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

MINERAL COMMODITY SUMMARIES 2003

Abrasives
Aluminum
Antimony
Arsenic
Asbestos
Barite
Bauxite
Beryllium
Bismuth
Boron
Bromine
Cadmium
Cement
Cesium
Chromium
Clays
Cobalt
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Copper
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Iron and Steel
Kyanite
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Mercury
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Phosphate Rock
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Potash
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Rare Earths
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Sand and Gravel
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Silver
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Stone
Strontium
Sulfur
Talc
Tantalum
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Vanadium
Vermiculite
Yttrium
Zinc
Zirconium

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

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

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

This publication has been prepared by the Minerals Information Team. Information about the team and its products is available from the Internet at URL <http://minerals.usgs.gov/minerals> or by writing to Chief Scientist, Minerals Information Team, 988 National Center, Reston, VA 20192.

KEY PUBLICATIONS

Minerals Yearbook—These annual publications review the mineral industries of the United States and foreign countries. They contain statistical data on minerals and materials and include information on economic and technical trends and developments. The 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 Indexes—This monthly publication provides economic indicators of selected industrial minerals processing activities.

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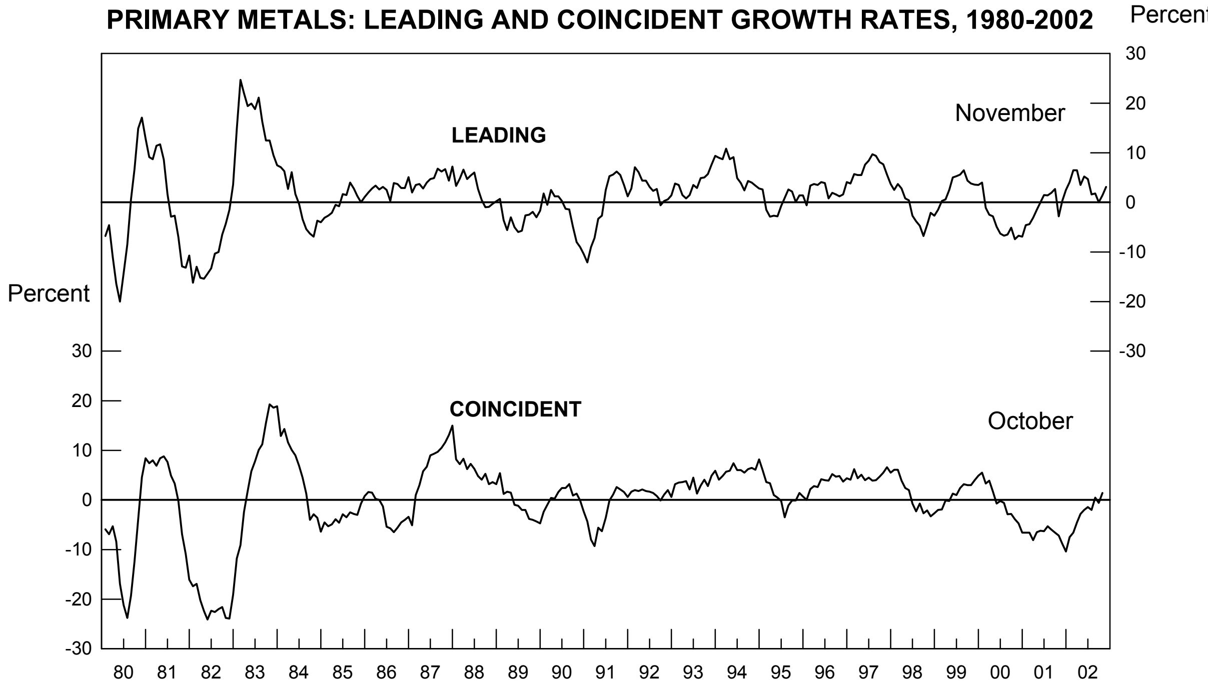
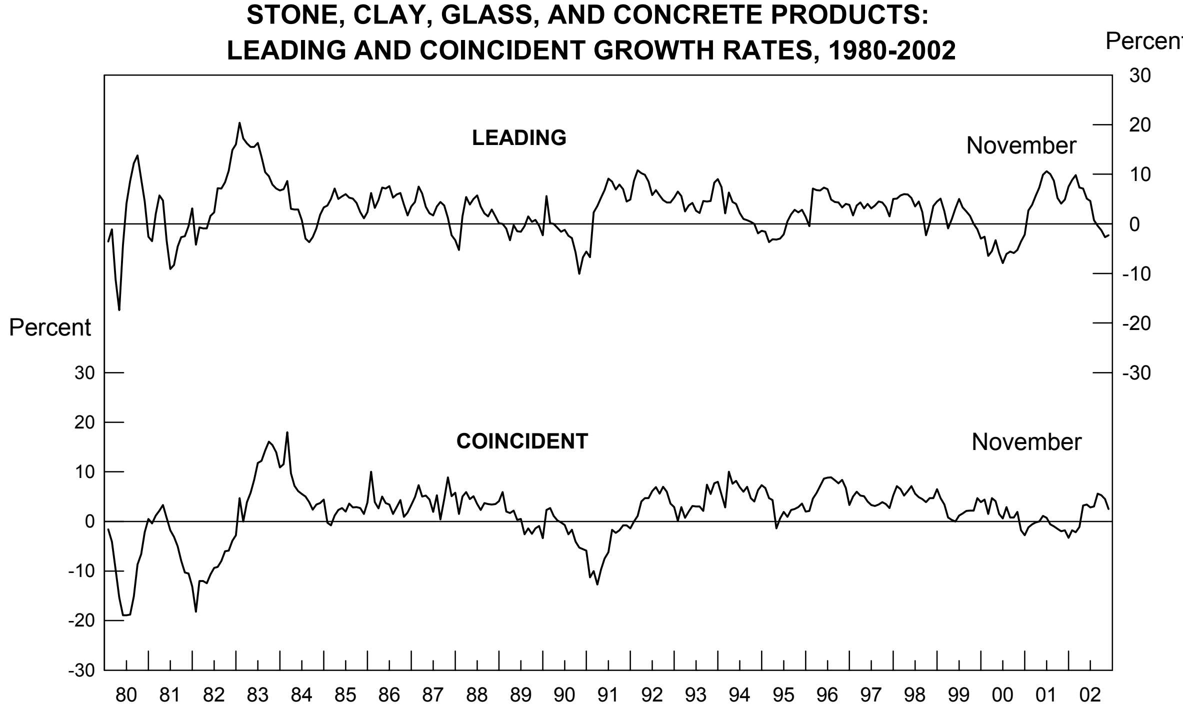
GROWTH RATES OF LEADING AND COINCIDENT INDEXES FOR MINERAL PRODUCTS

PRIMARY METALS: LEADING AND COINCIDENT GROWTH RATES, 1980-2002



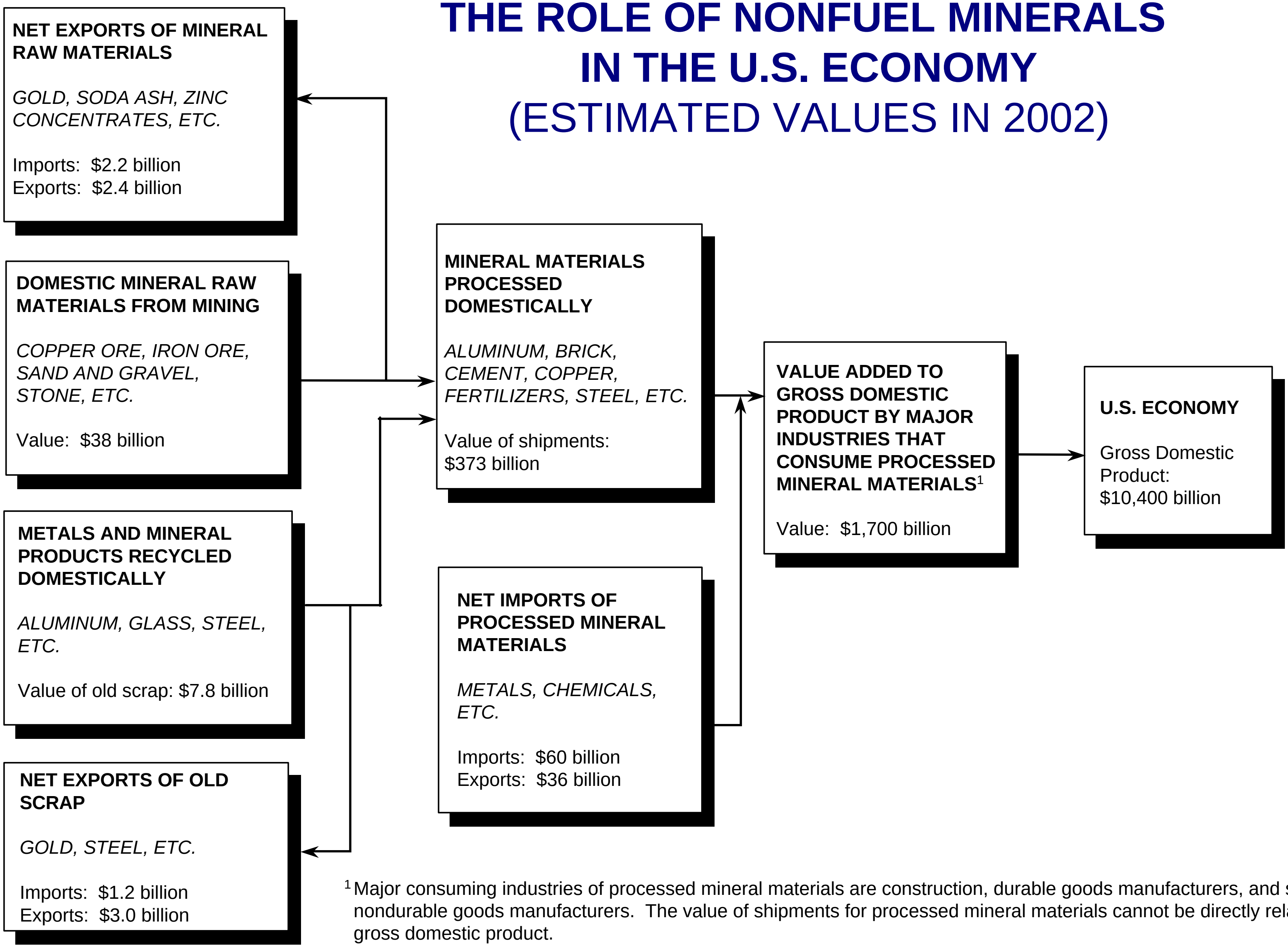
STONE, CLAY, GLASS, AND CONCRETE PRODUCTS: LEADING AND COINCIDENT GROWTH RATES, 1980-2002



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 2002)



[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.

