabricators accounted for more than 90% of the silver consumed in arts and industry. The remainder was consumed mostly by small companies and artisans. Aesthetic uses of silver for decorative articles, jewelry, tableware, and coinage were overshadowed by industrial and technical uses. Industrial and technical uses include photographic materials, electrical products, catalysts, brazing alloys, dental amalgam, and bearings.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: Mine | 1,570 | 2,180 | 2,060 | 1,950 | 2,060 |
| Refinery: Primary | NA | 2,200 | 2,300 | 2,000 | 2,200 |
| Secondary | NA | 1,360 | 1,700 | 1,500 | 1,600 |
| Imports for consumption[2] | 3,010 | 2,540 | 3,330 | 2,660 | 4,360 |
| Exports[2] | 2,950 | 3,080 | 2,250 | 481 | 346 |
| Consumption, apparent[e] | NA | 6,000 | 6,200 | 6,100 | 7,700 |
| Price, dollars per troy ounce[3] | 5.19 | 4.89 | 5.54 | 5.25 | 5.25 |
| Stocks, yearend: Treasury Department[4] | 402 | 484 | 582 | 617 | 600 |
| COMEX, CBT[5] | 4,550 | 3,430 | 2,360 | 2,360 | 2,400 |
| National Defense Stockpile | 1,450 | 1,220 | 1,030 | 778 | 200 |
| Employment, mine and mill,[6] number | 1,400 | 1,550 | 1,550 | 1,600 | 1,500 |
| Net import reliance[7] as a percent of apparent consumption[e] | NA | E | 43 | 39 | 52 |

**Recycling:** About 1,600 tons of silver was recovered from old and new scrap in 2000.

**Import Sources[2] (1996-99):** Canada, 36%; Mexico, 31%; Peru, 8%; United Kingdom, 5%; and other, 20%.

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

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

**Government Stockpile:** The Government continued to dispose of the silver held in the National Defense Stockpile, using it primarily for the production of commemorative coins and the Eagle silver bullion coins. During the past 18 years, from 1982 through September 30, 2000, the Government has reduced the quantity of silver held in the Stockpile from 4,300 tons to about 496 tons.

**Stockpile Status—9-30-00[8]**

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Silver | 496 | — | 496 | 311 | 319 |

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# SILVER

**Events, Trends, and Issues:** Photographic applications account for about 28% of total silver demand, and digital imaging is considered to be a potential threat to this sector of the market. In contrast to the use of silver halide film in conventional photography, digital technology converts images directly into electronic form, thereby avoiding the need for silver. Silver halide pictures may also be scanned into electronic form, which necessitates the use of silver in taking and printing the picture but eliminates the need for silver halide technology in further processing.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[9] | Reserve base[9] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 1,950 | 2,060 | 33,000 | 72,000 |
| Australia | 1,720 | 1,850 | 30,000 | 36,000 |
| Canada | 1,250 | 1,300 | 37,000 | 47,000 |
| Mexico | 2,340 | 2,500 | 37,000 | 40,000 |
| Peru | 2,220 | 2,000 | 25,000 | 37,000 |
| Other countries | 8,230 | 8,190 | 120,000 | 190,000 |
| World total (may be rounded) | 17,700 | 17,900 | 280,000 | 420,000 |

**World Resources:** More than two-thirds of world silver resources are associated with copper, lead, and zinc deposits, often at great depths. The remainder is in vein deposits in which gold is the most valuable metallic component. Although most recent discoveries have been primarily gold and silver deposits, significant future reserves and resources are expected from major base metal discoveries that contain byproduct silver. Although 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 primary 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. E Net exporter. NA Not available.
[1]One metric ton (1,000 kilograms) = 32,150.7 troy ounces.
[2]Refined bullion, plus silver content of ores, concentrates, precipitates, and doré; excludes coinage, waste, and scrap material.
[3]Handy & Harman quotations.
[4]Balance in U.S. Mint only.
[5]COMEX: Commodity Exchange Inc., New York. CBT: Chicago Board of Trade.
[6]Source: Mine Safety and Health Administration.
[7]Defined as imports - exports + adjustments for Government and industry stock changes.
[8]See Appendix B for definitions.
[9]Includes silver recoverable from base metal ores. See Appendix C for definitions.

# SODA ASH

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** Four companies in Wyoming with five plants, one company in California with one plant, and one company with one plant in Colorado comprised the U.S. soda ash (sodium carbonate) industry, which was the largest in the world. The six producers had a combined annual nameplate capacity of 14.5 million tons. Sodium bicarbonate, sodium sulfate, potassium chloride, potassium sulfate, borax, and other minerals were produced as coproducts from sodium carbonate production in California. Sodium bicarbonate, sodium sulfite, sodium tripolyphosphate, and chemical caustic soda were manufactured as coproducts at several of the Wyoming soda ash plants. Sodium bicarbonate was produced as a coproduct at the Colorado operation. The total estimated value of domestic soda ash produced in 2000 was $680 million.[1]

Based on final 1999 data, the estimated 2000 reported distribution of soda ash by end use was glass, 51%; chemicals, 26%; soap and detergents, 11%; distributors, 5%; flue gas desulfurization, pulp and paper, and water treatment, 2% each; and other, 1%.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production[2] | 10,200 | 10,700 | 10,100 | 10,200 | 10,200 |
| Imports for consumption | 107 | 101 | 83 | 92 | 90 |
| Exports | 3,840 | 4,190 | 3,660 | 3,620 | 3,800 |
| Consumption: Reported | 6,390 | 6,480 | 6,550 | 6,430 | 6,500 |
| Apparent | 6,470 | 6,620 | 6,560 | 6,740 | 6,500 |
| 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 | 82.60 | 77.25 | 75.30 | 69.11 | 67.00 |
| Stocks, producer, yearend | 271 | 259 | 273 | 248 | 275 |
| Employment, mine and plant, number | 2,800 | 2,800 | 2,700 | 2,600 | 2,400 |
| Net import reliance[3] as a percent of apparent consumption | E | E | E | E | E |

**Recycling:** Producers do not recycle soda ash. Glass container producers, however, are using cullet glass, thereby reducing soda ash consumption.

**Import Sources (1996-99):** Canada, 99%; and other, 1%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Disodium carbonate | 2836.20.0000 | 1.2% ad val. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

**Events, Trends, and Issues:** On October 9, the newest U.S. soda ash company began operation at its $250 million facility at Parachute, CO. This is the world's first natural soda ash plant that will use nahcolite (natural sodium bicarbonate) as feedstock instead of trona or sodium-carbonate-bearing brines. Hot water was injected into 26 production wells at the site, which is about 72 kilometers from the processing plant. The enriched solution will be transported through a buried insulated pipeline. The first soda ash product was scheduled for shipment in January 2001. The operation employed approximately 130 people, of which the majority were local residents.

The economic problems in Asia that began in late-1997 and continued into 2000 had basically subsided by midyear. Although U.S. soda ash exports began to rise by mid-2000, China continued to increase its soda ash production and exports to local Asian consumers.

In September, all domestic soda ash producers announced a $5.00 per short ton price increase effective October 1 or as contracts permit. Because the majority of soda ash is sold on annual calendar-year contacts beginning in January, how much the price increased by yearend 2000 was uncertain.

A fully recyclable plastic beer bottle was introduced nationwide by a major national beer manufacturing company.

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# SODA ASH

The product had been test marketed since late 1998, and growing consumer and retailer demand for the container led to the decision to expand production lines for the new plastic bottle. Aside from its recyclability with other polyethylene terephthalate plastic containers, the new plastic bottle keeps beer as cold as glass containers and longer than aluminum cans, is one-seventh the weight of comparably sized glass containers, is resealable, and is unbreakable. Its unbreakability makes the plastic beer bottle more acceptable at places where glass bottles are prohibited, such as beaches and stadiums. Many baseball, basketball, football, and hockey stadiums have endorsed the plastic beer containers. The growing consumer acceptance for plastic beer bottles will reduce glass container production and, therefore, soda ash consumption.

World soda ash consumption is forecast to remain favorable into the next millennium because of growing demand for soda ash in developing nations, especially in the Far East and in South America. Exports will continue to be the most important market for increased U.S. soda ash sales. Consolidation within the U.S. soda ash industry will reduce the number of suppliers but should strengthen soda ash sales and prices. Soda ash consumption in glass containers will probably continue to decline as lightweight bottles and plastic containers displace the quantity of new raw materials for glass manufacture.

Notwithstanding the economic problems in certain areas of the world, the overall world demand for soda ash is expected to grow 1.5% to 2% per year in the early part of this century. Domestic demand is expected to be slightly higher in 2001.

**World Production, Reserves, and Reserve Base:**

| | Production | | Reserves[4 5] | Reserve base[4 5] |
|---|---|---|---|---|
| Natural: | 1999 | 2000[e] | | |
| United States | 10,200 | 10,200 | [6]23,000,000 | [6]39,000,000 |
| Botswana | 196 | 190 | 400,000 | NA |
| Kenya | 240 | 225 | 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 (may be rounded) | 10,600 | 10,600 | 24,000,000 | 40,000,000 |
| World total, synthetic (rounded) | 22,300 | 20,400 | — | — |
| World total (rounded) | 32,900 | 31,000 | — | — |

**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 that are 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 that are 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 enable companies to develop some of the deeper economic trona. Wyoming trona resources are being depleted at the rate of about 15 million tons per year (8.3 million tons per year of soda ash). Searles Lake and Owens Lake in California contain an estimated 815 million tons of soda ash reserves. At least 62 identified natural sodium carbonate deposits are in the world; some 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.
[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 in California and Texas. Fifteen companies operating 17 plants in 15 States recovered byproduct sodium sulfate from various manufacturing processes, including ascorbic acid, battery reclamation, cellulose, rayon, and silica pigments. More than one-half of total production was as byproduct from these facilities. 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, 45%; textiles, 18%; pulp and paper, 13%; glass, 10%; and miscellaneous, 14%.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: Total (natural and synthetic)[1] | 602 | 640 | 571 | 599 | 525 |
| Imports for consumption | 177 | 150 | 110 | 87 | 80 |
| Exports | 86 | 86 | 90 | 137 | 125 |
| Consumption, apparent (natural and synthetic) | 690 | 697 | 591 | 549 | 480 |
| 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 percent of apparent consumption | 13 | 9 | 3 | 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 (1996-99):** Canada, 95%; Mexico, 4%; and other, 1%.

| **Tariff: Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| 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:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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# SODIUM SULFATE

**Events, Trends, and Issues:** In July, a petition for the imposition of an antidumping duty on imports of anhydrous sodium sulfate from Canada was filed with the U.S. International Trade Commission (USITC) by the two U.S. natural sodium sulfate companies. The petitioners claimed that the imported Canadian product was sold at less than fair market value and at prices lower than the Canadian producers' cost of production. The domestic producers cited that the low-priced product adversely affected their sales to domestic customers. In August, the USITC issued its determination that there was no reasonable indiction that imported anhydrous sodium sulfate from Canada materially injured or threatened the U.S. sodium sulfate industry.

A Canadian-based mining company announced details of its plans to construct an iodine heap-leaching facility in Chile that would also produce potassium nitrate and sodium sulfate. The first phase of the proposed project at Aguas Blancas was scheduled to come on-stream in the first quarter of 2001. Production of sodium sulfate will begin in the project's third phase of development, which may be as late as 2007. Because of the reduced demand for sodium sulfate during the past 2 years, the company intended to wait until the demand for sodium sulfate in developing countries improved. Once in operation, the facility will have an annual capacity of 300,000 tons and be one of the lowercost producers in the world.

Sodium sulfate production and consumption in 2001 is expected to be slightly lower than that for 2000, with detergents remaining the largest sodium sulfate-consuming sector. 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 between 1.5 million and 2.0 million tons.

| | Reserves[3] | Reserve base[3] |
|---|---|---|
| Natural: | | |
| 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 | 100,000 | 200,000 |
| World total, natural (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 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 can also be obtained as a byproduct from the production of ascorbic acid, boric acid, cellulose, chromium chemicals, lithium carbonate, rayon, resorcinol, and silica pigments. The quantity and availability of byproduct sodium sulfate are dependent on the production capabilities of the primary industries and the sulfate recovery rates.

**Substitutes:** In pulp and paper, emulsified sulfur and caustic soda (sodium hydroxide) can replace sodium sulfate. In detergents, a variety of products can substitute for sodium sulfate. In glassmaking, soda ash and calcium sulfate have been substituted for sodium sulfate with less effective results.

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

# STONE (CRUSHED)[1]

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

**Domestic Production and Use:** Crushed stone valued at $8.7 billion was produced by 1,500 companies operating 3,800 active quarries in 49 States. Leading States, in order of production, were Texas, Florida, Pennsylvania, Illinois, Georgia, Missouri, Ohio, North Carolina, Virginia, and Tennessee, together accounting for 51% of the total output. It is estimated that, of the 1.6 billion tons of crushed stone produced in 2000, about 43% was for unspecified uses with 14% estimated for nonrespondents. Of the remaining 866 million tons, 84% was used as construction aggregates mostly for highway and road construction and maintenance; 13% for chemical and metallurgical uses, including cement and lime manufacture; 2% for agricultural uses; and 1% for special and miscellaneous uses and products. To provide a more accurate estimate of the consumption patterns for crushed stone, the "unspecified uses" as defined in the U.S. Geological Survey (USGS) Minerals Yearbook, are not included in the above percentages. Of the total crushed stone produced in 2000, about 70% was limestone and dolomite; 16%, granite; 7%, traprock; and the remaining 7%, was shared, in descending order of quantity, by sandstone and quartzite, miscellaneous stone, marble, slate, calcareous marl, shell, and volcanic cinder and scoria.

The estimated output of crushed stone in the 48 conterminous States shipped for consumption in the first 9 months of 2000 was 1.2 billion tons, which represents an increase of 3.1% compared with the same period of 1999. The estimated output of construction sand and gravel produced for consumption in the first 9 months of 2000 was 860 million metric tons, an increase of 4.1% compared with the same period of 1999. Additional production information, by quarter for each State, geographic division, and the United States, is published in the USGS quarterly Mineral Industry Surveys for Crushed Stone and Sand and Gravel.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production | 1,330 | 1,410 | 1,510 | 1,540 | 1,590 |
| Imports for consumption | 11 | 12 | 14 | 12 | 12 |
| Exports | 3 | 4 | 4 | 4 | 4 |
| Consumption, apparent | 1,338 | 1,418 | 1,520 | 1,548 | 1,598 |
| Price, average value, dollars per metric ton | 5.40 | 5.64 | 5.39 | 5.35 | 5.40 |
| Stocks, yearend | NA | NA | NA | NA | NA |
| Employment, quarry and mill, number[e 3] | 76,000 | 77,600 | 78,500 | 79,000 | 79,000 |
| Net import reliance[4] as a percent of apparent consumption | — | — | — | — | — |

**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 (1996-99):** Canada, 54%; Mexico, 31%; The Bahamas, 8%; and other, 7%.

| **Tariff:** **Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| Crushed stone | 2517.10.00 | Free. |

**Depletion Allowance:** For some special uses, 14% (Domestic and foreign); if used as riprap, ballast, road material, concrete aggregate, and similar purposes, 5% (Domestic and foreign).

**Government Stockpile:** None.

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# STONE (CRUSHED)

**Events, Trends, and Issues:** Crushed stone output increased 3.9% in 2000 to 1.6 billion tons. It is estimated that in 2001, domestic production and apparent consumption will be about 1.65 billion tons each, a 3.8% increase. The Transportation Equity Act for the 21st Century (Public Law 105-178) appropriated $205 billion through 2003, a 44% increase compared to the previous Intermodal Surface Transportation Efficiency Act legislation. The law guarantees that $165 billion will be obligated for highways and $35 billion for transit work. The guaranteed amounts are linked to actual Highway Trust Fund receipts, and can only be used for highways and highway safety programs. The States are also guaranteed a return of at least 90.5% of their contributions to the Highway Trust Fund. The legislation also established timetables for determining if States are complying with the U.S. Environmental Protection Agency's new air quality standards for particulate matter, also known as PM 2.5.

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

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves and reserve base[5] |
|---|---|---|---|
| | 1999 | 2000[e] | |
| United States | 1,540 | 1,590 | Adequate except where special |
| Other countries | 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 construction aggregates include sand and gravel, slag, sintered or expanded clay or shale, and perlite or vermiculite.

[e]Estimated. NA Not available.
[1]See also Stone (Dimension).
[2]See Appendix A for conversion to short tons.
[3]Including office staff.
[4]Defined as imports - exports + 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.

# STONE (DIMENSION)[1]

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** Approximately 1.25 million tons of dimension stone, valued at $243 million, was sold or used in 2000. Dimension stone was produced by 142 companies, operating 192 quarries, in 33 States and Puerto Rico. Leading producer States, in descending order by tonnage, were Indiana, Vermont, Wisconsin, Georgia, and Texas. These five States accounted for 48% of the tonnage output. Leading producer States, in descending order by value, were Indiana, Vermont, Texas, Minnesota, and South Dakota. These States contributed 49% of the value of domestic production. Approximately 36%, by tonnage, of dimension stone sold or used was limestone, followed by granite (35%), sandstone (16%), marble (3%), slate (2%), and miscellaneous stone (8%). By value, the largest sales or uses were for granite (45%), followed by limestone (29%), sandstone (10%), slate (6%), marble (4%), and miscellaneous stone (6%). Rough block represented 57% of the tonnage and 40% of the value of all the dimension stone sold or used by domestic producers, including exports. The largest uses of rough block, by tonnage, were in construction (49%) and monuments (19%). Dressed stone was sold for flagging (25%), ashlars and partially squared pieces (19%), and curbing (10%), by tonnage.

| **Salient Statistics—United States:**[2] | **1996** | **1997** | **1998** | **1999** | **2000**[e] |
|---|---|---|---|---|---|
| Production: Tonnage | 1,150 | 1,180 | 1,140 | 1,250 | 1,250 |
| Value, million dollars | 234 | 225 | 225 | 255 | 243 |
| Imports for consumption, value, million dollars | 462 | 548 | 698 | 808 | 1,060 |
| Exports, value, million dollars | 50 | 55 | 60 | 55 | 71 |
| Consumption, apparent, value, million dollars | 646 | 718 | 863 | 1,010 | 1,230 |
| 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 percent of apparent consumption (based on value) | 64 | 69 | 74 | 75 | 80 |
| Granite only: | | | | | |
| Production | 501 | 444 | 420 | 437 | 430 |
| Imports for consumption | NA | NA | NA | NA | NA |
| Exports (rough and finished) | 137 | 166 | 145 | 166 | 160 |
| 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 percent 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 (1996-99 by value):** Dimension stone: Italy, 38%; Canada, 9%; Spain, 9%; India, 6%; and other, 38%. Granite only: Italy, 44%; Brazil, 17%; Canada, 10%; India, 10%; and other, 19%.

**Tariff:** Dimension stone tariffs ranged from free to 6.5% ad valorem for countries with normal trade relations in 2000, according to type, degree of preparation, shape, and size. Most crude or rough trimmed stone was imported for 3.0% ad valorem or less.

**Depletion Allowance:** 14% (Domestic and foreign); slate used or sold as sintered or burned lightweight aggregates, 7.5% (Domestic and foreign); dimension stone used for rubble and other nonbuilding purposes, 5% (Domestic and foreign).

**Government Stockpile:** None.

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# STONE (DIMENSION)

**Events, Trends, and Issues:** Domestic production remained steady at 1.25 million tons valued at $243 million in 2000—a $12 million decrease in value compared with that of 1999. Imports increased by 31% in value to $1.06 billion, making 2000 the third consecutive year of double-digit increases in imports. Dimension stone exports rose to $71 million. With the continued growth in the U.S. economy, markets for dimension stone have increased. Apparent consumption, by value, was $1.2 billion in 2000—a $220 million increase over the previous year. Dimension stone is being used more commonly in residential markets. Additionally, improved quarrying, finishing, and handling technology, as well as a greater variety of stone and the rising costs of alternative construction materials, are among the factors that suggest an increased demand for dimension stone during the next 5 to 10 years.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves and reserve base[5] |
|---|---|---|---|
| | 1999 | 2000[e] | |
| United States | 1,250 | 1,250 | 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 brick, concrete, steel, aluminum, resin-agglomerated stone, ceramic tile, plastics, and glass.

[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, 10%; pyrotechnics and signals, 6%; and other applications, 9%.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production, strontium minerals | — | — | — | — | — |
| Imports for consumption: | | | | | |
| Strontium minerals | 11,600 | 12,500 | 10,600 | 13,700 | 12,000 |
| Strontium compounds | 20,500 | 26,000 | 25,000 | 26,800 | 31,000 |
| Exports, compounds | 712 | 599 | 875 | 2,890 | 4,700 |
| Shipments from Government stockpile excesses | — | — | — | — | — |
| Consumption, apparent, celestite and compounds | 31,400 | 37,900 | 34,700 | 37,600 | 38,000 |
| Price, average value of mineral imports at port of exportation, dollars per ton | 67 | 72 | 60 | 73 | 63 |
| Net import reliance[2] as a percent of apparent consumption | 100 | 100 | 100 | 100 | 100 |

**Recycling:** None.

**Import Sources (1996-99):** Strontium minerals: Mexico, 100%. Strontium compounds: Mexico, 91%; Germany, 7%; and other, 2%. Total imports: Mexico, 94%; Germany, 5%; and other, 1%.

| **Tariff:** Item | Number | Normal Trade Relations[3] 12/31/00 |
|---|---|---|
| Celestite | 2530.90.0010 | Free. |
| Strontium metal | 2805.22.1000 | 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 | 2816.20.0000 | 4.2% ad val. |

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

**Government Stockpile:** Although 5,100 tons of celestite is in the National Defense Stockpile, none of it is stockpile grade; its total value is listed as zero. The stockpile goal for celestite was reduced to zero in 1969, and at that time, the stockpile contained stockpile- and nonstockpile-grade material. Since then, all the stockpile-grade celestite has been sold. Although the nonstockpile-grade celestite has been offered for sale, none has been sold since 1979. The fiscal year 2001 Annual Materials Plan, announced at the end of September 2000 by the Defense National Stockpile Center, listed 3,270 tons of 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.

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# STRONTIUM

**Events, Trends, and Issues:** With celestite production second only to Mexico, Spain has historically exported its celestite output. The new strontium carbonate plant that was completed in 2000 created additional celestite demand for domestic processing. With a large celestite deposit, Algeria was looking for partners to expand production and to build a strontium carbonate plant for the export market.

**World Mine Production, Reserves, and Reserve Base:**[4]

| | Mine production | | Reserves[5] | Reserve base[5] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | — | — | — | 1,400,000 |
| Algeria | 5,400 | 5,400 | | |
| Argentina | 3,000 | 3,000 | | |
| China | 35,000 | 35,000 | | |
| Iran | 20,000 | 20,000 | | |
| Mexico | 120,000 | 120,000 | Other: | Other: |
| Pakistan | 600 | 600 | 6,800,000 | 11,000,000 |
| Spain | 95,000 | 95,000 | | |
| Tajikistan | NA | NA | | |
| Turkey | 25,000 | 25,000 | | |
| World total (may be rounded) | [6]304,000 | [6]304,000 | 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.
[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]No tariff for Mexico for items shown.
[4]Metric tons of strontium minerals.
[5]See Appendix C for definitions.
[6]Excludes Tajikistan.

# SULFUR

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

**Domestic Production and Use:** In 2000, elemental sulfur and byproduct sulfuric acid were produced at 128 operations in 30 States and the U.S. Virgin Islands. Total shipments were valued at about $320 million. Elemental sulfur production was 9.4 million tons; Texas and Louisiana accounted for about 50% of domestic production. Elemental sulfur was recovered at petroleum refineries, natural-gas-processing plants, and coking plants by 52 companies at 121 plants in 26 States and the U.S. Virgin Islands. Elemental sulfur was produced at one mine by using the Frasch method of mining; that mine closed during the year. Byproduct sulfuric acid, representing 10% of sulfur in all forms, was recovered at 11 nonferrous smelters in 8 States by 9 companies. Three copper smelters that previously generated byproduct sulfuric acid were idle. Domestic elemental sulfur provided 67% of domestic consumption, and byproduct acid accounted for 7%. The remaining 26% of sulfur consumed was provided by imported sulfur and sulfuric acid. About 90% of sulfur was consumed in the form of sulfuric acid. Agricultural chemicals (primarily fertilizers) composed 70% of reported sulfur demand; petroleum refining, 15%; metal mining, 6%; and organic and inorganic chemcials, 5%. Other uses, accounting for 4% 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:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production: | | | | | |
| Frasch[e] | 2,900 | 2,820 | 1,800 | 1,780 | 1,000 |
| Recovered elemental | 7,480 | 7,650 | 8,220 | 8,220 | 8,400 |
| Other forms | 1,430 | 1,550 | 1,610 | 1,320 | 1,000 |
| Total[e] | 11,800 | 12,000 | 11,600 | 11,300 | 10,400 |
| Shipments, all forms | 11,800 | 11,900 | 12,100 | 11,100 | 10,600 |
| Imports for consumption: | | | | | |
| Recovered, elemental | 1,960 | 2,060 | 2,270 | 2,580 | 3,000 |
| Sulfuric acid, sulfur content | 678 | 659 | 668 | 447 | 460 |
| Exports: | | | | | |
| Frasch and recovered elemental | 855 | 703 | 889 | 685 | 700 |
| Sulfuric acid, sulfur content | 38 | 39 | 51 | 51 | 58 |
| Consumption, apparent, all forms | 13,600 | 13,900 | 14,100 | 13,400 | 13,300 |
| Price, reported average value, dollars per ton of elemental sulfur, f.o.b., mine and/or plant | 34.11 | 36.06 | 29.14 | 37.81 | 32.00 |
| Stocks, producer, yearend | 646 | 761 | 283 | 451 | 300 |
| Employment, mine and/or plant, number | 3,100 | 3,100 | 3,100 | 3,000 | 3,000 |
| Net import reliance[1] as a percent of apparent consumption | 13 | 13 | 18 | 16 | 22 |

**Recycling:** About 3 million tons of spent acid was reclaimed from petroleum refining and chemical processes.

**Import Sources (1996-99):** Elemental: Canada, 67%; Mexico, 23%; Venezuela, 7%; and other, 3%. Sulfuric acid: Canada, 75%; Japan, 8%; Mexico, 7%; Germany, 4%; and other, 6%. Total sulfur imports: Canada, 70%; Mexico, 20%; Venezuela, 4%; and other, 6%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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.

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# SULFUR

**Events, Trends, and Issues:** The last domestic Frasch sulfur mine closed in August as a result of reduced demand, low prices, and increased production costs, thus permanently ending discretionary sulfur production in the United States. Production of recovered elemental sulfur from petroleum refineries will continue its steady growth, supported by new facilities being installed to increase refining capacity and the capability of current operations to handle higher sulfur crude oil, especially from Mexico and Venezuela. During the next few years, oil refineries will be installing additional equipment to remove even more sulfur from gasoline to comply with the new environmental regulations enacted in 2000. Recovered sulfur from natural gas processing was about the same. The amount of byproduct sulfuric acid produced is closely tied to copper smelting, which has experienced a slump in recent years; and so, byproduct acid production continued its downward trend.