2002 U.S. NET IMPORT RELIANCE FOR SELECTED NONFUEL MINERAL MATERIALS

Commodity	Percent	Major Import Sources (1998-2001)[1]
ARSENIC (trioxide)	100	China, Chile, Mexico
ASBESTOS	100	Canada
BAUXITE and ALUMINA	100	Australia, Guinea, Jamaica, Brazil
COLUMBIUM (niobium)	100	Brazil, Canada, Germany, Estonia
FLUORSPAR	100	China, South Africa, Mexico
GRAPHITE (natural)	100	China, Mexico, Canada, Brazil
INDIUM	100	China, Canada, France, Russia
MANGANESE	100	South Africa, Gabon, Australia, Mexico
MICA, sheet (natural)	100	India, Belgium, Germany, China
QUARTZ CRYSTAL (industrial)	100	Brazil, Germany, Madagascar
STRONTIUM	100	Mexico, Germany
THALLIUM	100	Belgium, Canada, France, Russia, United Kingdom
VANADIUM	100	South Africa, Canada, China, Czech Republic
YTTRIUM	100	China, Japan, France, United Kingdom
GEMSTONES	99	Israel, Belgium, India
BISMUTH	95	Belgium, Mexico, China, United Kingdom
PLATINUM	93	South Africa, United Kingdom, Germany, Russia
DIAMOND (natural industrial stone)	89	Switzerland, Russia, United Kingdom, Ireland
STONE (dimension)	88	Italy, Canada, India, Spain
TITANIUM MINERAL CONCENTRATES	82	South Africa, Australia, Canada, Ukraine
POTASH	80	Canada, Russia, Belarus, Germany
TANTALUM	80	Australia, China, Japan, Thailand
TIN	79	Peru, China, Indonesia, Brazil, Bolivia
BARITE	76	China, India, Canada, Thailand
IODINE	76	Chile, Japan, Russia
COBALT	75	Finland, Norway, Russia, Canada
TUNGSTEN	70	China, Russia
PALLADIUM	69	Russia, South Africa, United Kingdom, Belgium
CHROMIUM	63	South Africa, Kazakhstan, Zimbabwe, Turkey, Russia
SILVER	61	Canada, Mexico, Peru, United Kingdom
ZINC	60	Canada, Mexico, Kazakhstan
RHENIUM	59	Chile, Kazakhstan, Germany, Russia
BERYLLIUM	55	Kazakhstan, Russia, Brazil, Philippines
MAGNESIUM METAL	54	Canada, China, Russia, Israel
TITANIUM (sponge)	54	Japan, Russia, Kazakhstan
RARE EARTHS	53	China, France, Japan, Estonia
PEAT	50	Canada
SILICON	47	Norway, South Africa, Russia, Canada
NICKEL	43	Canada, Norway, Russia, Australia
ANTIMONY	41	China, Mexico, Belgium, South Africa, Hong Kong
ALUMINUM	39	Canada, Russia, Venezuela, Mexico
COPPER	37	Canada, Chile, Peru, Mexico
MAGNESIUM COMPOUNDS	35	China, Australia, Canada, Israel
NITROGEN (fixed), AMMONIA	29	Trinidad and Tobago, Canada, Ukraine
GARNET (industrial)	28	Australia, India, China
PUMICE	28	Greece, Italy, Turkey
DIAMOND (dust, grit and powder)	27	Ireland, China, Ukraine
GYPSUM	25	Canada, Mexico, Spain
MICA, scrap and flake (natural)	24	Canada, India, China, Finland
PERLITE	23	Greece
CEMENT	19	Canada, Thailand, China, Venezuela, Greece
LEAD	18	Canada, Mexico, Australia, Peru
SALT	18	Canada, Chile, Mexico, The Bahamas
SULFUR	15	Canada, Mexico, Venezuela
IRON and STEEL	14	European Union, Canada, Japan, Mexico
IRON ORE	11	Canada, Brazil, Australia, Venezuela
TALC	8	China, Canada, France, Japan
IRON and STEEL SLAG	6	Italy, Japan, Canada
PHOSPHATE ROCK	6	Morocco

[1]In descending order of import share

SIGNIFICANT EVENTS, TRENDS, AND ISSUES

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

Following the recession of 2001, restrained consumer spending, declines in domestic manufacturing and industrial output, and increased unemployment led to an expansion of only about 2% in the domestic economy during 2002. Significant production declines in the U.S. metals industry were registered by copper, lead, and zinc producers. Steel producers, despite a slight improvement in output, continued to face strong foreign competition, higher energy costs, and lower prices for their products. Homebuilding and other domestic construction sectors—major consumers of nonmetallic mineral products, such as cement, brick, glass, and stone—remained strong enough to help raise the total output of industrial mineral materials slightly above previous year levels (table 1). A strong U.S. dollar relative to other national currencies continued to weaken the competitive stance of U.S. metal and nonmetal mineral materials companies in markets at home and abroad compared with foreign producers.

Overall Performance

The estimated value of all mineral-based products manufactured in the United States during 2002 increased by less than 1% to $373 billion (page 4). The estimated total value of U.S. raw nonfuel minerals mine production alone was $38 billion, a slight decrease compared with that of 2001. Within the raw nonfuel minerals category, however, there was a significant difference between the metal and nonmetal components: the estimated value of metals output dropped by 7% to about $8 billion, whereas, the estimated production value of industrial minerals increased slightly to $30 billion.

Net imports of raw minerals and processed mineral materials during 2002 reflected the effect of the 2001 recession, slow economic growth, and a continuing reliance on other countries for mineral products (page 5). Imports of raw and processed mineral materials fell by about 8% from previous year levels to a value of $62 billion; aluminum, copper, and steel were among the largest imports. Exports of raw and processed mineral materials during 2002 dropped by 14% to a value of $39 billion. Total imports and exports of metal ores/concentrates and raw industrial minerals were less than $5 billion.

Two major sectors of the U.S. economy, motor vehicle manufacturing and the construction industry, exerted considerable influence on domestic demand for mineral-based materials in 2002. In a largely successful effort to maintain sales, domestic motor vehicle manufacturers offered low- to no-interest loans to purchasers of new vehicles. Consequently, domestic market sales of U.S.-produced motor vehicles—incorporating large quantities of steel and other metals as well as significant amounts of glass and plastics—were maintained at previous year levels. The construction industry—accounting for most of the consumption of clay, cement, glass, sand and gravel, and stone—benefited from low mortgage rates available to purchasers of residential housing units. In addition, Federal expenditures for building highways and mass transit systems helped maintain demand for cement, sand and gravel, steel, and crushed stone in some areas (table 2). The indexes in table 2 now reflect a base year of 1997 compared with 1992, which was used previously.

In 2002, 15 States produced nonfuel mineral commodities with total production values of greater than $1 billion. These States were, in descending order, California, Nevada, Texas, Florida, Arizona, Michigan, Georgia, Missouri, Pennsylvania, Utah, Minnesota, Ohio, Alaska, Wyoming, and New York; they composed 64% of the U.S. total output value (table 3).

U.S. production of mineral fertilizer nutrients improved significantly from results posted in 2001, primarily in response to increased domestic and foreign demand, especially for finished phosphate fertilizers for export to China. Domestic demand for phosphate rock, sulfur, and potash was up slightly. Low ammonia prices and high inventory levels in the first part of the year led some ammonia producers to temporarily idle a significant portion of their ammonia production capacity.

In fiscal year 2002, the Defense Logistics Agency (DLA) sold $359 million of excess mineral materials from the National Defense Stockpile (NDS). (More information can be found in the “Government Stockpile” sections in the mineral commodity reports that follow.) Under authority of The Defense Production Act of 1950, the U.S. Geological Survey advises the DLA on acquisitions and disposals of NDS mineral materials. At the end of the fiscal year, mineral materials valued at more than $1.85 billion remained in the stockpile.

Outlook

At yearend 2002, economists were divided about the state of the economic recovery from the recession of 2001. Expected holiday consumer spending was less than anticipated; the stock market did not improve, partly because corporate scandals had undermined investor confidence; record new home sales continued as home mortgage rates reached a 40-year low; productivity improved significantly; and the unemployment rate stayed at 6%.

The speed and strength of expansion in the domestic mineral materials industry will depend to a great extent on how long consumers will maintain the pace of new motor vehicle and new home purchases that was underway in 2002. Overall, the expectation is that expansion in industrial minerals production and consumption will outpace that of the metals.

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

TABLE 1.—U.S. MINERAL INDUSTRY TRENDS

	1998	1999	2000	2001	2002[e]
Total mine production:[1]					
Metals	11,400	9,800	10,100	8,530	7,960
Industrial minerals	28,200	29,300	29,200	29,800	30,000
Coal	19,700	18,300	18,000	19,600	19,100
Employment:[2]					
Coal mining	75	70	64	67	67
Metal mining	38	34	31	27	25
Industrial minerals, except fuels	83	86	86	85	85
Chemicals and allied products	587	583	575	560	550
Stone, clay, and glass products	439	443	457	446	432
Primary metal industries	560	547	548	508	454
Average weekly earnings of production workers:[3]					
Coal mining	857	856	850	892	919
Metal mining	812	813	809	819	814
Industrial minerals, except fuels	681	689	706	734	748
Chemicals and allied products	738	749	771	787	807
Stone, clay, and glass products	591	606	626	654	673
Primary metal industries	684	703	737	738	770

[e]Estimated.

[1]Million dollars.

[2]Thousands of production workers.

[3]Dollars.

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

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

	1998	1999	2000	2001	2002[e]
Gross domestic product (billion dollars)	8,782	9,274	9,825	10,082	10,400
Industrial production (1997=100):					
Total index	106	110	115	111	110
Manufacturing	107	112	117	113	111
Nonmetallic mineral products	105	106	106	107	108
Primary metals:	102	102	99	88	86
Iron and steel	100	100	100	87	89
Aluminum	105	105	99	86	88
Nonferrous metals (except aluminum)	109	101	88	90	78
Chemicals	101	104	106	105	106
Mining:	98	94	96	97	94
Coal	101	100	98	101	95
Oil and gas extraction	98	96	96	98	97
Metals	99	91	90	82	73
Nonmetallic minerals	105	107	107	108	108
Capacity utilization (percent):					
Total industry	83	82	83	77	76
Mining:	88	86	89	88	85
Metals	91	84	85	81	73
Nonmetallic minerals	86	86	86	87	87
Housing starts (thousands)	1,620	1,640	1,570	1,600	1,700
Automobile sales (thousands)[1]	6,750	6,990	6,840	6,000	6,000
Highway construction, value, put in place (billion dollars)	44	49	50	54	55

[e]Estimated.