World production of native sulfur decreased in response to increased production of recovered elemental sulfur; pyrites production decreased because of environmental and cost considerations. Many countries that had not previously recovered sulfur at oil refineries were upgrading their refineries for that purpose and improving sulfur capture at nonferrous metal smelters. Improving economic conditions in developing countries prompted increased environmental protection measures approaching those in Japan, North America, and Western Europe.

Apparent consumption of sulfur in all forms is projected to remain steady at about 13.3 million tons in 2001 unless phosphate fertilizer demand increases. To supply steady consumption while production decreases, additional imports will be necessary. Additional facilities for importing formed sulfur were under development.

**World Production, Reserves, and Reserve Base:**

| | Production—All forms | | Reserves[2] | Reserve base[2] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 11,300 | 10,400 | 140,000 | 230,000 |
| Canada | 10,100 | 10,300 | 160,000 | 330,000 |
| Chile | 1,040 | 1,100 | NA | NA |
| China | 5,690 | 5,200 | 100,000 | 250,000 |
| Finland | 725 | 730 | NA | NA |
| France | 1,100 | 1,100 | 10,000 | 20,000 |
| Germany | 1,190 | 1,200 | NA | NA |
| Iran | 910 | 920 | NA | NA |
| Italy | 678 | 700 | NA | NA |
| Japan | 3,460 | 3,500 | 5,000 | 15,000 |
| Kazakhstan | 1,320 | 1,400 | NA | NA |
| Kuwait | 675 | 680 | NA | NA |
| Mexico | 1,310 | 1,300 | 75,000 | 120,000 |
| Netherlands | 574 | 580 | NA | NA |
| Poland | 1,510 | 1,300 | 130,000 | 300,000 |
| Russia | 5,270 | 5,500 | NA | NA |
| Saudi Arabia | 2,400 | 2,400 | 100,000 | 130,000 |
| Spain | 955 | 900 | 50,000 | 300,000 |
| United Arab Emirates | 1,090 | 1,200 | NA | NA |
| Other countries | 6,700 | 7,000 | 630,000 | 1,800,000 |
| World total (may be rounded) | 57,100 | 57,400 | 1,400,000 | 3,500,000 |

**World Resources:** Resources of elemental sulfur in evaporite and volcanic deposits and sulfur associated with natural gas, petroleum, tar sands, and metal sulfides amount to about 5 billion tons. The sulfur in gypsum and anhydrite is almost limitless, and some 600 billion tons are 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 unless the deposits are already developed. Sulfur from petroleum and metal sulfides may be recovered where they are 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. NA Not available.

[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 2000 domestic talc production was $25 million. There were 12 talc-producing mines in 6 States in 2000. Companies in Montana, New York, Texas, and Vermont accounted for most of the domestic production. Ground talc was consumed in ceramics, 27%; paper, 22%; paint, 18%; plastics, 8%; roofing, 8%; cosmetics, 4%; and other, 13%. Three firms in California and North Carolina accounted for all of the domestic pyrophyllite production, which decreased from that of 1999. Consumption was, in decreasing order, in ceramics, refractories, and paint.

| **Salient Statistics—United States:**[1] | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, mine | 994 | 1,050 | 971 | 925 | 961 |
| Sold by producers | 909 | 942 | 870 | 881 | 877 |
| Imports for consumption | 187 | 123 | 165 | 208 | 290 |
| Exports | 192 | 179 | 146 | 147 | 165 |
| Shipments from Government stockpile excesses | — | — | — | ([2]) | — |
| Consumption, apparent | 989 | 992 | 990 | 986 | 1,090 |
| Price, average, processed dollars per ton | 111 | 118 | 126 | 116 | 117 |
| Stocks, producer, yearend | NA | NA | NA | NA | NA |
| Employment, mine and mill | 750 | 750 | 700 | 700 | 680 |
| Net import reliance[3] as a percent of apparent consumption | E | E | 2 | 6 | 12 |

**Recycling:** Insignificant.

**Import Sources (1996-99):** China, 45%; Canada, 19%; France, 12%; Japan, 9%; and other, 15%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Crude, not ground | 2526.10.0000 | Free. |
| Ground, washed, powdered | 2526.20.0000 | Free. |
| Cut or sawed | 6815.99.2000 | Free. |

**Depletion Allowance:** Block steatite talc: 22% (Domestic), 14% (Foreign). Other: 14% (Domestic and foreign).

**Government Stockpile:**

**Stockpile Status—9-30-00**[4]
**(Metric tons)**

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Talc, block and lump | 907 | — | 907 | 907 | 2 |
| Talc, ground | 988 | — | 988 | — | — |

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# TALC AND PYROPHYLLITE

**Events, Trends, and Issues:** Production increased 4%, and sales were unchanged from those of 1999. Apparent consumption increased 10%. Exports increased by 12% compared with those of 1999. Canada was the major importer of U.S. talc. U.S. imports of talc increased by 39% compared with those of 1999. Canada, China, and Japan supplied approximately 77% of the imported talc and accounted for more than 60% of the increase in imports in 2000.

The U.S. Department of Health and Human Services, National Toxicology Program, considered including talc on its list of carcinogens in its *10th Report on Carcinogens* for Congress. The program panel cited the results of recent health studies and reevaluations of previous studies as the basis for this action.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[5] | Reserve base[5] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States[1] | 925 | 961 | 140,000 | 540,000 |
| Brazil | 452 | 450 | 14,000 | 54,000 |
| China | 3,900 | 3,900 | Large | Large |
| India | 535 | 530 | 4,000 | 9,000 |
| Japan | 800 | 825 | 130,000 | 200,000 |
| Korea, Republic of | 875 | 880 | 14,000 | 18,000 |
| Other countries | 1,980 | 1,940 | Large | Large |
| World total (rounded) | 9,470 | 9,490 | 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. E Net exporter. NA Not available
[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]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. The value of tantalum consumed in 2000 was estimated at about $200 million.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, mine | — | — | — | — | — |
| Imports for consumption: | | | | | |
| Concentrate, metal, alloys | 563 | 467 | 588 | 564 | 700 |
| Other[1] | NA | NA | NA | NA | NA |
| Exports, concentrate, metal, alloys, waste, and scrap[e] | 290 | 340 | 440 | 480 | 540 |
| Government stockpile releases[e 2] | 34 | 20 | 213 | 5 | 133 |
| Consumption: Reported, raw material | NA | NA | NA | NA | NA |
| Apparent | 524 | 570 | 738 | 555 | 650 |
| Price, tantalite, dollars per pound[3] | 27.75 | 28.76 | 33.79 | 34.00 | 68.00 |
| Stocks, industry, processor, yearend | NA | NA | NA | NA | NA |
| Employment | NA | NA | NA | NA | NA |
| Net import reliance[4] as a percent of apparent consumption | 80 | 80 | 80 | 80 | 80 |

**Recycling:** Combined prompt industrial and obsolete scrap consumed represented about 20% of apparent consumption.

**Import Sources (1996-99):** Australia, 38%; China, 14%; Thailand, 12%; Japan, 9%; and other, 27%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| 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: | | |
| Waste and scrap | 8103.10.3000 | Free. |
| Powders | 8103.10.6030 | 2.5% ad val. |
| Alloys and metal | 8103.10.6090 | 2.5% ad val. |
| Tantalum, wrought | 8103.90.0000 | 4.4% ad val. |

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

**Government Stockpile:** For fiscal year 2000, ending September 30, 2000, the Defense National Stockpile Center (DNSC) sold about 2 tons of tantalum contained in tantalum carbide powder valued at about $254,000, about 23 tons of tantalum capacitor-grade metal powder valued at about $3.7 million, about 18 tons of tantalum vacuum-grade metal ingots valued at about $3.84 million, about 134 tons of tantalum contained in tantalum minerals valued at about $42.7 million, and about 9 tons of tantalum contained in tantalum oxide valued at about $1.32 million from the National Defense Stockpile (NDS). The DNSC also proposed maximum disposal limits in fiscal year 2001 of about 2 tons of tantalum contained in tantalum carbide powder, about 23 tons of tantalum capacitor-grade metal powder, about 18 tons of tantalum vacuum-grade metal ingots, about 136 tons of tantalum contained in tantalum minerals, and about 9 tons of tantalum contained in tantalum oxide. In December, the DNSC sold about 2 tons of tantalum contained in tantalum carbide powder valued at about $1.3 million and about 93 tons of tantalum contained in tantalum minerals valued at about $91 million (about $364 per pound tantalum pentoxide content). For calender year 2000, total sales of tantalum minerals from the NDS averaged about $219 per pound tantalum pentoxide content. The NDS uncommitted inventories shown below include a small quantity in nonstockpile-grade tantalum capacitor-grade metal powder and about 417 tons of tantalum contained in nonstockpile-grade minerals.

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# TANTALUM

### Stockpile Status—9-30-00[5]

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Tantalum: | | | | | |
| Carbide powder | 7 | — | 7 | 2 | 2 |
| Metal: | | | | | |
| Capacitor-grade powder | 39 | — | 23 | 23 | 23 |
| Ingots | 81 | — | 27 | 18 | 18 |
| Minerals | 870 | 106 | 870 | 136 | 134 |
| Oxide | 37 | — | 37 | 9 | 9 |

**Events, Trends, and Issues:** Total consumption of tantalum in 2000 increased owing to continued strong demand for tantalum powder for the production of tantalum capacitors. Major end uses for tantalum capacitors include portable telephones, pagers, personal computers, and automotive electronics. Tantalum imports increased; imports for consumption of tantalum mineral concentrates rose significantly, with Australia supplying more than 60% of quantity and value. Exports increased; Israel, Hong Kong, Germany, Japan, and the United Kingdom were the major recipients of the tantalum materials. In early December, quoted spot price ranges for tantalum ore (per pound tantalum pentoxide content), in three published sources, were $145 to $175, $140 to $170, and $200 to $230, substantially higher than the $33 to $35, $28 to $31.50, and $45 to $48 quoted in early January. Strong global tantalum demand and an apparent shortage of tantalum source materials for processing contributed to the price increase. To address the tantalum source materials shortage, the world’s largest producer, located in Australia, initiated a 3-year expansion program which is expected to more than double its annual production capacity to more than 1,000 tons of tantalum pentoxide contained in mineral concentrates. The most recent industry source (August 1999) on tantalum product prices indicated that the average selling prices per pound tantalum content for some tantalum products were as follows: capacitor-grade powder, $135 to $260; capacitor wire, $180 to $270; and vacuum-grade metal for superalloys, $75 to $100. Presumably these prices have increased, based on the escalating price for tantalum ore, but public information on current prices for these products was not available. No domestic mine production is expected in 2001, and it is estimated that U.S. apparent consumption will be about 700 tons.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production[6] 1999 | Mine production[6] 2000[e] | Reserves[7] | Reserve base[7] |
|---|---|---|---|---|
| United States | — | — | — | Negligible |
| Australia | 350 | 370 | 25,000 | 45,000 |
| Brazil | 90 | 90 | NA | 3,000 |
| Canada | 52 | 50 | 3,000 | 5,000 |
| Nigeria | 3 | 3 | NA | 7,000 |
| Other countries[8] | — | — | NA | NA |
| World total | 495 | 513 | 28,000 | 60,000 |

**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, Canada, and Nigeria. The United States has about 1,500 tons of tantalum resources in identified deposits, all of which were considered uneconomic at 2000 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.
[1]Synthetic concentrates, tin slags, tantalum oxide, potassium fluotantalate, and waste and scrap.
[2]Net quantity (uncommitted inventory).
[3]Average value, contained tantalum pentoxides, 60% basis.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix B for definitions.
[6]Excludes production of tantalum contained in tin slags.
[7]See Appendix C for definitions.
[8]Bolivia, China, Russia, and Zambia also produce (or are thought to produce) tantalum, 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:** Tellurium and tellurium dioxide of commercial grades were recovered in the United States at one copper refinery, principally from anode slimes, but also from lead refinery skimmings. High-purity tellurium, tellurium master alloys, and tellurium compounds were produced by primary and intermediate processors from commercial-grade metal and tellurium dioxide. Tellurium was used mainly in the production of free-machining steels. It was used as a minor additive in copper and lead alloys and malleable cast iron, as an accelerator in rubber compounding, in thermoelectric applications, and as a semiconductor in thermal-imaging and photoelectric applications. Tellurium was added to selenium-base photoreceptor alloys to increase the photo speed. In 2000, 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:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, refinery | W | W | W | W | W |
| Imports for consumption: | | | | | |
| Unwrought, waste and scrap[1] | 74 | 64 | 89 | 38 | 40 |
| Exports | NA | NA | NA | NA | NA |
| Consumption, apparent | NA | NA | NA | NA | NA |
| Price, dollars per pound, 99.7% minimum[2] | 21 | 19 | 18 | 15 | 14 |
| Stocks, producer, refined, yearend | W | W | W | W | W |
| Employment, number | NA | NA | NA | NA | NA |
| Net import reliance[3] as a percent of apparent consumption | NA | NA | NA | NA | NA |

**Recycling:** There was no domestic secondary production of tellurium. However, some tellurium may have been recovered abroad from selenium-base photoreceptor scrap exported by the United States for recycling.

**Import Sources (1996-99):** United Kingdom, 26%; Philippines, 19%; Belgium, 17%; Canada, 14%; and other, 24%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Metal | 2804.50.0020 | Free. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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# TELLURIUM

**Events, Trends, and Issues:** Domestic and world tellurium demand in 2000 was about the same as it was in 1999. World production was steady; oversupply remained a problem. Detailed information on the world tellurium market was not available.

Cadmium telluride is one of the most promising thin-film photovoltaic module compounds for power generation, achieving some of the highest power conversion ratios yet obtained. A possible application of this technology that would significantly affect tellurium demand is for power supplies in remote areas, mainly in developing countries, where the largest percentage increases in power consumption are expected to occur early in this century.

**World Refinery Production, Reserves, and Reserve Base:**

| | Refinery production | | Reserves[4] | Reserve base[4] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | W | W | 3,000 | 6,000 |
| Canada | 67 | 65 | 700 | 1,500 |
| Japan | 35 | 35 | — | — |
| Peru | 22 | 25 | 500 | 1,600 |
| Other countries[5] | NA | NA | 16,000 | 29,000 |
| World total (rounded) | [6]124 | [6]125 | 20,000 | 38,000 |

**World Resources:** The figures shown for reserves and reserve base include only tellurium contained in economic copper deposits. In addition, significant quantities of tellurium are contained in economic gold and lead deposits, but currently none is recovered. Deposits of coal, copper, and other metals that are of subeconomic grade contain several times the amount of tellurium contained in identified economic copper deposits. However, it is unlikely that tellurium contained in these deposits can be recovered economically.

**Substitutes:** The chief substitutes for tellurium are selenium, bismuth, and lead in metallurgical applications; selenium and sulfur in rubber compound applications; and selenium, germanium, and organic compounds in electronic applications.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Imports of boron and tellurium are grouped together under the Harmonized Tariff Schedule; however, imports of boron are thought to be small relative to tellurium.
[2]Yearend prices quoted by the sole producer.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions. Estimates include tellurium contained in copper resources only.
[5]In addition to the countries listed, Australia, Belgium, China, France, Germany, Kazakhstan, the Philippines, Russia, and the United Kingdom produce refined tellurium, but output is not reported and available information is inadequate for formulation of reliable production estimates.
[6]Excludes refinery production from the United States and "Other countries."

# THALLIUM

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

**Domestic Production and Use:** Thallium is a byproduct metal recovered in some countries from flue dusts and residues collected in the smelting of copper, zinc, and lead ores. Although thallium was contained in ores mined or processed in the United States, it was not recovered domestically in 2000. Consumption of thallium metal and its compounds continued in most of their established end uses. These uses included a semiconductor material for selenium rectifiers, an activator in gamma radiation detection equipment, an electrical resistance component in infrared radiation detection and transmission equipment, and a crystalline filter for light diffraction in acousto-optical measuring devices. Other uses included an alloying component with mercury for low-temperature measurements, an additive in glass to increase its refractive index and density, a catalyst or intermediate in the synthesis of organic compounds, and a high-density liquid for sink-float separation of minerals. Also, the use of radioactive thallium compounds for medical purposes in cardiovascular imaging was continued in 2000.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, mine | — | — | — | — | — |
| Imports for consumption[1] | 166 | 168 | 104 | 838 | 100 |
| Exports | NA | NA | NA | NA | NA |
| Consumption[e] | 300 | 300 | 300 | 380 | 300 |
| Price, metal, dollars per kilogram[2] | 1,200 | 1,280 | 1,280 | 1,295 | 1,295 |
| Net import reliance[3] as a percent of apparent consumption | 100 | 100 | 100 | 100 | 100 |

**Recycling:** None.

**Import Sources (1996-99):** Belgium, 51%; Canada, 33%; Germany, 12%; and United Kingdom, 4%.

| Tariff: Item | Number | Normal Trade Relations[4] 12/31/00 |
|---|---|---|
| Unwrought; waste and scrap; powders | 8112.91.6000 | 4.0% ad val. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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# THALLIUM

**Events, Trends, and Issues:** Research and development activities of both a basic and applied nature were conducted during 2000 to improve and expand the use of thallium. These activities focused principally on the development of high-temperature superconducting materials for such applications as magnetic resonance imaging, storage of magnetic energy, magnetic propulsion, and electric power generation and transmission; further use of radioactive thallium in clinical diagnostic applications, including cardiovascular and oncological imaging, also was studied. In addition, the use of thallium salt as a catalyst in the cyanidation process for the recovery of gold was investigated during the year.

Thallium metal and its compounds are highly toxic materials and are strictly controlled to prevent threats 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. With regard to such toxicity concerns, the U.S. Department of Transportation issued a notice of proposed rulemaking during the year that addressed international harmonization in the transport of hazardous materials, including the transport of thallium-containing materials. The proposed rule amended the Hazardous Materials Regulations of the United States to conform with recent changes in the standards of the International Maritime Dangerous Goods Code, the International Civil Aviation Organization's Technical Instructions for the Safe Transport of Dangerous Goods by Air, and the United Nations Recommendations on the Transport of Dangerous Goods.

**World Mine Production, Reserves, and Reserve Base:**[5]

| | Mine production | | Reserves[6] | Reserve base[6] |
|---|---|---|---|---|
| | 1999 | 2000 | | |
| United States | ([7]) | ([7]) | 32,000 | 120,000 |
| Other countries | 15,000 | 15,000 | 350,000 | 530,000 |
| World total (may be rounded) | 15,000 | 15,000 | 380,000 | 650,000 |

**World Resources:** World resources of thallium contained in zinc resources total about 17 million kilograms; most are located in Canada, Europe, and the United States. An additional 630 million kilograms is in world coal resources. The average thallium content of the Earth's crust has been estimated at 0.7 part per million.

**Substitutes:** While other light-sensitive materials can substitute for thallium and its compounds in specific electronic applications, ample supplies of thallium discourage development of substitute materials.

[e]Estimated. NA Not available.
[1]Unwrought; waste and scrap; powders, including thallium contained in compounds.
[2]Estimated price of 99.999%-pure granules in 100-gram lots.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]No tariff for Canada and Mexico for item shown.
[5]Estimates, based on thallium content of zinc ores.
[6]See Appendix C for definitions.
[7]Thallium contained in mined base-metal ores, estimated at 450 to 500 kilograms per year, is separated from the base metals but not extracted for commercial use.

# THORIUM

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

**Domestic Production and Use:** The primary source of the world's thorium is the rare-earth and thorium phosphate mineral monazite. Monazite was not recovered as a salable product during processing of heavy mineral sands in 2000. Past production had been as a byproduct of titanium and zirconium mineral processing during which monazite was recovered for its rare-earth content. 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. The value of thorium metal, alloys, and compounds used by the domestic industry was estimated to be about $420,000.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production, refinery[1] | — | — | — | — | — |
| Imports for consumption: | | | | | |
| Thorium ore and concentrates (monazite), gross weight | 101 | 20 | — | — | — |
| Thorium ore and concentrates (monazite), $ThO_2$ content | 7.07 | 1.40 | — | — | — |
| Thorium compounds (oxide, nitrate, etc.), gross weight | 26.30 | 13.50 | 7.45 | 5.29 | 15.10 |
| Thorium compounds (oxide, nitrate, etc.), $ThO_2$ content | 19.45 | 10.00 | 5.51 | 3.91 | 11.10 |
| Exports: | | | | | |
| Thorium ore and concentrates (monazite), gross weight | 2 | — | — | — | — |
| Thorium ore and concentrates (monazite), $ThO_2$ content | .14 | — | — | — | — |
| Thorium compounds (oxide, nitrate, etc.), gross weight | .06 | .24 | 1.13 | 2.52 | 4.04 |
| Thorium compounds (oxide, nitrate, etc.), $ThO_2$ content | .04 | .18 | .84 | .79 | 2.98 |
| Shipments from Government stockpile excesses ($ThNO_3$) | — | .82 | — | — | — |
| Consumption: Reported, ($ThO_2$ content[e]) | 4.9 | 13.0 | 7.0 | 7.0 | NA |
| Apparent | 26.3 | 12.0 | 4.7 | 3.1 | 8.2 |
| Price, yearend, dollars per kilogram: | | | | | |
| Nitrate, welding-grade[2] | 5.46 | 5.46 | 5.46 | 5.46 | 5.46 |
| Nitrate, mantle-grade[3] | 14.32 | 27.00 | 27.00 | 27.00 | 27.00 |
| Oxide, yearend: 99.9% purity[4] | 88.50 | 82.50 | 82.50 | 82.50 | 82.50 |
| 99.99% purity[4] | 107.25 | 107.25 | 107.25 | 107.25 | 107.25 |
| Stocks, industrial, yearend | 35.2 | 12.8 | NA | NA | NA |
| Net import reliance[5] as a percent of apparent consumption | NA | 100 | 100 | 100 | 100 |

**Recycling:** None.

**Import Sources (1996-99):** Monazite: Australia, 67%; and France, 33%. Thorium compounds: France, 99.4%; and other, 0.6%.

| Tariff: Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Thorium ores and concentrates (monazite) | 2612.20.0000 | Free. |
| Thorium compounds | 2844.30.1000 | 5.5% ad val. |

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

**Government Stockpile:**

Stockpile Status—9-30-00[6]

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Thorium nitrate (gross weight) | 3,218 | — | 2,944 | 2,946 | — |

**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 2000. Domestic demand for thorium ores, compounds, metals, and alloys has exhibited a long-term declining trend. Thorium consumption in the United States remained level in 1999 at 7.0 tons, however, most material was consumed in a nonrecurring application. In 2000, thorium consumption, primarily for use in catalyst applications, is estimated to increase. On the basis of data through July 2000, the average value of imported thorium compounds decreased to $47.76 per kilogram from the 1999 average of $53.15 per kilogram (gross weight).

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# THORIUM

A thorium research company announced that it had obtained its fourth and final U.S. patent in February for a thorium-based nonproliferative seed-and-blanket nuclear facility assembly.[7]

A researcher from the University of Vienna's Institute for Experimental Physics presented a paper on the nonproliferative commercial Radkowsky thorium-fuel concept. The reactor was initially designed to use a seed of enriched uranium-zirconium alloy to initiate the thorium fuel cycle. The thorium-fueled reactor design, however, can also be adapted to "burn" plutonium by using a plutonium-zirconium alloy. The design is adaptable to many existing pressurized water reactors (PWR) or Russian-designed Vodo Vodyanyi Energeticheskiy Reaktor (VVER) reactors with either minor or no changes to the existing designs especially because the thorium fuel installs in the same space as the uranium cores. Conventional uranium fueled reactors produce approximately 50 times more plutonium than those using thorium.[8]

The use of thorium in the United States has decreased significantly since the 1980's when consumption averaged 45 tons per year. Increased costs to monitor and dispose of thorium have caused the 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. Use of thorium has been forecast to decline unless a low-cost disposal process is developed or new technology creates renewed demand.

**World Refinery Production, Reserves, and Reserve Base:**

| | Refinery production | | Reserves[9] | Reserve base[9] |
|---|---|---|---|---|
| | 1999 | 2000 | | |
| 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 | NA | NA | 35,000 | 39,000 |
| Other countries | NA | NA | 90,000 | 100,000 |
| World total (rounded) | NA | NA | 1,200,000 | 1,400,000 |

Reserves and reserve base are contained primarily in 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 that could not be met from existing stockpiles 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 provinces similar to those of reserves. The largest share are 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 for 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.
[1]All domestically consumed thorium was derived from imported materials.
[2]U.S. Department of Defense, Defense Logistics Agency. Based on sales from the National Defense Stockpile.
[3]Rhodia Canada, Inc., f.o.b. port of entry, duty paid, $ThO_2$ basis.
[4]Rhodia Rare Earths, Inc., 1 to 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]Radkowsky Thorium Power Corporation news release, 2000, RTPC's fourth and final patent issued for non-proliferative seed-and-blanket fuel assembly. RTPC news, Washington, DC, February 15, 1 p.
[8]Higatsberger, Michael, 1999, The non-proliferative commercial Radkowsky thorium fuel concept: International Atomic Energy Agency Technical Committee on "Utilisation Options in Emerging Nuclear Energy Systems," Vienna, November 15-17, 28 p.
[9]See Appendix C for definitions.

# TIN

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

**Domestic Production and Use:** In 2000, no tin was mined domestically. Production of tin at the only U.S. tin smelter, at Texas City, TX, stopped in 1989. Twenty-five firms consumed about 81% of the primary tin. The major uses were as follows: cans and containers, 30%; electrical, 20%; 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, $318 million; imports for consumption, refined tin, $391 million; and secondary production (old scrap), $73 million.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production: Secondary (old scrap) | 7,710 | 7,830 | 8,390 | 8,600 | 8,900 |
| Secondary (new scrap) | 3,930 | 4,540 | 7,710 | 7,700 | 8,000 |
| Imports for consumption, refined tin | 30,200 | 40,600 | 44,000 | 47,500 | 48,000 |
| Exports, refined tin | 3,670 | 4,660 | 5,020 | 6,770 | 7,000 |
| Shipments from Government stockpile excesses | 11,800 | 11,700 | 12,200 | 765 | 12,000 |
| Consumption reported: Primary | 36,500 | 36,200 | 37,100 | 38,400 | 39,000 |
| Secondary | 8,180 | 8,250 | 8,620 | 8,890 | 9,000 |
| Consumption, apparent | 48,400 | 55,300 | 60,600 | 59,700 | 61,900 |
| Price, average, cents per pound: | | | | | |
| New York market | 288 | 264 | 261 | 255 | 255 |
| New York composite | 412 | 381 | 373 | 366 | 370 |
| London | 279 | 256 | 251 | 245 | 370 |
| Kuala Lumpur | 275 | 252 | 246 | 241 | 266 |
| Stocks, consumer and dealer, yearend | 10,900 | 11,200 | 10,500 | 10,700 | 10,700 |
| Net import reliance[1] as a percent of apparent consumption | 83 | 86 | 85 | 85 | 86 |

**Recycling:** About 16,900 tons of tin from old and new scrap was recycled in 2000. Of this, about 8,900 tons was recovered from old scrap at 5 detinning plants and 46 secondary nonferrous metal processing plants.