[1]Excludes imports.

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

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2002[p 1]

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$968,000	16	2.55	Cement (portland), stone (crushed), lime, sand and gravel (construction), cement (masonry).
Alaska	1,030,000	13	2.72	Zinc, gold, lead, silver, sand and gravel (construction).
Arizona	1,920,000	5	5.05	Copper, sand and gravel (construction), cement (portland), molybdenum concentrates, stone (crushed).
Arkansas	543,000	25	1.43	Bromine, stone (crushed), cement (portland), sand and gravel (construction), lime.
California	3,440,000	1	9.07	Sand and gravel (construction), cement (portland), boron minerals, stone (crushed), gold.
Colorado	619,000	23	1.63	Sand and gravel (construction), cement (portland), stone (crushed), molybdenum concentrates, gold.
Connecticut[2]	142,000	42	0.37	Stone (crushed), sand and gravel (construction), stone (dimension), clays (common), gemstones.
Delaware[2]	17,500	49	0.05	Sand and gravel (construction), magnesium compounds, gemstones.
Florida	2,020,000	4	5.32	Phosphate rock, stone (crushed), cement (portland), sand and gravel (construction), cement (masonry).
Georgia	1,450,000	7	3.82	Clays (kaolin), stone (crushed), clays (fuller's earth), cement (portland), sand and gravel (construction).
Hawaii	75,300	45	0.20	Stone (crushed), sand and gravel (construction), gemstones.
Idaho	307,000	35	0.81	Phosphate rock, sand and gravel (construction), silver, molybdenum concentrates, stone (crushed).
Illinois	950,000	17	2.50	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), lime.
Indiana	740,000	18	1.95	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry), lime.
Iowa	487,000	26	1.28	Stone (crushed), cement (portland), sand and gravel (construction), gypsum (crude), lime.
Kansas	661,000	21	1.74	Cement (portland), helium (Grade-A), salt, stone (crushed), helium (crude).
Kentucky[2]	372,000	32	0.98	Stone (crushed), lime, cement (portland), sand and gravel (construction), clays (ball).
Louisiana	294,000	36	0.77	Salt, sand and gravel (construction), stone (crushed), sand and gravel (industrial), lime.
Maine	106,000	43	0.28	Sand and gravel (construction), cement (portland), stone (crushed), stone (dimension), cement (masonry).
Maryland[2]	375,000	31	0.99	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry), stone (dimension).
Massachusetts[2]	235,000	38	0.62	Stone (crushed), sand and gravel (construction), lime, stone (dimension), clays (common).
Michigan	1,580,000	6	4.16	Cement (portland), iron ore (usable), sand and gravel (construction), stone (crushed), magnesium compounds.
Minnesota[2]	1,090,000	11	2.86	Iron ore (usable), sand and gravel (construction), stone (crushed), sand and gravel (industrial), stone (dimension).
Mississippi	176,000	40	0.46	Sand and gravel (construction), clays (fuller's earth), cement (portland), stone (crushed), clays (bentonite).
Missouri	1,290,000	8	3.39	Stone (crushed), cement (portland), lead, lime, sand and gravel (construction).
Montana	442,000	30	1.16	Palladium metal, sand and gravel (construction), platinum metal, cement (portland), gold.
Nebraska[2]	88,600	44	0.23	Cement (portland), stone (crushed), sand and gravel (construction), lime, cement (masonry).
Nevada	2,900,000	2	7.63	Gold, sand and gravel (construction), lime, silver, diatomite.
New Hampshire[2]	68,000	47	0.18	Sand and gravel (construction), stone (crushed), stone (dimension), gemstones.
New Jersey[2]	285,000	37	0.75	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), greensand marl, peat.

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 2002[p 1]—Continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
New Mexico	$571,000	24	1.50	Potash, copper, sand and gravel (construction), stone (crushed), cement (portland).
New York	1,010,000	15	2.67	Stone (crushed), cement (portland), salt, sand and gravel (construction), wollastonite.
North Carolina	708,000	19	1.86	Stone (crushed), phosphate rock, sand and gravel (construction), sand and gravel (industrial), feldspar.
North Dakota	38,700	48	0.10	Sand and gravel (construction), lime, stone (crushed), clays (common), sand and gravel (industrial).
Ohio	1,060,000	12	2.78	Stone (crushed), sand and gravel (construction), salt, lime, cement (portland).
Oklahoma	462,000	27	1.22	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), gypsum (crude).
Oregon	320,000	34	0.84	Stone (crushed), sand and gravel (construction), cement (portland), diatomite, pumice and pumicite.
Pennsylvania[2]	1,270,000	9	3.35	Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry).
Rhode Island[2]	17,300	50	0.05	Sand and gravel (construction), stone (crushed), sand and gravel (industrial), gemstones.
South Carolina[2]	460,000	28	1.21	Cement (portland), stone (crushed), cement (masonry), sand and gravel (construction), clays (kaolin).
South Dakota	186,000	39	0.49	Cement (portland), sand and gravel (construction), stone (crushed), gold, stone (dimension).
Tennessee	629,000	22	1.66	Stone (crushed), cement (portland), zinc, sand and gravel (construction), clays (ball).
Texas	2,180,000	3	5.74	Cement (portland), stone (crushed), sand and gravel (construction), salt, lime.
Utah	1,240,000	10	3.26	Copper, gold, sand and gravel (construction), cement (portland), salt.
Vermont[2]	70,700	46	0.19	Stone (dimension), stone (crushed), sand and gravel (construction), talc (crude), gemstones.
Virginia	697,000	20	1.83	Stone (crushed), cement (portland), sand and gravel (construction), lime, clays (fuller's earth).
Washington	450,000	29	1.18	Sand and gravel (construction), stone (crushed), cement (portland), diatomite, gold.
West Virginia	173,000	41	0.45	Stone (crushed), cement (portland), sand and gravel (industrial), lime, salt.
Wisconsin[2]	340,000	33	0.89	Sand and gravel (construction), stone (crushed), lime, sand and gravel (industrial), stone (dimension).
Wyoming	1,010,000	14	2.67	Soda ash, clays (bentonite), helium (Grade-A), cement (portland), sand and gravel (construction).
Undistributed	416,000	XX	1.10	
Total	38,000,000	XX	100.00	

[p]Preliminary. XX Not applicable.

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

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

Significant International Events[2]

In all likelihood, 2002 will be remembered as a year in which the economy and mineral markets showed no clear direction. Early in the year, economic growth seemed to return following the recession in 2001; by the end of 2002, however, it was not clear that the recession of 2001 had actually ended (Hall and others, 2003).

Germany, Japan, and the United States, three of the largest national economies, had problems of deflation or lethargy in investment and production. In Germany, investment was weak, productivity was in a slough, and nonperforming loans were becoming a problem. In Japan, the decade-long deflation worsened. In the United States, the collapse of the technology bubble along with the aftermath of the terrorist destruction of the World Trade Center towers was followed by a mass withdrawal of money in equities. In Latin America, each country had troubles that were somewhat different but,

[2]David B. Doan, W. David Menzie, and staff.

in some cases, were ascribable to fiscal problems that were allowed to become monetary problems because currencies were manipulated to manage debt. Africa continued to provide the world with a variety of mineral resources while suffering revolutions, coups, land grabs, and the danger of starvation. Russia continued its transition to a market economy and tried to increase startup industry and output.

The common problem for much of the world seemed to be a lack of committed investment capital to spark the confidence that would rebuild productivity worldwide. Compounding the overall economic problem was the spectre of a war with Iraq. Major world economies and some minor economies that have been unable to create economic growth based on demand from their own enterprises and consumers have been relying on the U.S. consumer to sustain a demand for imports. The U.S. consumer has been willing thus far, but a certain proportion of the load has been charged to credit cards and other small-loan sources, neither of which are unlimited. Thus the strength of the U.S. economy has diminished and now relies to a greater extent on the collective purchasing power of its citizens. There were a few brighter spots. China enjoyed solid growth in its gross domestic product (GDP) during the previous year and provided increasing demands for exports, which included mineral commodities, from other Asian countries. The Republic of Korea expanded its capital markets to attract foreign portfolio investment. Thailand's recovery and growth was led by consumer demand. Overall direction of the world economy concerning growth or recession was unclear.

Review of National or Regional Economies

The decline of equities markets reduced the effect of the United States as the source of economic strength that the world had come to accept. "Irrational exuberance," particularly in the technological stocks, was gradually replaced by uncertainty and caution. The situation was not helped by a string of revelations of financial irregularities at the highest levels of several major corporations. This exacerbated the weakening of confidence in the equities markets, which resulted in a reduction or collapse of asset values throughout the national economy. By generating a diminished proportion of demand growth of the world economy, the United States no longer provided unlimited time for other countries to restructure their fiscal systems, to reduce interest rates, and to adjust their trade arrangements to participate in a global expansion. With the economy already weakened by a recession, newly established U.S. tariffs on a variety of steel products, which included rolled steel and steel wire, were met by threats of retaliation by the European Union (EU) and other countries.

Because Japan has shown little progress in confronting the problems that resulted from the collapse of domestic real estate values more than a decade ago, the domestic debt structure has been affected to the point that banks have become overwhelmed by nonperforming loans. Consequently, calling the loans would result in a plethora of prominent bankruptcies with consequent effects on labor, credit, and investment. Not calling the loans, however, could put the separate banks, if not the entire banking system, in jeopardy. Fixing the banks would be important for several reasons (Dvorak, 2002). Because bank lending is about equal to total economic output, banks are the main funnel of cash to Japanese business, a funnel that many believe is jammed. So long as banks keep nonperforming "deadbeat" corporate borrowers in business, other healthier companies will not get the funding they need to grow. The size of Japan's loan-default problem is thought to be so large that the banks are not able to handle the losses on their own. Taking bad loans off banks' books will not solve the problem. Failing borrowers must be liquidated or restructured and their depreciated assets sold at market prices. Resistance to doing this is based at least partly on the intricacies of Japanese politics. Devaluing the yen might stimulate exports and improve cash flow, but other Asian countries would lose market share that they need to support their own economic recoveries. As with the United States, Japan needs consumer demand to help keep its economy afloat, but much potential consumer purchasing power is going into savings. The weakness of the Japanese banking system could have an important effect on the supply of minerals because Japanese companies have been avid investors in natural resources projects throughout the world for several decades. The continuation of such investments will be important to a world in which the development of countries with large populations, most notably China and India, will significantly increase the demand for minerals.