**Import Sources (1996-99):** China, 19%; Brazil, 17%; Peru, 16%; Bolivia, 14%; and other, 34%.

**Tariff:** Most major imports of tin, including unwrought metal, waste and scrap, and unwrought tin alloys, enter duty free.

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

**Government Stockpile:** The Defense National Stockpile Center (DNSC) no longer sells tin on a monthly basis. Two DNSC tin sales are now held each year, normally in the spring and in the fall, for about 6,000 tons each. The DNSC announced that its Annual Materials Plan for fiscal year 2001 calls for sales of up to 12,000 tons of stockpile tin. Stockpile tin is warehoused at four depots, with the largest holdings at Hammond, IN, and Baton Rouge, LA.

**Stockpile Status—9-30-00[2]**

| **Material** | **Uncommitted inventory** | **Committed inventory** | **Authorized for disposal** | **Disposal plan FY 2000** | **Disposals FY 2000** |
|---|---|---|---|---|---|
| Pig tin | 59,686 | 10,528 | 59,686 | 12,000 | 11,984 |

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# TIN

**Events, Trends, and Issues:** The Steel Recycling Institute (SRI), Pittsburgh, PA, announced that the domestic steel can recycling rate was 58% in 1999 compared with 56% in 1998. Tin, as well as steel, is recovered in can recycling. SRI noted that 200 million Americans had access to steel can recycling programs.

The world tin industry's major research and development laboratory, based in the United Kingdom, was in its sixth full year under its new structure. The laboratory has been privatized, with funding supplied by numerous major tin producing and consuming firms rather than by the Association of Tin Producing Countries. The laboratory reported progress in several areas of research to develop new tin uses; among these were a tin foil capsule to replace lead foil capsules on wine bottles and a new noncyanide-based electrolyte with a coating of tin and zinc, which could replace cadmium as an environmentally acceptable anticorrosion coating on steel. The laboratory focused its efforts on possible new uses for tin that would take advantage of tin's relative nontoxicity compared with other metals—lead-free solders, antimony-free flame-retardant chemicals, and lead-free shotgun pellets.

In the World Mine Production, Reserves, and Reserve Base table below, several reserve and reserve base numbers were changed from those in the prior Mineral Commodity Summaries. Changes were made for countries like Brazil, China, Indonesia, and Thailand based on recently updated information received.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[3] | Reserve base[3] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | — | — | 20,000 | 40,000 |
| Australia | 10,000 | 9,000 | 210,000 | 600,000 |
| Bolivia | 11,000 | 12,000 | 450,000 | 900,000 |
| Brazil | 13,000 | 13,000 | 2,200,000 | 2,500,000 |
| China | 62,000 | 64,000 | 3,500,000 | 4,000,000 |
| Indonesia | 48,000 | 50,000 | 800,000 | 900,000 |
| Malaysia | 7,000 | 7,000 | 1,200,000 | 1,400,000 |
| Peru | 30,000 | 32,000 | 300,000 | 400,000 |
| Portugal | 3,000 | 3,000 | 70,000 | 80,000 |
| Russia | 5,000 | 5,000 | 300,000 | 350,000 |
| Thailand | 3,000 | 3,000 | 340,000 | 400,000 |
| Other countries | 6,000 | 2,000 | 180,000 | 200,000 |
| World total (may be rounded) | 198,000 | 200,000 | 9,600,000 | 12,000,000 |

**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 were available to sustain current (2000) production rates well into the next 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.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix B for definitions.
[3]See Appendix C for definitions.

# TITANIUM MINERAL CONCENTRATES[1]

(Data in thousand metric tons of $TiO_2$ content, unless otherwise noted)

**Domestic Production and Use:** Two firms produced ilmenite and rutile concentrates from heavy-mineral sands operations in Florida and Virginia. The value of titanium mineral concentrates consumed in the United States in 2000 was about $530 million. The major coproduct of mining from ilmenite and rutile deposits was zircon. About 95% of titanium mineral concentrates was consumed by $TiO_2$ pigment producers. The remainder was used in welding rod coatings and for manufacturing metal, carbides, and chemicals.

| Salient Statistics—United States: | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production[2] (ilmenite and rutile, rounded) | 200 | 400 | 400 | 300 | 300 |
| Imports for consumption: | | | | | |
| Ilmenite and slag | 641 | 651 | 732 | 776 | 617 |
| Rutile, natural and synthetic | 305 | 311 | 365 | 324 | 440 |
| Exports,[e] all forms | 10 | 15 | 38 | 6 | 9 |
| Estimated consumption: | | | | | |
| Ilmenite and slag | 1,010 | 1,060 | [3] 980 | [3]963 | [3]1,000 |
| Rutile, natural and synthetic | 365 | 383 | 392 | 413 | 430 |
| Price, dollars per metric ton: | | | | | |
| Ilmenite, bulk, 54% $TiO_2$, f.o.b. Australian ports | 87 | 83 | 77 | 98 | 95 |
| Rutile, yearend, bulk, f.o.b. Australian ports | 563 | 530 | 500 | 473 | 485 |
| Slag:[e] | | | | | |
| 80% $TiO_2$, f.o.b. Sorel, Quebec | 292 | 294 | 338 | 390 | 349 |
| 85% $TiO_2$, f.o.b. Richards Bay, South Africa | 353 | 390 | 385 | 406 | 413 |
| Stocks, mine, distributor and consumer, yearend: | | | | | |
| Ilmenite | 267 | 234 | 270 | 343 | 300 |
| Rutile | 77 | 80 | 111 | 96 | 100 |
| Employment, mine and mill, number[e] | 400 | 400 | 450 | 450 | 450 |
| Net import reliance[4] as a percent of reported consumption | 57 | 68 | 76 | 75 | 76 |

**Recycling:** None.

**Import Sources (1996-99):** Ilmenite and slag: South Africa, 53%; Australia, 27%; Canada, 11%; India, 5%; and other, 4%. Natural and synthetic rutile: Australia, 53%; South Africa, 39%; Malaysia, 2%; India, 1%; and other, 5%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Synthetic rutile | 2614.00.3000 | Free. |
| Ilmenite and ilmenite sand | 2614.00.6020 | Free. |
| Rutile concentrate | 2614.00.6040 | Free. |
| Titanium slag | 2620.90.5000 | Free. |

**Depletion Allowance:** Ilmenite and rutile: 22% (Domestic), 14% (Foreign).

**Government Stockpile:** None.

**Events, Trends, and Issues:** Global production of ilmenite and slag in 2000 was estimated to be nearly unchanged when compared with that of 1999. Domestic consumption of ilmenite and titanium slag concentrates in 2000 was estimated to increase 4% when compared with that of 1999. In 2000, the United States continued its reliance on imported feedstocks primarily from Australia and South Africa.

Development efforts were proceeding at the minerals sands deposits near Camden, TN. At yearend, construction of a heavy mineral separation pilot plant was near completion.

In Australia, numerous exploration and development studies were underway in the Murray Basin, Western Australia. In the fourth quarter, a new heavy mineral concentrator commenced production at Eneabba North, Western Australia.

Feasibility studies continued at Kwale, Kenya, and Corridor Sands, Mozambique. In addition, a drilling program was underway at Truro, Nova Scotia, Canada. Production from Kwale, Kenya, was scheduled for 2002.

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# TITANIUM MINERAL CONCENTRATES

Fewer environmental pollution problems are encountered when pigment is produced from rutile rather than ilmenite. The chloride process, using a rutile feed, generates about 0.2 ton of waste per ton of $TiO_2$ product; the sulfate process, using ilmenite, generates about 3.5 tons of waste per ton of product. Producing synthetic rutile from ilmenite results in about 0.7 ton of waste, mainly iron oxide, per ton of product. Direct chlorination of ilmenite generates about 1.2 tons of waste, mainly ferric chloride, per ton of $TiO_2$.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production 1999 | Mine production 2000[e] | Reserves[5] | Reserve base[5] |
|---|---|---|---|---|
| Ilmenite: | | | | |
| United States | [6]300 | [6]300 | 13,000 | 59,000 |
| Australia | 1,140 | 1,100 | [7]100,000 | [7]140,000 |
| Canada[8] | 760 | 760 | 31,000 | 36,000 |
| India | 204 | 205 | 30,000 | 38,000 |
| Norway[8] | 266 | 270 | 40,000 | 40,000 |
| South Africa[8] | 935 | 935 | 63,000 | 63,000 |
| Ukraine | 225 | 286 | 5,900 | 13,000 |
| Other countries | 283 | 259 | 63,000 | 98,000 |
| World total (ilmenite, rounded) | 4,100 | 4,000 | 350,000 | 480,000 |
| Rutile: | | | | |
| United States | ([9]) | ([9]) | 700 | 1,800 |
| Australia | 181 | 226 | [7]19,000 | [7]53,000 |
| India | 15 | 15 | 6,600 | 7,700 |
| South Africa | 122 | 122 | 8,300 | 8,300 |
| Ukraine | 45 | 45 | 2,500 | 2,500 |
| Other countries | 8 | 8 | 7,900 | 100,000 |
| World total (rutile, rounded) | [10]370 | [10]410 | 45,000 | 170,000 |
| World total (ilmenite and rutile, rounded) | 4,500 | 4,500 | 390,000 | 660,000 |

**World Resources:** Ilmenite supplies about 90% of the world's demand for titanium minerals. World ilmenite resources total about 1 billion tons of titanium dioxide. Identified world resources of rutile (including anatase) total about 230 million tons of contained $TiO_2$.

**Substitutes:** Ilmenite, leucoxene, rutile, slag, and synthetic rutile compete as feedstock sources for producing $TiO_2$ pigment, titanium metal, and welding rod coatings. In the future, commercial processes may be developed to use anatase and perovskite.

[e]Estimated.
[1]See also Titanium and Titanium Dioxide.
[2]Rounded to one significant digit to avoid revealing 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 to avoid revealing company proprietary data.
[7]Derived from data published by the Australian Bureau of Resource Sciences.
[8]Mine production is primarily used to produce titaniferous slag. Reserves and reserve base are ilmenite.
[9]Included with ilmenite to avoid revealing company proprietary data.
[10]Excludes the United States.

# TITANIUM AND TITANIUM DIOXIDE[1]

(Data in metric tons, unless otherwise noted)

**Domestic Production and Use:** Titanium sponge metal was produced by two firms with operations in Nevada and Oregon. Ingot was made by the two sponge producers and by nine other firms in seven States. About 30 firms consumed ingot to produce forged components, mill products, and castings. In 2000, an estimated 60% of the titanium metal used was in aerospace applications. The remaining 40% was used in armor, chemical processing, power generation, marine, medical, sporting goods, and other nonaerospace applications. The value of sponge metal consumed was about $164 million, assuming an average selling price of $9.37 per kilogram ($4.25 per pound). The value of ingot produced from sponge and scrap was estimated to be $500 million.

In 2000, titanium dioxide ($TiO_2$) pigment, valued at about $3.1 billion, was produced by four companies at eight facilities in seven States. Estimated use of $TiO_2$ pigment by end use was paint, varnishes, and lacquers, 50%; plastics, 21%; paper, 20%; and other, 9%. Other uses of $TiO_2$ included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Titanium sponge metal: | | | | | |
| Production | W | W | W | W | W |
| Imports for consumption | 10,100 | 16,100 | 10,900 | 6,000 | 7,800 |
| Exports | 528 | 976 | 348 | 807 | 1,900 |
| Shipments from Government stockpile excesses | — | 227 | 1,384 | 515 | 4,240 |
| Consumption, reported | 28,400 | 32,000 | 28,200 | 18,100 | 17,500 |
| Price, dollars per pound, yearend | 4.40 | 4.40 | 4.40 | 4.25 | 4.25 |
| Stocks, industry yearend[e] | 4,390 | 5,470 | 10,600 | 8,280 | 7,600 |
| Employment, number[e] | 300 | 300 | 300 | 300 | 300 |
| Net import reliance[2] as a percent of reported consumption | 37 | 47 | 39 | 44 | 62 |
| Titanium dioxide: | | | | | |
| Production | 1,230,000 | 1,340,000 | 1,330,000 | 1,350,000 | 1,440,000 |
| Imports for consumption | 167,000 | 194,000 | 192,000 | 225,000 | 225,000 |
| Exports | 332,000 | 405,000 | 398,000 | 383,000 | 470,000 |
| Consumption, apparent | 1,080,000 | 1,130,000 | 1,130,000 | 1,160,000 | 1,190,000 |
| Price, rutile, list, dollars per pound, yearend | 1.09 | 1.05 | .98 | 1.01 | 1.01 |
| Stocks, producer, yearend | 107,000 | 108,000 | 103,000 | 137,000 | 136,000 |
| Employment, number[e] | 4,600 | 4,600 | 4,600 | 4,600 | 4,600 |
| Net import reliance[2] as a percentage of apparent consumption | E | E | E | E | E |

**Recycling:** New scrap metal recycled by the titanium industry was about 19,200 tons in 2000. Estimated use of titanium as scrap and in the form of ferrotitanium made from scrap by the steel industry was about 6,500 tons; by the superalloy industry, 700 tons; and, in other industries, 700 tons. Old scrap reclaimed was about 400 tons.

**Import Sources (1996-99):** Sponge metal: Russia, 49%; Japan, 36%; Kazakhstan, 8%; China, 3%; and other, 4%. Titanium dioxide pigment: Canada, 38%; Germany,14%; France, 9%; Spain, 7%; and other, 32%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Titanium oxides (unfinished $TiO_2$ pigment) | 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 | 8108.10.1000 | Free. |
| Unwrought titanium metal | 8108.10.5000 | 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.

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# TITANIUM AND TITANIUM DIOXIDE

**Government Stockpile:** The Defense National Stockpile Center continued to solicit offers for the sale of titanium sponge held in the Government stockpile. In addition to the quantities shown below, the stockpile contained 7,840 tons of nonstockpile-grade sponge. For fiscal year 2001, 4,540 tons of titanium sponge is being offered for sale.

**Stockpile Status—9-30-00[3]**

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Titanium sponge | 19,100 | 3,390 | 19,100 | 4,540 | 4,240 |

**Events, Trends, and Issues:** In 2000, domestic production of titanium pigment was 1.44 million tons, a 6% increase compared with 1999. Imports of pigment were unchanged compared with 1999, while exports increased significantly. Apparent consumption of titanium pigment increased about 3%; published prices of rutile-grade pigment were unchanged.

The number of domestic $TiO_2$ pigment producers was reduced to four when the Savannah, GA, facility was acquired by another $TiO_2$ producer. At New Johnsonville, TN, a third line was being added to increase capacity an estimated 65,000 tons per year. Other global $TiO_2$ pigment capacity expansions were expected at Chavara, India; Duisberg, Germany; Greatham, United Kingdom; Huelva, Spain; Kwinana, Western Australia; and Telok Kalong, Malaysia.

Owing to reduced demand from commercial aircraft manufacturers, consumption of titanium sponge metal decreased 3% compared with that of 1999. Domestic production of titanium ingot and mill product shipments were estimated to have decreased 8% and 10%, respectively.

**World Sponge Metal Production and Sponge and Pigment Capacity:**

| | Sponge production | | Capacity 2000[4] | |
|---|---|---|---|---|
| | 1999 | 2000[e] | Sponge | Pigment |
| United States | W | W | 21,600 | 1,540,000 |
| Australia | — | — | — | 189,000 |
| Belgium | — | — | — | 70,000 |
| Canada | — | — | — | 75,000 |
| China[e] | 2,500 | 2,500 | 7,000 | 45,000 |
| Finland | — | — | — | 100,000 |
| France | — | — | — | 238,000 |
| Germany | — | — | — | 360,000 |
| Italy | — | — | — | 80,000 |
| Japan | 18,900 | 19,000 | 25,800 | 336,000 |
| Kazakhstan[e] | 9,000 | 10,000 | 22,000 | 1,000 |
| Mexico | — | — | — | 120,000 |
| Russia[e] | 14,000 | 15,000 | 26,000 | 20,000 |
| Spain | — | — | — | 65,000 |
| Ukraine[e] | 4,000 | 4,000 | 6,000 | 120,000 |
| United Kingdom | — | — | — | 304,000 |
| Other countries | — | — | — | 630,000 |
| World total (rounded) | [5]48,000 | [5]51,000 | 110,000 | 4,300,000 |

**World Resources:** Resources and reserves of titanium minerals (ilmenite and rutile) are discussed in Titanium Mineral Concentrates. Titanium for domestic sponge production was obtained from rutile or rutile substitutes. The feedstock sources for pigment production were ilmenite, slag, and synthetic rutile.

**Substitutes:** There are few substitutes for titanium in aircraft and space use without some sacrifice of performance. For industrial uses, high-nickel steel, zirconium, and, to a limited extent, the superalloy metals may be substituted. In certain applications, 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.
[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 the United States.

# TUNGSTEN

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

**Domestic Production and Use:** The last recorded production of tungsten concentrates in the United States was in 1994. In 2000, a California-based tungsten processor ceased operations. At yearend, approximately nine companies in the United States processed tungsten concentrates, ammonium paratungstate, tungsten oxide, and/or scrap to make tungsten powder, tungsten carbide powder, and/or tungsten chemicals. Nearly 75 industrial consumers were surveyed on a monthly or annual basis. Data reported by these consumers indicates that approximately 70% of the tungsten consumed in the United States went into making cemented carbide parts to be used as cutting and wear-resistant materials primarily in the metalworking, oil and gas drilling, mining, and construction industries. The remaining tungsten was consumed in making lamp filaments, electrodes, and other components for the electrical and electronics industries, 17%; steels, superalloys, and wear-resistant alloys, 12%; and chemicals for catalysts and pigments, 1%. The total estimated value of tungsten consumed in 2000 was $300 million.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: Mine | — | — | — | — | — |
| Secondary | 2,670 | 2,930 | 3,350 | 5,250 | 5,300 |
| Imports for consumption: Concentrate | 4,190 | 4,850 | 4,750 | 2,870 | 2,500 |
| Other forms | 7,580 | 7,980 | 8,490 | 8,230 | 7,800 |
| Exports: Concentrate | 18 | 12 | 10 | 26 | 60 |
| Other forms | 2,540 | 2,570 | 3,640 | 2,860 | 2,400 |
| Government stockpile shipments: Concentrate | — | — | — | ([1]) | 1,300 |
| Other forms | — | — | — | ([1]) | 700 |
| Consumption: Reported, concentrate | 5,260 | 6,590 | [2]3,210 | [2]2,100 | W |
| Apparent, all forms | 10,900 | 12,200 | 12,300 | 13,200 | 14,700 |
| Price, concentrate, dollars per mtu $WO_3$,[3] average: | | | | | |
| U.S. spot market, Platt's Metals Week | 66 | 64 | 52 | 47 | 47 |
| European market, Metal Bulletin | 53 | 47 | 44 | 40 | 44 |
| Stocks, industry, yearend: Concentrate | 569 | 658 | 514 | W | W |
| Other forms | W | 2,550 | 2,780 | 2,520 | 2,290 |
| Net import reliance[4] as a percent of apparent consumption | 89 | 84 | 77 | 64 | 68 |

**Recycling:** During 2000, the tungsten content of scrap consumed by processors and end users was estimated at 5,300 tons. This represented approximately 36% of apparent consumption of tungsten in all forms.

**Import Sources (1996-99):** Tungsten content of ores and concentrates, intermediate and primary products, wrought and unwrought tungsten, and waste and scrap: China, 39%; Russia, 21%; Bolivia, 5%; Portugal, 5%; and other, 30%.

| **Tariff:** Item | Number | Normal Trade Relations[5] 12/31/00 |
|---|---|---|
| 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 | 7.5% 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. In addition to the data listed in the table below, as of September 30, 2000, the stockpile also contained the following quantities of uncommitted nonstockpile-grade materials authorized for disposal (tons of tungsten content): ores and concentrates, 7,010; ferrotungsten, 383; metal powder, 151; and carbide powder, 48.

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# TUNGSTEN

**Stockpile Status—9-30-00[6]**

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Carbide powder | 323 | 309 | 323 | 454 | 749 |
| Ferrotungsten | 309 | 123 | 309 | 136 | 142 |
| Metal powder | 606 | — | 606 | 68 | 67 |
| Ores and concentrates | 25,000 | 1,560 | 25,000 | 1,810 | 1,360 |

**Events, Trends, and Issues:** World tungsten supply continued to be dominated by Chinese production and exports. Beginning in 1999 and continuing into 2000, the Chinese Government took several steps to control the release of Chinese tungsten into the world market and to increase prices. By November 2000, prices quoted by Metal Bulletin for ammonium paratungstate and tungsten ore concentrates had increased significantly as compared with those of early 1999.

The absence of new mine development, declining production from operating mines, and closure of mines outside China continue to be concerns for tungsten consumers. In 1999, a new source of supply became available when the U.S. Government began selling tungsten materials from the National Defense Stockpile. By law, sales of materials from the stockpile must not result in undue disruption to the usual markets of producers, processors, and consumers of the materials; or avoidable loss to the United States.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production 1999 | Mine production 2000[e] | Reserves[7] | Reserve base[7] |
|---|---|---|---|---|
| United States | — | — | 140,000 | 200,000 |
| Australia | — | — | 1,000 | 63,000 |
| Austria | 1,610 | 1,600 | 10,000 | 15,000 |
| Bolivia | 334 | 350 | 53,000 | 100,000 |
| Brazil | — | — | 20,000 | 20,000 |
| Burma | 87 | 90 | 15,000 | 34,000 |
| Canada | — | — | 260,000 | 490,000 |
| China | 24,000 | 24,000 | 820,000 | 1,200,000 |
| Korea, North | 700 | 600 | NA | 35,000 |
| Korea, Republic of | — | — | 58,000 | 77,000 |
| Portugal | 450 | 750 | 25,000 | 25,000 |
| Russia | 3,500 | 3,700 | 250,000 | 420,000 |
| Thailand | 29 | 30 | 30,000 | 30,000 |
| Uzbekistan | 200 | 150 | NA | 20,000 |
| Other countries | 130 | 190 | 300,000 | 450,000 |
| World total (rounded) | 31,000 | 31,500 | 2,000,000 | 3,200,000 |

**World Resources:** More than 90% of the world's estimated tungsten resources is outside the United States. Nearly 40% of these resources is in China, 15% is in Canada, and 13% is in Russia.

**Substitutes:** Cemented tungsten carbide remained a primary cutting-tool insert material because of its versatility in meeting technical requirements in many turning and milling operations. However, ceramics, ceramic-metallic composites, and other materials continued to be developed and utilized as substitutes to meet the changing needs of the world market. Increased quantities of carbide cutting-tool inserts were coated with nitrides, oxides, and carbides to extend the life of the inserts. Tungsten remained the preferred and essentially unsubstitutable material for filaments, electrodes, and contacts in lamp and lighting applications. However, an electrodeless, nontungsten lamp is available for commercial and industrial use.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Less than ½ unit.
[2]Excludes 6 months of withheld data.
[3]A metric ton unit (mtu) of tungsten trioxide ($WO_3$) contains 7.93 kilograms of tungsten.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]Special tariff rates apply for Canada and Mexico for items shown.
[6]See Appendix B for definitions.
[7]See Appendix C for definitions.

# VANADIUM

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

**Domestic Production and Use:** Eight firms make up the U.S. vanadium industry. One of these firms processes ferrophosphorus slag generated at a mine in Idaho, while the others process material such as petroleum residues, spent catalysts, utility ash, and vanadium-bearing iron slag to produce ferrovanadium, vanadium pentoxide, vanadium metal, and vanadium-bearing chemicals or specialty alloys. Metallurgical use, primarily as an alloying agent for iron and steel, accounts for about 95% 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. With regard to total domestic consumption, major end-use distribution was as follows: carbon steel 32%; high-strength low-alloy steel, 23%; full alloy steel, 21%; tool steel, 9%; and other, 15%.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production: | | | | | |
| Mine, mill | W | W | W | W | W |
| Petroleum residues, recovered basis | 3,730 | NA | NA | NA | NA |
| Imports for consumption: | | | | | |
| Ash, ore, residues, slag | 2,270 | 2,950 | 2,400 | 1,650 | 2,000 |
| Vanadium pentoxide, anhydride | 485 | 711 | 847 | 208 | 800 |
| Oxides and hydroxides, other | 11 | 126 | 33 | — | 10 |
| Aluminum-vanadium master alloys (gross weight) | 2 | 11 | 298 | 1,210 | 50 |
| Ferrovanadium | 1,880 | 1,840 | 1,620 | 1,930 | 2,400 |
| Exports: | | | | | |
| Vanadium pentoxide, anhydride | 241 | 614 | 681 | 747 | 600 |
| Oxides and hydroxides, other | 2,670 | 385 | 232 | 70 | 100 |
| Aluminum-vanadium master alloys (gross weight) | 310 | 974 | 856 | 514 | 700 |
| Ferrovanadium | 479 | 446 | 579 | 213 | 100 |
| Shipments from Government stockpile | 201 | 260 | — | — | — |
| Consumption: Reported | 4,630 | 4,710 | 4,380 | 3,830 | 4,000 |
| Price, average, dollars per pound $V_2O_5$ | 3.19 | 3.90 | 5.47 | 1.99 | 2.00 |
| Stocks, consumer, yearend | 305 | 323 | 336 | 368 | 300 |
| Employment, mine and mill, number | 390 | 400 | 400 | 400 | 400 |
| Net import reliance[1] as a percent of reported consumption | 31 | 94 | 78 | 80 | 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.

**Import Sources (1996-99):** Ferrovanadium: Canada, 43%; South Africa, 20%; China, 17%; Czech Republic, 8%; and other, 12%. Vanadium pentoxide: South Africa, 98%; and other, 2%.

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

| Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Vanadium pentoxide anhydride | 2825.30.0010 | 10.8% ad val. |
| Vanadium oxides and hydroxides, other | 2825.30.0050 | 10.8% ad val. |
| Vanadates | 2841.90.1000 | 8.4% 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:** Disposal of the vanadium pentoxide held in the National Defense Stockpile was completed in 1997.

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# VANADIUM

**Events, Trends, and Issues:** Preliminary data indicate that U.S. vanadium consumption in 2000 increased 4% from that in 1999. Among the major uses for vanadium, carbon steel accounted for 31% of domestic consumption. Full alloy steel and high-strength low-alloy steel accounted for 23% and 26% of domestic consumption, respectively.

Both ferrovanadium and vanadium pentoxide prices remained low during 2000. Articles in various industry-related publications attributed the falling prices primarily to an increased supply of material.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[2] | Reserve base[2] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | W | W | 45,000 | 4,000,000 |
| China | 16,000 | 16,000 | 2,000,000 | 3,000,000 |
| Russia | 9,000 | 9,000 | 5,000,000 | 7,000,000 |
| South Africa | 16,000 | 16,000 | 3,000,000 | 12,000,000 |
| Other countries | 1,000 | 1,000 | NA | 1,000,000 |
| World total (may be rounded) | [3]42,800 | [3]42,000 | 10,000,000 | 27,000,000 |

**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 are adequate to supply current domestic needs, a substantial part of U.S. demand is currently met by foreign material because of price advantages.