As the largest economy in the EU, Germany's economic strength or weakness is reflected by fluctuations in the value of the euro versus that of other currencies. After the decline of the U.S. equities markets and investment shifting to EU countries, the value of the euro climbed closer to the value of the dollar, but Germany's economy is being severely tested by domestic fiscal and labor policies as well as natural disasters. In August, a catastrophic flood inundated much of the eastern provinces. In Saxony, for example, 180 bridges, 20% of the rail network, and 480 miles of roads were destroyed or made unusable; Dresden, the capital, was severely damaged. Physical rebuilding will cost roughly $20 billion, with social costs more difficult to reckon, and all at a time of stagnation of the German economy (Kielinger, 2002). To repair the flood damage, an anticipated tax cut was postponed, and corporate taxes were increased. Germany has 10% unemployment, and layoffs are at record highs for skilled and unskilled workers. As in Japan, consumer savings are up sharply. Perhaps least tractable is the burden of labor and social entitlement costs that militate against new hiring. The European Central Bank has seen no urgency to cut its lending rates to stimulate investment. In the meantime, European productivity loses ground. Progress is being made, however, in adopting a uniform set of financial standards for the EU, starting with a single accounting standard for all listed companies in the EU.

Late in 2001, the EU announced a significant expansion; it has agreed to welcome 10 new members—Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia—by 2004. EU firms have invested in the cement industries of Eastern European countries and are now showing increased interest in the steelmaking facilities in these countries.

Russia addressed its problem of capital flight, possibly $300 billion in 12 years, by declaring an amnesty on repatriation provided a 13% income tax is paid on the returning funds (Chazan, 2000). Relatively modest foreign direct investment was expected to improve, but overall, the economy grew by 5% during 2001. Devaluation of the ruble in 1998 drove up import prices and made local mineral products more competitive. Otherwise, the country enjoyed its increasing importance as a petroleum producer to the benefit of its cashflow and GDP. Although the price of palladium declined from the extremely high levels of 2001, Norilsk Nickel RAO, which was one of the largest mining companies in the world, continued to increase corporate transparency by announcing a policy of releasing quarterly reports of base-metal production and continued to seek overseas assets by proposing to purchase 51% of the U.S. platinum-group-metals producer Stillwater Mining Co. As one of the world's largest oil exporters, Russia was a significant presence in world petroleum markets.

Latin America worked its way through a variety of problems; the policy of privatizing Government-operated utilities and businesses no longer enjoyed the popularity it did in the 1990s. In many cases, central banks in Latin America have not been able to ensure price stability (O'Grady, 2002). Argentina saw its economic problems of 2001 devolve into one of the worst financial crises in living memory (Economist, 2002a). A lack of agreement on what has gone wrong has made designing solutions difficult. The economy is contracting, inflation is surging, and the banking system is in ruins. Meanwhile, the Government found itself owing the World Bank, the International Monetary Fund, and other multilateral investors and with no clear idea of where the money will come from. Brazil, which was the largest economy in Latin America, conducted orderly elections after the 8-year administration of Fernando Cardosa, who did much to modernize Brazil's Government and economy at the expense of assembling a very large public debt (Economist, 2002b). The new president, a member of the Workers' Party, will face the necessity of generating fiscal surpluses to address the public debt as well as targeting Brazil's inflation to engender monetary stability. Brazil is a country rich in natural resources and available labor. Bringing these assets together coherently could result in higher levels of productivity, which will be the key to economic expansion.

Venezuela, which was one of the major suppliers of petroleum to the United States, endured a failed coup aimed at displacing the existing Government. The chief opposition, however, was by labor unions, which did not necessarily share the policies of the Government. In June, inflation reached 16.2%, which was the highest level in 3 years (Lifsher, 2002). Consumer price rises hit a 30% annualized rate, and the currency dropped by 46% against the U.S. dollar. All of this has put Venezuela into a deep recession. At yearend, opponents of the Venezuelan administration called a general strike that severely decreased the country's oil exports. Chile, which had a population of only 16 million, enjoyed a stream of direct foreign investment in 2001 that exceeded that of India, which had a population of 1 billion. Mexico continued on the path of reform. Early in the year, Standard & Poor increased Mexico's debt rating to investment grade; this is expected to lower borrowing costs for Government and business. Mexico had the only currency that appreciated (5%) against the dollar in 2001 (Bartley, 2002). Inflation has been brought down steadily since 1995. Late in the year, the Government agreed to a wage settlement that fended off a potentially damaging strike by the oil workers of Petroleos Mexicanos.

Although rich in resources, many African countries were beset by coups, riots, ethnic massacres, and land appropriations. West Africa typified the continent's situation. In recent years, Ghana and Mali have increased their production of gold, and the proposed West African Gas Pipeline offers the possibility of developing energy-consuming industries in the region. Several countries in the region, notably Burkina Faso and Liberia, however, have been identified as playing a role in al Qaeda's conversion of cash into diamonds (Farah, 2002). Civil war has broken out in another West African country, Cote d'Ivoire. Smuggling and illicit trading of diamonds have provided a negotiable form of capital that compared with normal currency transactions, stays "off the books," and is difficult to trace. The death of Jonas Savimbi, the leader of the National Union for the Total Independence of Angola (UNITA), the signing of a peace treaty that ended the civil war in Angola, and peace negotiations in Congo (Kinshasa) seem to offer hope for peace and even improved economies. Peace and Angola's recently expanded oil reserves could provide a real opportunity for development. As Zambia learned, however, peace, resources, and market economies alone may not be enough to revive the region's mineral industries, which face low metals prices and facilities that have been neglected for years. East Africa benefited from new gold development in Tanzania and the full operation of the Mozal aluminum smelter in Mozambique. Africa's economic position remains precarious; diamond, gold, and petroleum production were well established, but many inhabitants of African countries lived in poverty and starvation and lacked basic medical facilities and support in the face of the AIDS epidemic. Concerns about the transparency of transactions related to natural resource investment have lead to calls for investment capital for development to be carefully sequestered and supervised and for information about the payment of resource royalties to be released to the public.

East Asia and South Asia presented a mixed picture in 2002. One of the two most populous countries, India, saw its best performing states lag behind East Asian competitors, and without a faster rate of economic reform, India could fall even farther behind (Luce, 2002). Foreign direct investment levels were among the lowest in the world at 0.5% of the GDP compared with 4.4% in China, for example. The Republic of Korea, however, was a model of growth in Southeast Asia while trying to cool an overheated economy with consumer debt that approached 70% of the GDP and experiencing a reduced level of exports (Day and Hae, 2002). Although the cure for burgeoning credit problems is usually increasing the cost of money, increases in interest rates were thought to be dangerous because many borrowers would be pushed into insolvency, thus creating a situation similar to that of Japan. Between the extremes represented by India and the Republic of Korea were the continuing economic improvements in the Philippines and Thailand, where overcapacity and loss of confidence in 1997 ignited an economic contraction and consolidation of assets that spread to much of the world during the following 5 years. Asian exports are again showing strength, but the demand is from China, not the United States.

China, in turn, continued to privatize state-owned (largely military-operated) businesses; the process of privatization has not been without difficulty. The most commonly encountered problem was that of outstanding loans that had gone to these businesses simply to keep them alive. Many of these loans are not only moribund, but a severe burden to the banking system. Some are being purchased at greatly discounted prices (Wall Street Journal, 2002). At least four Government asset management companies were set up in 1999 to help the largest state banks dispose of nonperforming loans, which have been estimated to amount to more than $450 billion. China, however, enjoyed increasing direct foreign investment that showed no signs of abatement. In China's mixed economy, state-owned enterprises are losing value as fast as efficient exporters funded by foreign capital can create it (Restall, 2002). These likely are growing pains associated with the transition from the rigidly controlled central planning of the Communist era to an embryonic form of rapidly developing capitalism. The growth in China's economy is reaching the point that a demand for consumer goods, which includes automobiles, is beginning to develop. Should China develop a consumer society along the lines of the EU and the United States, demand for mineral products will grow considerably. Less developed countries of Southeast Asia are vulnerable to competition with China for foreign direct investment if they maintain economic policies to promote exports at the expense of domestic consumption. As savings rates in the smaller economies of the region are driven downward by reduced availability of capital, increased domestic consumption and less export-dependent economies may lead to higher quality growth in those countries (Restall, 2002).

Indonesia continued to chart an uncertain course since the downfall of the Suharto regime. With the explosions in the Bali nightclubs, concerns about terrorism were added to the problems of uncertainty over central-versus-local government control that have recently discouraged mineral exploration in the country. The environment for mineral exploration in Indonesia has deteriorated to the point that it ranked last in the Frazier Institute's policy potential index, which is a combined index that measures the effect of Government policies on taxation, environmental regulation, administration and duplication of regulations, uncertainty over land access, labor issues, infrastructure, socioeconomic agreements, and political stability (Frazier Institute, 2002, p. 6). Nevertheless, mineral production in Indonesia continued to increase as several large projects that were in the pipeline came to full production.

Trends and Outlook for World Mine Production of Copper, Lead, Zinc, and Gold[3]

World mine production of copper increased by 45% to 13.2 million metric tons (Mt) of contained copper, between 1990 and 2000, an annual rate of growth of 3.8% (table 4). During the same period, mine production of copper fell by 9% in the United States and increased by 58% in other countries. Most of the increase came from expanded production in Chile (3.01 Mt) and Indonesia [846,000 metric tons (t)]. In Peru, production increased by 215,000 t. After increasing to 13.7 Mt in 2001, world copper production fell by about 2.2% to 13.4 Mt in 2002. Low copper prices and a large increase in stocks in late 2001 resulted in several firms decreasing production in 2002. Mine production of copper in the United States fell by about 16%, or 210,000 t. Production in Chile fell by 6%, or 290,000 t, including a reduction of 140,000 t at Escondida, which was the world's largest copper producer (BHP Billiton, 2002). A strike in Mexico reduced production by 37,000 t. Although production was reduced by about 90,000 t at Tintaya (BHP Billiton, 2002), the startup of Antamina resulted in an increase in production in Peru (128,000 t). Production also rose in Russia (60,000 t). The large decreases in Chile and the United States may have quite different long-term implications. BHP Billiton (2002) plans to expand capacity at Escondida but will adjust mine production to be in line with demand for copper. The decrease in production in the United States could result in the permanent closure of some mines and may result in other mines becoming swing producers that produce only during periods of average or above average prices. Some analysts (Smith, 2001) have cautioned that production from the 20 largest producers will peak in 2005 and that 5 new deposits the size of Antamina will need to be brought into production between 2005 and 2014 just to maintain production at 2005 levels. The decision of Anglo American Corporation in early 2002 to withdraw from operations in Zambia, where it had operated the Konkola open pit mine and had planned to develop the Konkola Deep underground mine, will only add to the need to place additional deposits in the production pipeline.

World mine production of lead declined by 270,000 t, or 8%, between 1990 and 2000 (table 5). Changes in the production of individual countries were even more dramatic. Between 1990 and 2000, China's mine production of lead increased by 345,000 t, or 110%. Australian mine production increased by 169,000 t; Peruvian production, 61,000 t; and Irish production, more than 23,000 t. During this same period, mine production of lead declined by 92,000 t in Canada, 49,000 t in Mexico, and 32,000 t in the United States. Between 2001 and 2002, world mine production of lead declined by almost 100,000 t (about 3%), and United States production declined by 16,000 t (also 3%). Mine production declined by 59,000 t in Sweden and 49,000 t in Canada. The steep decline in Canadian mine production of lead has coincided with the closure of the Nanisivik, the Polaris, and the Sullivan Mines. Between 2002 and 2007, production of lead is expected to

[3]Text and tables in this section have been revised from an earlier version posted on the web February 12-14, 2003.

TABLE 4.—WORLD COPPER MINE PRODUCTION

(Thousand metric tons)

Country	1990	1995	2000	2001	2002[e]
Argentina	—	—	145	192	204
Australia	327	398	841	869	850
Canada	794	726	634	633	625
Chile	1,590	2,490	4,600	4,740	4,450
China	285	445	593	590	580
Indonesia	164	444	1,010	1,050	1,100
Iran	66	102	125	133	134
Kazakhstan	400	200	430	470	450
Mexico	294	334	365	367	330
Mongolia	124	122	125	134	135
Papua New Guinea	170	213	203	204	204
Peru	339	410	554	722	850
Poland	329	384	465	474	500
Russia	650	525	600	620	680
Zambia	421	316	257	300	320
Other countries	1,600	1,040	950	900	850
Total (rounded)	7,550	8,150	11,900	12,400	12,300
United States	1,580	1,850	1,440	1,340	1,130
World total (rounded)	9,130	10,000	13,200	13,700	13,400

[e]Estimated. — Zero.

TABLE 5.—WORLD LEAD MINE PRODUCTION

(Thousand metric tons)

Country	1990	1995	2000	2001	2002[e]
Australia	570	455	739	714	715
Canada	241	211	149	149	100
China	315	520	660	600	650
Greece	26	21	18	29	30
India	23	34	29	27	25
Ireland	35	69	58	45	55
Kazakhstan	200	40	40	38	38
Korea, North	80	80	70	60	60
Mexico	187	164	138	135	140
Morocco	69	68	81	83	80
Peru	210	238	271	271	295
Poland	61	59	55	51	55
South Africa	69	88	75	51	49
Spain	59	30	40	50	50
Sweden	98	137	107	95	36
Other countries	630	225	129	190	115
Total (rounded)	2,870	2,440	2,660	2,590	2,490
United States	497	394	465	466	450
World total (rounded)	3,370	2,830	3,100	3,100	2,900

[e]Estimated.

increase in China, Ireland, Peru, and South Africa and is expected to decrease in Spain.

Between 1990 and 2000, world mine production of zinc increased by 1.6 Mt, or 23% (table 6). Production increased by almost 1.2 Mt in China, 470,000 t in Australia, 326,000 t in Peru, 309,000 t in the United States, and 126,000 t in India. The increases in U.S. production primarily took place at the Red Dog Mine in Alaska. During the same period, mine production of zinc decreased by 200,000 t in Canada and by 58,000 t in both Brazil and Spain. World mine production of zinc was essentially unchanged from 2001 to 2002. U.S. production declined by 10,000 t in 2001 and by 102,000 t in 2002 as a result of the continuing decline of zinc prices. The Coy,

TABLE 6.—WORLD ZINC MINE PRODUCTION
(Thousand metric tons)

Country	1990	1995	2000	2001	2002[e]
Australia	940	937	1,410	1,520	1,520
Bolivia	104	146	149	141	142
Brazil	158	189	100	100	101
Canada	1,200	1,120	1,000	1,000	1,000
China	619	1,010	1,780	1,700	1,500
India	74	155	200	146	150
Iran	29	145	85	85	87
Ireland	166	184	263	225	250
Kazakhstan	315	225	325	344	350
Mexico	307	364	393	429	475
Morocco	19	80	103	89	90
Namibia	38	30	39	32	32
Peru	584	692	910	1,060	1,150
Poland	153	155	155	160	160
Russia	170	131	136	124	130
Spain	258	172	200	157	150
Sweden	164	167	177	156	145
Thailand	62	29	24	13	20
Other countries	1,250	690	480	520	650
Total (rounded)	6,600	6,620	7,930	8,000	8,160
United States	543	664	852	842	740
World total (rounded)	7,150	7,280	8,780	8,850	8,900

[e]Estimated.

Immel, and Young Mines were closed in East Tennessee. In New York, the Balmat Mine was closed, and the Pierrepont Mine was placed on care and maintenance. Between 2002 and 2005, production in Peru is projected to increase by 400,000 t as the Antamina Mine reaches full production, and production in Namibia is expected to increase by almost 150,000 t after the Skorpion Mine begins production.

Between 1990 and 2000, world mine production of gold increased at a rate of 1.9% per year, or 440 t (table 7). Production from the United States for the same period increased by 1.8% per year, or 59 t. As listed in table 7, major gold-producing countries that significantly increased gold production during the decade included Indonesia (nearly 114 t), China (80 t), Ghana (55 t), Australia (52 t), Papua New Guinea (42 t), Chile (27 t), Mali (23 t), and Tanzania (nearly 12 t). Countries whose gold production decreased significantly included South Africa (177 t), Brazil (51 t), Russia (40 t), and Canada (nearly 13 t). In 2002, world mine production of gold declined 50 t, or about 2%, and in the United States, production declined by 35 t, or 10%. Production increased by 40 t in Indonesia as the Batu Hijau porphyry copper-gold deposit reached full production. Table 7 lists the outlook for future mine production of gold based upon an analysis of production trends at existing facilities, planned expansions, and proposed new mines that are judged to have a good chance of being developed within the indicated times. These production outlooks are not forecasts of future production, but rather represent the combination of production trends with industry plans. The outlook for mine production of gold from countries other than the United States from 2002 to 2007 is for an increase of 310 t; this represents an increase of 2.7% per year. Significant increases are projected for South Africa (83 t), China (40 t), Russia (30 t), Indonesia (25 t), Peru (25 t), Argentina (22 t), Canada (15 t), Mali (11 t), and Tanzania (10 t). Australian mine production of gold, however, is expected to decline by 10 t. Perhaps the most significant change is for South Africa; the three new mines scheduled to come online within the next several years appear likely to reverse the decline in South Africa's production of gold (400 t in 2002 from a high of almost 700 t in the early 1970s).

At the end of 2002, the threat of terrorism and the possibility of war in Iraq are major uncertainties that face the economies of the United States and much of the world. In addition, market adjustments and corporate governance issues have resulted in a loss of investor confidence in U.S. equities markets. If new investments in copper, lead, zinc, and gold production facilities are to happen, then economic growth must improve. This, in turn, will require a return of investor confidence, which appears unlikely as long as terrorism and the threat of war dominate the world's attention.

TABLE 7.—WORLD GOLD MINE PRODUCTION

(Metric tons)

Country	1990	1995	2000	2001	2002[e]	*2003[e]*	*2005[e]*	*2007[e]*
Argentina	1	1	26	31	33	35	45	55
Australia	244	254	296	285	280	270	270	270
Brazil	102	63	50	51	51	52	52	52
Canada	169	152	156	160	160	165	170	175
Chile	28	45	54	43	40	40	40	40
China	100	140	180	185	175	190	210	215
Ghana	17	53	72	68	72	70	65	75
Indonesia	11	64	125	130	170	175	185	195
Kazakhstan	30	18	28	30	32	33	35	35
Mali	5	4	29	42	44	45	50	55
Papua New Guinea	32	52	76	67	69	70	70	70
Philippines	25	27	37	34	34	35	35	35
Peru	10	56	132	138	140	150	160	165
Russia	183	132	143	152	170	180	190	200
South Africa	605	524	428	402	395	450	455	480
Tanzania	4	—	15	30	37	40	45	45
Uzbekistan	65	65	62	63	63	63	65	65
Other countries	176	232	277	325	265	270	280	290
Total (rounded)	1,810	1,880	2,190	2,240	2,230	2,330	2,420	2,520
United States	294	317	353	335	300			
Total (rounded)	2,100	2,200	2,540	2,570	2,530			

[e]Estimated. — Zero.

Note: Data in italicized columns represent production outlooks.