**Substitutes:** Steels containing various combinations of other alloying elements can be substituted for steels containing vanadium. Metals, such as columbium, manganese, molybdenum, titanium, and tungsten, are to some degree interchangeable with vanadium as alloying elements in steel. Platinum and nickel can replace vanadium compounds as catalysts in some chemical processes. There is currently no acceptable substitute for vanadium in aerospace titanium alloys.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix C for definitions.
[3]Excludes U.S. mine production.

# VERMICULITE

(Data in thousand metric tons, unless otherwise noted)

**Domestic Production and Use:** Two companies, with mining and processing facilities, produced vermiculite concentrate. One company had its operation in South Carolina, and the other company had an operation in Virginia and an operation in South Carolina run by its subsidiary company. Most of the vermiculite concentrate was shipped to 19 exfoliating plants in 10 States. The end uses for exfoliated vermiculite were estimated to be agriculture and insulation, 80%; lightweight concrete aggregates (including concrete, plaster, and cement premixes), 16%; and other, 4%.

| **Salient Statistics—United States:** | 1996 | 1997 | 1998 | 1999 | 2000[e] |
|---|---|---|---|---|---|
| Production[1] | W | W | W | [e 2]175 | 175 |
| Imports for consumption[e] | 48 | 67 | 68 | 71 | 60 |
| Exports[e] | 8 | 8 | 11 | 7 | 5 |
| Consumption, apparent, concentrate | W | W | W | [e]240 | 230 |
| Consumption, exfoliated | 135 | [e]155 | [e]170 | [e]175 | 170 |
| Price, average value, concentrate, dollars per ton, f.o.b. mine | W | W | W | W | W |
| Stocks, producer, yearend | NA | NA | NA | NA | NA |
| Employment, mine and mill, number[e] | 230 | 230 | 230 | 230 | 230 |
| Net import reliance[3] as a percent of apparent consumption | W | W | W | [e]27 | 24 |

**Recycling:** Insignificant.

**Import Sources (1996-99):** South Africa, 73%; China, 23%; and other, 4%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Vermicullite, perlite and chlorites, unexpanded | 2530.10.0000 | Free. |
| Exfoliated vermiculite, expanded clays, foamed slag, and similar expanded materials | 6806.20.0000 | Free. |

**Depletion Allowance:** 14% (Domestic and foreign).

**Government Stockpile:** None.

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# VERMICULITE

**Events, Trends, and Issues:** In western Europe, the United Kingdom is reported to be the largest consumer of crude (concentrate) vermiculite, with a 31% share. France is the next largest user, with 26%, followed by Austria, 11%; Germany, 8%; Italy, 4%; Spain, 4%; and other countries, 16%. Consumption of exfoliated vermiculite in western Europe is 24% in boards; 22%, horticulture; 17%, insulation; 15%, plasters; and 22%, other. The boards are said to be more durable than the drywall produced in North America. Other uses in western Europe include friction linings (where exfoliated vermiculite has partially replaced asbestos), specialty plasters, refractory mixes, and acoustic tiles.[4]

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production | | Reserves[5] | Reserve base[5] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | [e 2]175 | 175 | 25,000 | 100,000 |
| Russia | 25 | 25 | NA | NA |
| South Africa | 209 | 210 | 20,000 | 80,000 |
| Other countries[6] | 122 | 130 | 5,000 | 20,000 |
| World total (rounded) | [e]530 | 540 | 50,000 | 200,000 |

**World Resources:** Marginal reserves of vermiculite, occurring in Colorado, Nevada, North Carolina, Texas, and Wyoming, are estimated to be 2 to 3 million tons. Resources in other countries may include material that does not exfoliate as well as U.S. and South African vermiculite.

**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. W Withheld to avoid disclosing company proprietary data.
[1]Concentrate sold and used by producers.
[2]Roskill Information Services, Ltd., 1999, The economics of vermiculite: London, Roskill Information Services, Ltd.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]Ellicott, Graham, 2000, Crude vermiculite: Industrial Minerals, no. 391, April, p. 27.
[5]See Appendix C for definitions.
[6]Excludes countries for which information is not available.

# 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 mined as a constituent of the mineral bastnasite, but was not recovered as a separate element during processing. Bastnasite, a rare-earth fluocarbonate mineral, was mined as a primary product at Mountain Pass, CA. Bastnasite's yttrium content is very small, and represents a potential minor source of the element. Yttrium used by the domestic industry was imported primarily as compounds.

Yttrium was used in many applications. Principal uses were in phosphors used in color televisions and computer monitors, trichromatic fluorescent lights, temperature sensors, and X-ray-intensifying screens. As a stabilizer in zirconia, yttrium was used in 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 was also used in heating-element alloys, superalloys, and high-temperature superconductors. The approximate distribution in 1999 by end use was as follows: lamp and cathode ray tube phosphors, 70%; oxygen sensors, laser crystals, miscellaneous, 16%; ceramics and abrasives, 9%, and alloys 5%.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production, mine | — | — | — | — | — |
| Imports for consumption: | | | | | |
| In monazite (yttrium oxide content[e]) | 1.11 | 0.22 | — | — | — |
| Yttrium compounds, greater than 19% to less than 85% oxide equivalent (gross weight) | 42 | 48 | 107 | 166 | 72 |
| Exports, in ore and concentrate | NA | NA | NA | NA | NA |
| Consumption, estimated[2] | 207 | 292 | 516 | 428 | 400 |
| Price, dollars: | | | | | |
| Monazite concentrate, per metric ton[3] | 244-285 | 400-400 | 400-400 | 400-400 | 400-400 |
| Yttrium oxide, per kilogram, 99.0% to 99.99% purity[4] | 17-85 | 17-85 | 22-85 | 22-85 | 25-200 |
| Yttrium metal, per kilogram, 99.0% to 99.9% purity[4] | 95-200 | 80-100 | 80-100 | 80-100 | 80-100 |
| Stocks, processor, yearend | NA | NA | NA | NA | NA |
| Net import reliance[e 5] as a percent of apparent consumption | 100 | 100 | 100 | 100 | 100 |

**Recycling:** Small quantities, primarily from laser crystals and synthetic garnets.

**Import Sources (1999):[e]** Yttrium compounds: China, 68%; Hong Kong, 15%; France, 12%; United Kingdom, 3%; and other, 2%.

| **Tariff: Item** | **Number** | **Normal Trade Relations 12/31/00** |
|---|---|---|
| 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% but <85% $Y_2O_3$ | 2846.90.4000 | Free. |
| Rare-earth compounds, including yttrium oxide, yttrium nitrate, and other individual compounds | 2846.90.8000 | 3.7% ad val. |

**Depletion Allowance:** Monazite: 22% on thorium content and 14% on yttrium and rare-earth content (Domestic), 14% (Foreign). Xenotime: 14% (Domestic and foreign).

**Government Stockpile:** None.

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# YTTRIUM

**Events, Trends, and Issues:** Yttrium demand in the United States decreased in 1999 and declined slightly in 2000 as prices increased. International yttrium markets continued to be competitive, although China was the source of most of the world's supply. The increase in domestic yttrium demand is primarily the result of U.S. dollar strength and the recessionary Asian economies minimizing inflation and undercutting commodity prices. Yttrium was consumed primarily in the form of high-purity compounds, especially the oxide and nitrate. Demand for yttrium metal increased in 2000 compared with that of 1999.

**World Mine Production, Reserves, and Reserve Base:**

| | Mine production[e 6] | | Reserves[7] | Reserve base[7] |
|---|---|---|---|---|
| | 1999 | 2000 | | |
| United States | — | — | 120,000 | 130,000 |
| Australia | — | — | 100,000 | 110,000 |
| Brazil | 15 | 15 | 400 | 1,500 |
| Canada | — | — | 3,300 | 4,000 |
| China | 2,200 | 2,200 | 220,000 | 240,000 |
| Congo (Kinshasa) | — | — | 570 | 630 |
| India | 55 | 55 | 36,000 | 38,000 |
| Malaysia | 7 | 7 | 13,000 | 21,000 |
| South Africa | — | — | 4,400 | 5,000 |
| Sri Lanka | 2 | 2 | 240 | 260 |
| Thailand | — | — | 600 | 600 |
| Former Soviet Union[8] | 125 | 125 | 9,000 | 10,000 |
| World total (rounded) | 2,400 | 2,400 | 510,000 | 560,000 |

**World Resources:** Large resources of yttrium in monazite and xenotime are available worldwide in ancient and recent placer deposits (monazite and xenotime), 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 relative to expected demand.

**Substitutes:** Substitutes for yttrium are available for some applications, but generally are much less effective. In most uses, especially in phosphors, electronics, and lasers, 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 is generally not as resilient.

[e]Estimated. NA Not available.
[1]See also Rare Earths and Scandium.
[2]Essentially all yttrium consumed domestically was imported or refined from imported ores and concentrates.
[3]Monazite concentrate prices derived from Metal Bulletin (1996) and U.S. Census Bureau data (1997-2000).
[4]Yttrium oxide and metal prices from Elements—Rare Earths, Specialty Metals and Applied Technology (a TradeTech publication), Denver, CO, and Rhodia Rare Earths, Inc., Shelton, CT, and the China Rare Earth Information Center, Baotou, China.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]Includes yttrium contained in rare-earth ores.
[7]See Appendix C for definitions.
[8]As constituted before December 1991.

# ZINC

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

**Domestic Production and Use:** The value of zinc mined in 2000, based on contained zinc recoverable from concentrate, was about $973 million. It was produced in 6 States by 19 mines operated by 8 mining companies. Alaska, Missouri, New York, and Tennessee accounted for 98% of domestic mine output; Alaska alone accounted for about three-fourths of production. Three primary and 12 large- and medium-sized secondary smelters refined zinc metal of commercial grade in 2000. 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 57% was used in galvanizing, 17% in zinc-base alloys, 13% in brass and bronze, and 13% 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:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production: Mine, zinc in ore[1] | 628 | 632 | 755 | 843 | 860 |
| Primary slab zinc | 226 | 226 | 234 | 240 | 265 |
| Secondary slab zinc | 140 | 140 | 134 | 131 | 135 |
| Imports for consumption: | | | | | |
| Ore and concentrate | 15 | 50 | 46 | 75 | 70 |
| Refined zinc | 827 | 876 | 879 | 966 | 970 |
| Exports: Ore and concentrate | 425 | 461 | 552 | 531 | 535 |
| Refined zinc | 2 | 4 | 2 | 2 | 2 |
| Shipments from Government stockpile | 15 | 32 | 26 | 22 | 40 |
| Consumption: Apparent, refined zinc | 1,210 | 1,260 | 1,290 | 1,340 | 1,400 |
| Apparent, all forms | 1,450 | 1,490 | 1,580 | 1,610 | 1,670 |
| Price, average, cents per pound: | | | | | |
| Domestic producers[2] | 51.1 | 64.6 | 51.4 | 53.5 | 56.0 |
| London Metal Exchange, cash | 46.5 | 59.7 | 46.5 | 48.8 | 51.0 |
| Stocks, slab zinc, yearend | 76 | 88 | 68 | 84 | 92 |
| Employment: Mine and mill, number[e] | 2,700 | 2,500 | 2,400 | 2,500 | 2,600 |
| Smelter primary, number[e] | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Net import reliance[3] as a percent of apparent consumption: | | | | | |
| Refined zinc | 69 | 70 | 71 | 72 | 71 |
| All forms of zinc | 57 | 59 | 58 | 60 | 60 |

**Recycling:** In 2000, an estimated 410,000 tons of zinc was recovered from waste and scrap; about one-third was recovered in the form of slab zinc and the remainder in alloys, oxide, and chemicals. Of the total amount of scrap recycled, 320,000 tons was derived from new scrap and 90,000 tons was derived from old scrap. About 20,000 tons of scrap was exported, mainly to Taiwan, and 24,000 tons was imported, mainly from Canada.

**Import Sources (1996-99):** Ore and concentrate: Peru, 52%; Mexico, 24%; Australia, 12%; and other, 12%. Metal: Canada, 57%; Mexico, 10%; Spain 7%; and other, 26%. Combined total: Canada, 55%; Mexico, 10%; Peru, 7%; and other, 28%.

| **Tariff:** **Item** | **Number** | **Normal Trade Relations[4] 12/31/00** |
|---|---|---|
| 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).

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# ZINC

**Government Stockpile:**

**Stockpile Status—9-30-00**[5]

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Zinc | 137 | 8 | 137 | 45 | 42 |

**Events, Trends, and Issues:** The reopening of the Clinch Valley Mine in Tennessee and increased output at the Red Dog Mine in Alaska, which supplies more than one-half of total U.S. output, increased production of zinc concentrate by about 3% in 2000. U.S. mine production greatly exceeded smelter capacity, necessitating exports of concentrate. More than one-third of all concentrate exports, which were supplied entirely by Red Dog, was processed at the Trail smelter in Canada; the remaining two-thirds went mainly to Asian smelters. The United States is the world's largest exporter of zinc concentrates; it is also the largest importer of zinc metal. Most of the increase in zinc metal production was supplied by CalEnergy LLC, which began producing zinc metal from a brine residue in 1999.[6] Additional increases in zinc metal output were the result of improved efficiencies at all three U.S. primary smelters.