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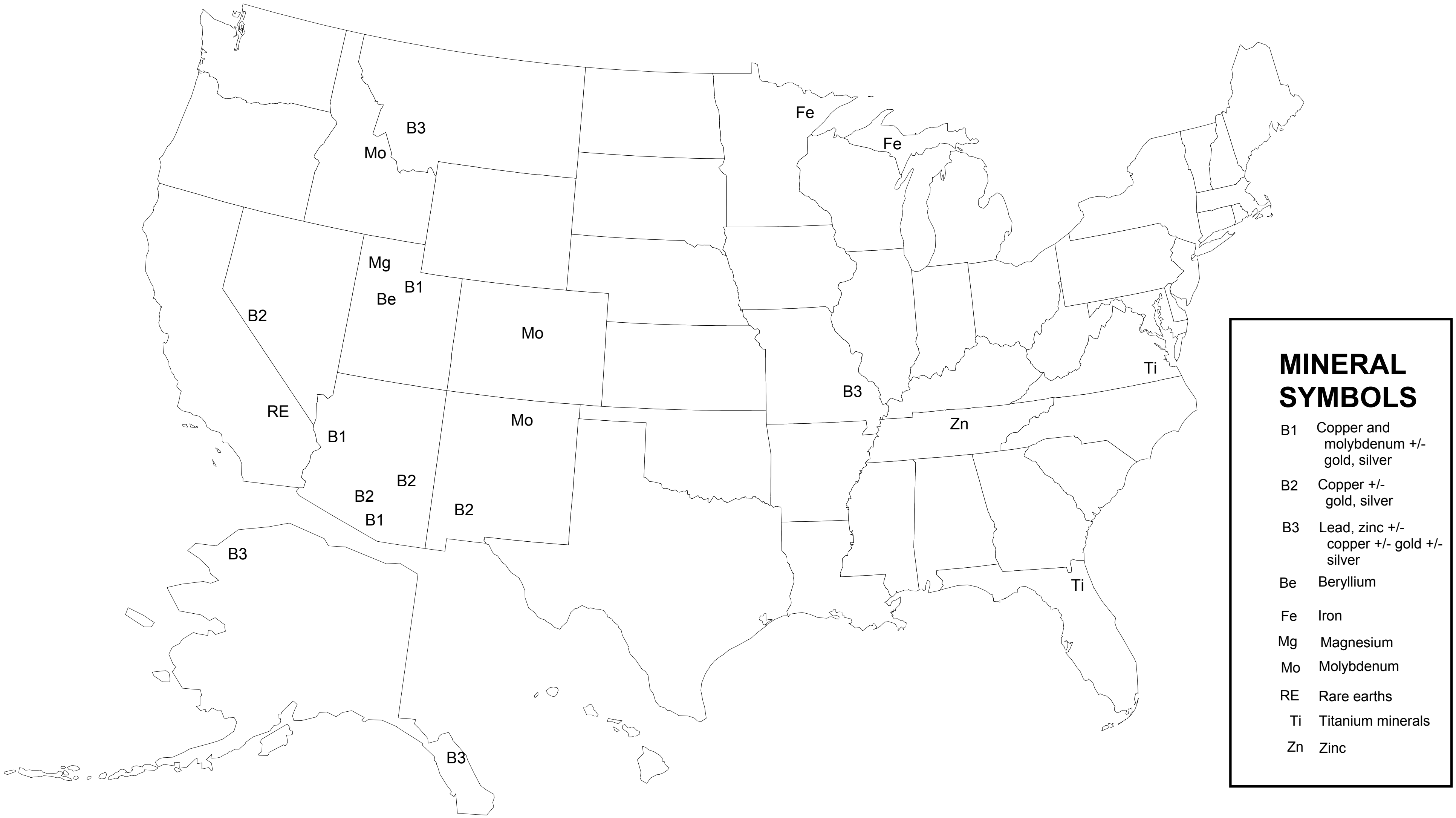
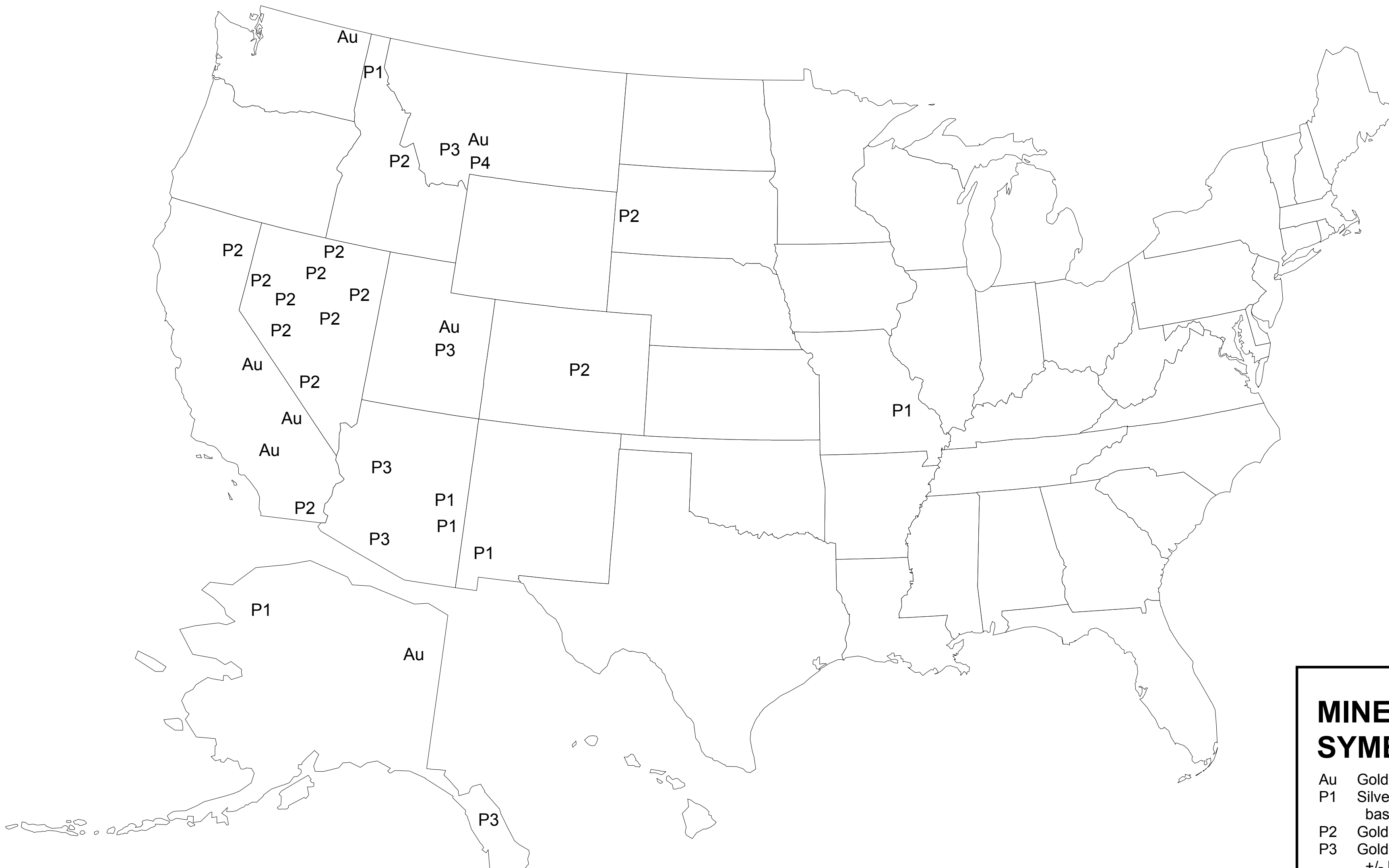
MAJOR BASE AND SPECIALTY METAL PRODUCING AREAS



MAJOR PRECIOUS METAL PRODUCING AREAS



MINERAL SYMBOLS

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

MAJOR INDUSTRIAL ROCK AND MINERAL PRODUCING AREAS - PART I

MINERAL SYMBOLS

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

MAJOR INDUSTRIAL ROCK AND MINERAL PRODUCING AREAS - PART II

MINERAL SYMBOLS

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

ABRASIVES (MANUFACTURED)

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

Domestic Production and Use: Fused aluminum oxide was produced by two companies at four plants in the United States and Canada. Production of regular-grade fused aluminum oxide had an estimated value of $4.1 million, and production of high-purity fused aluminum oxide was estimated at a value of more than $2.5 million. Silicon carbide was produced by two companies at two plants in the United States. Domestic production of crude silicon carbide had an estimated value of more than $16.2 million. Bonded and coated abrasive products accounted for most abrasive uses of fused aluminum oxide and silicon carbide.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, United States and Canada (crude):					
Fused aluminum oxide, regular	99,600	[1]85,000	[1]90,000	[1]50,000	[1]15,000
Fused aluminum oxide, high-purity[1]	15,000	10,000	10,000	10,000	5,000
Silicon carbide[1]	70,000	65,000	45,000	40,000	30,000
Imports for consumption (U.S.):					
Fused aluminum oxide	180,000	166,000	227,000	203,000	143,000
Silicon carbide	268,000	169,000	190,000	133,000	170,000
Exports (U.S.):					
Fused aluminum oxide	8,910	9,020	9,020	8,950	10,700
Silicon carbide	11,600	8,560	10,000	10,500	14,100
Consumption, apparent (U.S.):					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	NA	NA	NA	NA	186,000
Price, range of value, dollars per ton United States and Canada:					
Fused aluminum oxide, regular	361	351	331	302	271
Fused aluminum oxide, high-purity	550	425	566	530	494
Silicon carbide	610	600	585	600	541
Net import reliance[2] as a percentage of apparent consumption (U.S.)					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	NA	NA	NA	NA	84

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

Import Sources (1998-2001): Fused aluminum oxide, crude: Canada, 50%; China, 39%; and other, 11%. Fused aluminum oxide, grain: China, 44%; Canada, 25%; Austria, 9%; Germany, 9%; and other, 13%. Silicon carbide, crude: China, 83%; Canada, 12%; and other, 5%. Silicon carbide, grain: China, 49%; Brazil, 15%; Norway, 10%; Germany, 7%; and other, 19%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
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.

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ABRASIVES (MANUFACTURED)

Government Stockpile: During the first three quarters of 2002, the Department of Defense sold 76.2 tons of fused aluminum oxide abrasive grain from the National Defense Stockpile (NDS) for $34,300.

Stockpile Status—9-30-02[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Fused aluminum oxide, grain	16,176	11	16,176	5,443	76

Events, Trends, and Issues: Imports and higher operating costs continued to challenge producers in the United States and Canada. In June 2001, the last Canadian silicon carbide producer closed, leaving only two silicon carbide producers in the United States. This means that the United States will now depend on imports to meet most of its needs for silicon carbide. 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	
	2001	2002[e]	2001	2002[e]
United States and Canada	145,000	145,000	42,600	42,600
Argentina	—	—	5,000	5,000
Australia	50,000	50,000	—	—
Austria	60,000	60,000	—	—
Brazil	50,000	50,000	43,000	43,000
China	460,000	460,000	455,000	455,000
France	40,000	40,000	16,000	16,000
Germany	80,000	80,000	36,000	36,000
India	40,000	40,000	5,000	5,000
Japan	25,000	25,000	60,000	60,000
Mexico	—	—	45,000	45,000
Norway	—	—	80,000	80,000
Venezuela	—	—	30,000	30,000
Other countries	80,000	80,000	190,000	190,000
World total (rounded)	1,030,000	1,030,000	1,010,000	1,010,000

World Resources: Although domestic resources of raw materials for the production of fused aluminum oxide are rather limited, adequate resources are available in the Western Hemisphere. Domestic resources are more than adequate for the production of silicon carbide.

Substitutes: Natural and manufactured abrasives, such as garnet or metallic abrasives, can be substituted for fused aluminum oxide and silicon carbide in various applications.

[e]Estimated. NA Not available. — Zero.
[1]Rounded to the nearest 5,000 tons to protect proprietary data.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.

ALUMINUM[1]

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

Domestic Production and Use: In 2002, 11 companies operated 16 primary aluminum reduction plants; 6 smelters were temporarily idled. The 11 smelters east of the Mississippi River accounted for 75% of the production; whereas the remaining 11 smelters, which included the 9 Pacific Northwest smelters, accounted for only 25%. Based upon published market prices, the value of primary metal production was $3.9 billion in 2002. Aluminum consumption was centered in the East Central United States. Transportation accounted for an estimated 34% of domestic consumption in 2002; packaging, 25%; building, 17%; consumer durables, 7%; electrical, 7%; and other, 10%.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production:					
Primary	3,713	3,779	3,668	2,637	2,700
Secondary (from old scrap)	1,500	1,570	1,370	1,210	1,200
Imports for consumption	3,550	4,000	3,910	3,740	4,000
Exports	1,590	1,640	1,760	1,590	1,500
Shipments from Government stockpile excesses	([2])	—	—	—	—
Consumption, apparent[3]	7,090	7,770	7,530	6,230	6,400
Price, ingot, average U.S. market (spot), cents per pound	65.5	65.7	74.6	68.8	65.0
Stocks:					
Aluminum industry, yearend	1,930	1,870	1,550	1,300	1,300
LME, U.S. warehouses, yearend[4]	13	14	([2])	28	10
Employment, primary reduction, number	18,400	17,900	17,100	15,100	13,700
Net import reliance[5] as a percentage of apparent consumption	27	31	33	38	39

Recycling: In 2002, aluminum recovered from purchased scrap was about 3 million tons, of which about 60% came from new (manufacturing) scrap and 40% from old scrap (discarded aluminum products). Aluminum recovered from old scrap was equivalent to about 20% of apparent consumption.

Import Sources (1998-2001): Canada, 60%; Russia, 18%; Venezuela, 4%; Mexico, 2%; and other, 16%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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: The 121,000-ton-per-year Troutdale, OR, smelter and a 76,000-ton-per-year potline at the Rockdale, TX, smelter were permanently closed. Most of the smelter capacity that was idled in the Pacific Northwest at the end of 2001 remained off line. However, as energy shortages began to ease and take-or-pay energy contracts took effect, some smelters in the region began limited restarts.

Imports for consumption increased, reversing a 2-year decline. Canada and Russia accounted for approximately three-fourths of the total imports. U.S. exports decreased slightly. Canada and Mexico received an estimated two-thirds of total U.S. exports.

The price of primary aluminum ingot fluctuated through August 2002. In January, the average monthly U.S. market price for primary ingot quoted by Platts Metals Week was 64.65 cents per pound; in August, the price was 62.55 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 August was 58.59 cents per pound. According to American Metal Market, prices in the aluminum scrap and secondary aluminum alloy markets increased during the first quarter of the year before beginning a general downward trend that continued through the end of September.

World production continued to increase as temporarily idled capacity and new capacity expansions were brought on-stream. Inventories of metal held by producers, as reported by the International Aluminium Institute, decreased slightly during the first half of 2002. Inventories of metal held by the LME, however, exceeded 1.2 million tons, reaching levels not seen since the first half of 1995.

World Smelter Production and Capacity:

	Production		Yearend capacity	
	2001	2002[e]	2001	2002[e]
United States	2,637	2,700	4,370	4,190
Australia	1,798	1,800	1,810	1,820
Brazil	1,131	1,300	1,280	1,330
Canada	2,583	2,700	2,670	2,790
China	3,250	3,800	4,250	5,000
France	462	480	475	480
Norway	1,068	1,050	1,050	1,050
Russia	3,300	3,350	3,300	3,350
South Africa	663	690	685	695
Venezuela	570	600	640	640
Other countries	6,890	6,900	7,690	7,780
World total (rounded)	24,400	25,400	28,200	29,100

World Resources: Domestic aluminum requirements cannot be met by domestic bauxite resources. Potential domestic nonbauxitic aluminum resources are abundant and could meet domestic aluminum demand. However, no processes for using these resources have been proven economically competitive with those now used for bauxite. The world reserve base for bauxite is sufficient to meet world demand for metal well into the 21st century.

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

[e]Estimated. — Zero.
[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.

ANTIMONY

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

Domestic Production and Use: There was no domestic mine production of antimony in 2002. The only domestic source of antimony, a silver mine that produced antimony as a byproduct, closed early in 2001 without any output in the year. A small amount of antimony was recovered as a byproduct of lead and silver-copper smelting. Primary antimony metal and oxide was produced by three companies in Montana, New Jersey, and Texas, using foreign feedstock and a small amount of domestic feed material. The estimated value of primary antimony metal and oxide produced in 2002 was $30 million. Secondary antimony was recovered, mostly in alloy form, at lead smelters; its value, based on the price of antimony metal, was about $2 million. The estimated distribution of antimony uses was as follows: flame retardants, 55%; transportation, including batteries, 18%; chemicals, 10%; ceramics and glass, 7%; and other, 10%.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production:					
Mine (recoverable antimony)[1]	489	450	W	—	—
Smelter:					
Primary	24,000	23,800	20,900	18,000	16,000
Secondary	7,710	8,220	7,920	6,660	4,000
Imports for consumption	34,600	36,800	41,600	37,900	16,000
Exports of metal, alloys, oxide, and waste and scrap[2]	4,170	3,660	7,120	7,610	7,000
Shipments from Government stockpile	4,160	5,790	4,540	4,620	4,000
Consumption, apparent[3]	42,700	36,500	49,400	45,200	18,000
Price, metal, average, cents per pound[4]	72	63	66	65	79
Stocks, yearend	10,600	10,900	6,780	4,970	4,000
Employment, plant, number[e]	80	75	40	40	—
Net import reliance[5] as a percentage of apparent consumption	81	82	84	61	41

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 (1998-2001): Metal: China, 86%; Mexico, 6%; Hong Kong, 5%; and other, 3%. Ore and concentrate: China, 37%; Australia, 29%; Austria, 6%; and other, 28%. Oxide: China, 43%; Mexico, 20%; Belgium, 13%; South Africa, 10%; Bolivia, 6%; Hong Kong, 3%; and other, 5%. Total: China, 52%; Mexico, 21%; Belgium, 9%; South Africa, 9%; Hong Kong, 6%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Ore and concentrates	2617.10.0000	Free.
Antimony and articles thereof, including waste and scrap	8110.00.0000	Free.
Antimony oxide	2825.80.0000	Free.

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

Government Stockpile: Sales of antimony from the Defense National Stockpile Center proceeded for the 10th consecutive year. Sales were conducted on a negotiated bid basis and were held bimonthly on the first Thursday of the month. There was no maximum quantity for which a company could submit a bid, but the minimum quantity was 18 metric tons. Grade A and grade B ingots, cakes, and broken pieces were offered. The antimony sulfide ore inventory has been depleted. The Somerville, NJ, depot holds the remaining antimony inventory.

Stockpile Status—9-30-02[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Antimony	2,588	1,154	2,588	4,500	2,091

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ANTIMONY

Events, Trends, and Issues: In 2002, antimony production from domestic source materials was derived mainly from the recycling of lead-acid batteries. Recycling supplied only a minor portion of estimated domestic demand.

The price of antimony metal held fairly steady during the first half of 2002. Prices started the year at $0.63 per pound and ended the first half at $0.67 per pound. Prices rose sharply in July and August, ending August at $0.89 per pound. Prices in September increased to $1.13 per pound. Industry observers thought the significant price increases were caused by a dearth of antimony worldwide, caused mostly by the success of China's export control system.

During 2002, the United States and most major antimony-consuming countries experienced a marked decrease in demand that lasted through most of the year. It affected virtually all consumption categories, and observers attributed it mostly to the economic slowdown of recent years.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates have been revised for China, Kyrgyzstan, South Africa, and Tajikistan based on new information from those countries.

	Mine production		Reserves[7]	Reserve base[7]
	2001	2002[e]		
United States	—	—	80,000	90,000
Bolivia	2,000	2,200	310,000	320,000
China	135,000	125,000	790,000	2,400,000
Kyrgyzstan	150	200	120,000	250,000
Russia	4,500	5,000	350,000	370,000
South Africa	3,900	4,000	33,000	250,000
Tajikistan	2,500	3,000	50,000	150,000
Other countries	2,950	2,000	25,000	75,000
World total (may be rounded)	151,000	141,000	1,800,000	3,900,000

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

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

[e]Estimated. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Data for 1998-2000 from the U.S. Securities and Exchange Commission 10-K report.
[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[1]

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

Domestic Production and Use: Because arsenic was not recovered from domestic ores, all arsenic metal and compounds consumed in the United States were imported. Essentially all of the arsenic consumed was in compound form, principally arsenic trioxide, which was subsequently converted to arsenic acid and used in the production of wood preservatives. Arsenic metal was consumed in the manufacture of nonferrous alloys, principally lead alloys for use in lead-acid batteries. About 20 tons per year of high-purity arsenic was estimated to have been used in the manufacture of semiconductor material. The value of arsenic metal and compounds consumed domestically in 2002 was estimated to be less than $20 million.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Imports for consumption:					
Metal	997	1,300	830	1,030	700
Compounds	29,300	22,100	23,600	23,900	25,000
Exports, metal	177	1,350	41	57	100
Estimated consumption[2]	30,100	22,000	24,400	24,900	25,000
Value, cents per pound, average:[3]					
Metal (China)	57	59	51	75	120
Trioxide (Mexico)	32	29	32	28	33
Net import reliance[4] as a percentage of estimated consumption	100	100	100	100	100

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

Import Sources (1998-2001): Metal: China, 84%; Japan, 9%; Hong Kong, 4%; and other, 3%. Trioxide: China, 53%; Chile, 26%; Mexico, 6%; and other, 15%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/02**
Metal	2804.80.0000	Free.
Trioxide	2811.29.1000	Free.
Sulfide	2813.90.1000	Free.
Acid[5]	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: Because of the toxicity of arsenic and its compounds, environmental regulation will continue to be increasingly stringent, adversely affecting the long-term demand for arsenic. With the decision by the wood-preserving industry to eliminate arsenical wood preservatives from residential application by yearend 2003, the major use for arsenic is expected to decline significantly. Mitigating the pollution effects and potential health hazards of naturally occurring and anthropogenic arsenic will continue as important research and regulatory areas.