Domestic consumption of zinc metal continued to increase in 2000, mainly because of increased use of galvanized steel. The United States is the largest consumer of zinc and zinc products, but domestic metal production capacity, both primary and secondary, accounts for less than one-third of the quantity consumed. 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[7] | | Reserves[8] | Reserve base[8] |
|---|---|---|---|---|
| | 1999 | 2000[e] | | |
| United States | 843 | 860 | 25,000 | 80,000 |
| Australia | 1,160 | 1,250 | 34,000 | 85,000 |
| Canada | 1,010 | 900 | 11,000 | 31,000 |
| China | 1,370 | 1,400 | 33,000 | 80,000 |
| Mexico | 360 | 360 | 6,000 | 8,000 |
| Peru | 900 | 900 | 7,000 | 12,000 |
| Other countries | 2,400 | 2,300 | 72,000 | 130,000 |
| World total (may be rounded) | 8,040 | 8,000 | 190,000 | 430,000 |

**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 in prior Mineral Commodity Summaries.

[2]Platt's 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]American Metal Market, 1999, Cominco agrees to buy zinc: American Metal Market, v. 107, no. 178, September 15, p. 6.

[7]Zinc content of concentrate and direct shipping ore.

[8]See Appendix C for definitions.

# ZIRCONIUM AND HAFNIUM

(Data in metric tons, unless otherwise noted)

**Domestic Production and Use:** Zircon sand was produced at two mines in Florida and at one mine in Virginia. Zirconium and hafnium metal were produced from zircon sand by two domestic producers, one in Oregon and the other in Utah. Both metals are present in the ore, typically in a Zr to Hf ratio of 50:1. Primary zirconium chemicals were produced by the Oregon metal producer and at a plant in New Jersey. Secondary zirconium chemicals were produced by 10 other companies. Zirconia ($ZrO_2$) was produced from zircon sand at plants in Alabama, New Hampshire, New York, Ohio, and by the metal producer in Oregon. Zircon ceramics, opacifiers, refractories, and foundry applications are the largest end uses for zirconium. Other end uses of zirconium include abrasives, chemicals, metal alloys, welding rod coatings, and sandblasting. The largest market for hafnium metal is as an addition in superalloys.

| **Salient Statistics—United States:** | **1996** | **1997** | **1998** | **1999** | **2000[e]** |
|---|---|---|---|---|---|
| Production: Zircon ($ZrO_2$ content)[1] | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 |
| Imports: | | | | | |
| Zirconium, ores and concentrates ($ZrO_2$ content) | 60,100 | 40,600 | 58,200 | 37,500 | 42,600 |
| Zirconium, alloys, waste and scrap ($ZrO_2$ content) | 836 | 929 | 1,210 | 1,160 | 1,500 |
| Zirconium oxide ($ZrO_2$ content)[2] | 5,240 | 4,220 | 3,900 | 3,140 | 3,800 |
| Hafnium, unwrought, waste and scrap | 9 | 8 | 12 | 11 | 13 |
| Exports: | | | | | |
| Zirconium ores and concentrates ($ZrO_2$ content) | 22,780 | 28,800 | 26,600 | 45,200 | 37,900 |
| Zirconium, alloys, waste and scrap ($ZrO_2$ content) | 184 | 188 | 216 | 211 | 259 |
| Zirconium oxide ($ZrO_2$ content)[2] | 1,480 | 1,970 | 1,540 | 1,680 | 2,100 |
| Consumption, zirconium ores and concentrates, apparent ($ZrO_2$ content) | W | W | W | W | W |
| Prices: | | | | | |
| Zircon, dollars per metric ton (gross weight): | | | | | |
| Domestic[3] | 462 | 419 | 320 | 300 | 340 |
| Imported, f.o.b.[4] | 392 | 445 | 355 | 311 | 356 |
| Zirconium sponge, dollars per kilogram[5] | 20-26 | 20-26 | 20-26 | 20-26 | 20-26 |
| Hafnium sponge, dollars per kilogram[5] | 165-209 | 165-209 | 165-209 | 165-209 | 165-209 |
| Net import reliance[6] as a percent of apparent consumption: | | | | | |
| Zirconium | W | W | W | W | W |
| Hafnium | NA | NA | NA | NA | NA |

**Recycling:** Zirconium metal was recycled by four companies, one each in California, Michigan, New York, and Texas. Most of the zirconium recycled came from scrap generated during metal production and fabrication. Zircon foundry mold cores and spent or rejected zirconia refractories are often recycled. Recycling of hafnium metal was insignificant.

**Import Sources (1996-99):** Zirconium ores and concentrates: South Africa, 56%; Australia, 41%; and other, 3%. Zirconium, wrought, unwrought, waste and scrap: France, 62%; Germany, 11%; Canada, 6%; United Kingdom, 5%; and other, 16%. Hafnium, unwrought, waste and scrap: France, 79%; Germany, 8%; United Kingdom, 4%; and other, 9%.

| **Tariff:** Item | Number | Normal Trade Relations 12/31/00 |
|---|---|---|
| Zirconium ores and concentrates | 2615.10.0000 | Free. |
| Germanium oxides and $ZrO_2$ | 2825.60.0000 | 3.7% ad val. |
| Ferrozirconium | 7202.99.1000 | 4.2% ad val. |
| Zirconium, waste and scrap | 8109.10.3000 | Free. |
| Zirconium, other unwrought, powders | 8109.10.6000 | 4.2% ad val. |
| Zirconium, other wrought, alloys | 8109.90.0000 | 3.7% ad val. |
| Unwrought hafnium, waste and scrap | 8112.91.2000 | Free. |

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

**Government Stockpile:** In addition to 15,726 tons of baddeleyite ore (gross weight) held in the National Defense Stockpile, the U.S. Department of Energy (DOE) held over 500 tons of zirconium in various forms. DOE also maintained a stockpile of approximately 35 tons of hafnium.

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# ZIRCONIUM AND HAFNIUM

**Stockpile Status—9-30-00[7]**

| Material | Uncommitted inventory | Committed inventory | Authorized for disposal | Disposal plan FY 2000 | Disposals FY 2000 |
|---|---|---|---|---|---|
| Baddeleyite | 1,262 | 14,464 | 1,262 | 15,770 | 14,507 |

**Events, Trends, and Issues:** The global supply and demand of zirconium mineral concentrates was largely in balance in 2000. This trend is expected to continue over the next few years. In the long-term, however, supply shortages may occur unless new production sources of zirconium concentrates are developed. U.S. imports of zirconium ores and concentrates were estimated to have increased 14%, while exports increased 16% compared with those of 1999. A mining operation at Stony Creek, VA, began production of zircon and other heavy minerals in 1998. Initial capacity was expected to include up to 30,000 tons per year of zircon. An expansion is planned for the mine over the next 2 years. Availability of hafnium continued to exceed supply. Surpluses were stockpiled in the form of hafnium oxide. The demand for nuclear-grade zirconium metal, the production of which necessitates hafnium's removal, produces more hafnium than can be consumed by the metal's uses.

**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[8] (million metric tons, $ZrO_2$) | Reserve base[8] | Reserves[8] (thousand metric tons, $HfO_2$) | Reserve base[8] |
| | 1999 | 2000[e] | | | | |
| United States[1] | 100 | 100 | 3.4 | 5.3 | 68 | 97 |
| Australia | 400 | 400 | 9.1 | 29.8 | 182 | 596 |
| Brazil | 19 | 19 | .4 | .4 | 7 | 7 |
| China | [e]15 | 15 | .5 | 1.0 | NA | NA |
| India | 19 | 19 | 3.4 | 3.8 | 42 | 46 |
| South Africa | 400 | 400 | 14.3 | 14.3 | 259 | 259 |
| Ukraine | [e]65 | 65 | 4.0 | 6.0 | NA | NA |
| Other countries | 23 | 30 | .9 | 4.1 | NA | NA |
| World total (may be rounded) | [9]940 | [9]950 | 36 | 65 | 560 | 1,000 |

**World Resources:** Resources of zircon in the United States included about 14 million tons associated with titanium resources in heavy-mineral sand deposits. Phosphate 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. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Rounded to one significant digit to avoid revealing company proprietary data. $ZrO_2$ content of zircon is typically 65%.
[2]Includes germanium oxides and zirconium oxides.
[3]E.I. du Pont de Nemours & Co. and Iluka Resources, Inc., average price.
[4]U.S. Census Bureau trade data.
[5]American Metal Market, daily, Miscellaneous prices. Converted from pounds.
[6]Defined as imports - exports.
[7]See Appendix B for definitions.
[8]See Appendix C for definitions.
[9]Excludes the United States.

# 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 |
| 1 troy pound | = 12 troy ounces |

# APPENDIX B

## Terms Used for Materials in the National Defense Stockpile

**Uncommitted inventory**, as used by the Department of Defense, refers simply to material currently in the stockpile, whether stockpile-grade or nonstockpile-grade. In the tables for this report, only the stockpile-grade material is listed; nonstockpile-grade material, if any, is cited in the text.

**Committed inventory** refers to both stockpile-grade materials and nonstockpile-grade materials that have been sold or traded from the stockpile, either in the current fiscal year or in prior years, but not yet removed from stockpile facilities.

**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 loss to the United States.

**Disposal plan FY 2000** refers the Defense Logistics Agency's Annual Materials Plan for the fiscal year. Fiscal year 2000 is the period 10/1/99 through 9/30/00.

**Disposals FY 2000** refers to material sold or traded from the stockpile in fiscal year 2000; it may or may not have been removed by the buyers.

# APPENDIX C

## A Resource/Reserve Classification for Minerals[5]

### 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 collects information about the quantity and quality of all mineral resources. In 1976, the Survey and the U.S. Bureau of Mines developed a common classification and nomenclature, which was published as U.S. Geological Survey 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 U.S. Geological Survey and the U.S. Bureau of Mines collaborated to revise Bulletin 1450-A. Their work was published in 1980 as U.S. Geological Survey 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 systems, designed generally for all mineral materials, is shown graphically in figures 1 and 2; their components and 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 to 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

[5] 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 figure 1. 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***

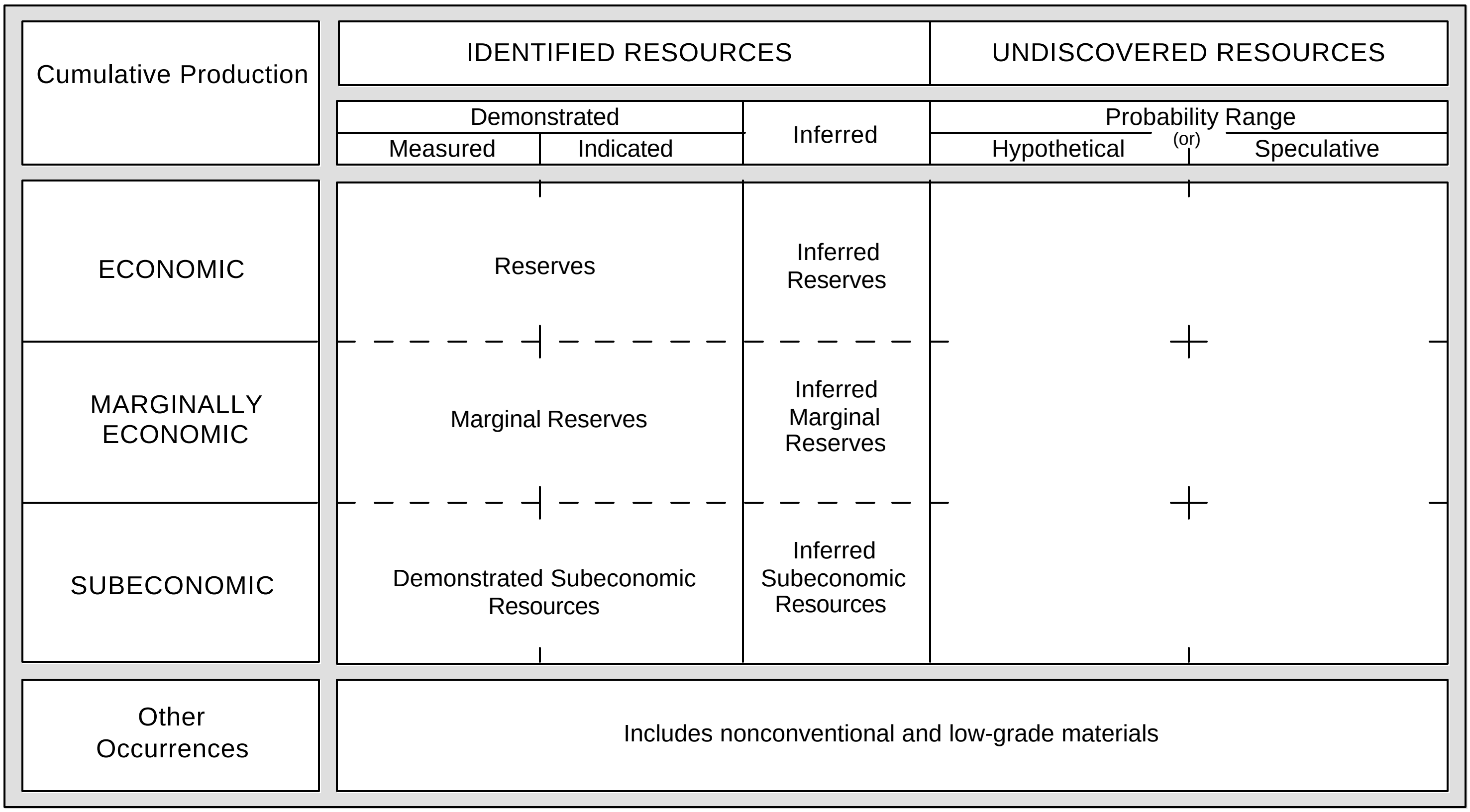


**FIGURE 2.--*Reserve Base* and *Inferred Reserve Base* Classification Categories**