World Production, Reserves, and Reserve Base:

	Production (arsenic trioxide)		Reserves and reserve base[6] (arsenic content)
	2001	2002[e]	
Belgium	1,000	1,000	
Chile	8,000	8,000	World reserves and reserve base are thought to be about 20 and 30 times, respectively, annual world production. The reserve base for the United States is estimated to be 80,000 tons.
China	16,000	16,000	
France	1,000	1,000	
Kazakhstan	1,500	1,500	
Mexico	2,500	2,500	
Peru	2,500	2,500	
Russia	1,500	1,500	
Other countries	1,500	1,000	
World total (may be rounded)	35,500	35,000	

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 chromated copper arsenate 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]Prepared by Robert G. Reese, Jr.
[2]Estimated to be the same as net imports.
[3]Calculated from U.S. Census Bureau import data.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]Tariff is free for Canada, Israel, Caribbean Basin countries, and designated Beneficiary Andean and developing countries.
[6]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, 71%; gaskets, 18%; friction products, 5%; and other, 6%.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production (sales), mine	6	7	5	5	3
Imports for consumption	16	16	15	13	9
Exports[1]	18	22	19	22	8
Shipments from Government stockpile excesses	3	5	—	—	—
Consumption, estimated	16	16	15	13	9
Price, average value, dollars per ton[2]	210	210	210	160	160
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number	25	20	19	15	15
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: Insignificant.

Import Sources (1998-2001): Canada, 96%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Asbestos	2524.00.0000	Free.

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

Government Stockpile: None

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ASBESTOS

Events, Trends, and Issues: The asbestos industry continues to be affected by liability issues and public opposition to the use of asbestos. In the United States, the last domestic asbestos mine closed in response to declining overseas markets. This marks the end of more than 120 years of continuous asbestos production in the United States. Proposed legislation in Congress (Senate bill 2641) to ban the use of asbestos in the United States is under review in the Senate Committee on Environment and Public Works. In Canada, Jeffrey Mine Inc. shut down its mining operation in response to declining prices and markets.

Shipments of asbestos declined to 3,000 tons in 2002 from 5,000 tons in 2001. Imports and exports declined by 31% and 64%, respectively, from those of 2001. Estimated consumption decreased by 31% to 9,000 tons in 2002. Some reported exports were likely to have been reexports, asbestos-containing products, or nonasbestos products. Actual exports of asbestos fiber were estimated to be approximately 3,000 tons. All the asbestos used in the United States was chrysotile. Canada remained the largest supplier of asbestos for domestic consumption.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2001	2002[e]		
United States	5	3	Small	Large
Brazil	170	170	Moderate	Moderate
Canada	340	340	Large	Large
China	360	360	Large	Large
Kazakhstan	235	235	Large	Large
Russia	750	750	Large	Large
South Africa	16	14	Small	Moderate
Zimbabwe	120	120	Moderate	Moderate
Other countries	54	50	Moderate	Large
World total (may be rounded)	2,050	2,040	Large	Large

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

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

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

BARITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Barite sales by domestic producers totaled about 400,000 tons in 2002, unchanged from 2001, as was the value at about $12 million. Sales were from three States, with the preponderance coming from Nevada, followed by Georgia and Tennessee. In 2001, an estimated 2.7 million tons of ground barite was sold from six States from domestic production and imports by domestic crushers and grinders. Nearly 98% 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, “leaded” glass, and as the raw material for barium chemicals. In the metal casting industry, barite forms part of the mold-release compounds. Barite also has become part of friction products (brake and clutch pads) for transportation vehicles. Because barite significantly 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 protect against radiation.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Sold or used, mine	476	434	392	400	400
Imports for consumption:					
Crude barite	1,850	836	2,070	2,470	1,270
Ground barite	20	17	16	29	15
Other	13	18	15	13	15
Exports	15	22	36	45	35
Consumption, apparent[1] (crude barite)	2,340	1,280	2,460	2,870	1,670
Consumption[2] (ground and crushed)	1,890	1,370	2,100	2,670	1,900
Price, average value, dollars per ton, mine	22.70	25.60	25.10	25.00	28.80
Employment, mine and mill, number[e]	410	300	330	340	320
Net import reliance[3] as a percentage of apparent consumption	80	66	84	86	76

Recycling: None.

Import Sources (1998-2001): China, 86%; India, 11%; Canada, 1%; Thailand, 1%; and other, 1%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
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: Imports for consumption of lower cost barite decreased by an estimated 50% compared with 2001 levels, but still greatly exceeded U.S. production. The major sources of imported barite have high-grade deposits with relatively low labor costs, and relatively low (per ton-mile) ocean transportation to U.S. Gulf Coast grinding plants. The Nevada producers were competitive in the California market, the Great Plains, and the Canadian markets, and will probably continue to utilize local mines for several years. In third quarter 2002 reports to stockholders, three of the four major domestic barite providers reported decreased barite consumption owing to decreased drilling activity. Drilling rig activity declined owing to natural gas price declines and the suspension of offshore drill rig operations caused by Tropical Storm Isidore along parts of the U.S. Gulf Coast.

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BARITE

Historically, petroleum well drilling has long been a driving force in the demand for barite, but oil well drilling has recently become less important to the demand for barite. The change began in early 1998, when oil-directed drill rig counts declined from about 400 to about 100 rigs in July 1999 owing to about a 40% decline in futures oil prices to less than $12 per barrel in February 1999.[4] U.S. barite consumption in 1999 was 1.28 million metric tons, down from 2.34 million tons in 1998. U.S. barite consumption in 2002 was about 1.67 million tons, down from about 2.87 million tons in 2001. In 2002, oil-directed drill rigs were nearly constant at 140 rigs for most of the year. In contrast, the U.S. gas-directed drill rig count has been about 80% of the total working rig count since early 1999, and, in response to gas price changes, has been driving the U.S. drill rig count since that time.

Imports of barite were about 700,000 tons for the first 6 months of 2002 and were estimated to be about 600,000 tons for the second half of the year.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for China and India have been increased based on new information from those countries.

	Mine production		Reserves[5]	Reserve base[5]
	2001	**2002[e]**		
United States	400	400	26,000	60,000
Algeria	52	52	9,000	15,000
Brazil	55	60	2,100	5,000
Burma	34	32	NA	NA
China	3,600	3,000	62,000	360,000
France	75	65	2,000	2,500
Germany	120	120	1,000	1,500
India	850	900	53,000	80,000
Iran	185	190	NA	NA
Korea, North	70	70	NA	NA
Mexico	130	130	7,000	8,500
Morocco	320	400	10,000	11,000
Russia	60	60	2,000	3,000
Thailand	57	30	9,000	15,000
Turkey	100	100	4,000	20,000
United Kingdom	60	70	100	600
Other countries	200	270	12,000	160,000
World total (rounded)	6,700	6,000	200,000	750,000

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 750 million tons are identified.

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

[e]Estimated. NA Not available.
[1]Sold or used by domestic mines - exports + imports.
[2]Domestic and imported crude barite sold or used by domestic grinding establishments.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]Oil & Gas Journal, 1998-2002, Baker Hughes [domestic] rig count, U.S. industry scoreboard, futures prices [weekly]: Oil & Gas Journal, various issues, various pages.
[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 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 approximately one-half of the alumina it required. Of the total alumina used, about 90% went to primary aluminum smelters and the remainder went to nonmetallurgical uses. Annual alumina capacity was 5.75 million tons, with three Bayer refineries in operation and one temporarily idled at midyear.

Salient Statistics—United States:[2]	1998	1999	2000	2001	2002[e]
Production, bauxite, mine	NA	NA	NA	NA	NA
Imports of bauxite for consumption[3]	11,600	10,400	9,030	8,670	8,500
Imports of alumina[4]	4,050	3,810	3,820	3,100	3,000
Exports of bauxite[3]	108	168	147	88	70
Exports of alumina[4]	1,280	1,230	1,090	1,250	1,200
Shipments of bauxite from Government stockpile excesses[3]	3,300	4,180	1,100	3,640	1,000
Consumption, apparent, bauxite and alumina (in aluminum equivalents)[5]	5,000	4,870	3,840	3,670	3,300
Price, bauxite, average value U.S. imports (f.a.s.) dollars per ton	23	22	23	23	21
Stocks, bauxite, industry, yearend[3]	1,860	1,440	1,300	1,750	1,300
Net import reliance,[6] bauxite and alumina, as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1998-2001):[7] Bauxite: Guinea, 39%; Jamaica, 28%; Brazil, 14%; Guyana, 11%; and other, 8%. Alumina: Australia, 63%; Suriname, 15%; Jamaica, 9%; and other, 13%. Total: Australia, 29%; Guinea, 21%; Jamaica, 19%; Brazil, 9%; and other, 22%.

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 2002 had normal-trade-relations status.

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

Government Stockpile:

Stockpile Status—9-30-02[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Bauxite, metal grade:					
Jamaica-type	1,710	5,350	1,710	2,030	2,530
Suriname-type	—	1,450	—	—	—
Bauxite, refractory-grade, calcined	42	2	42	44	1

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BAUXITE AND ALUMINA

Events, Trends, and Issues: World production of bauxite increased slightly compared with that for 2001. Based on production data from the International Aluminium Institute, world alumina production during the first 2 quarters of 2002 was essentially unchanged from that for the same period in 2001.

The 2003 fiscal year Annual Materials Plan (AMP) submitted to Congress by the Defense National Stockpile Center proposed the sale of 2.03 million dry metric tons of Jamaica-type, metallurgical-grade bauxite and 43,700 calcined metric tons of refractory-grade bauxite from the National Defense Stockpile during the period October 1, 2002, to September 30, 2003. These or remaining inventory, whichever are lower, are the maximum amounts that could be sold under the new AMP and not necessarily the amounts that would actually be offered for sale.[9]

Spot prices for metallurgical-grade alumina, as published by Metal Bulletin, fluctuated during the year. The published price range began the year at $130 to $140 per ton. By the end of May, the price range had increased to $157 to $160 per ton before beginning a downward slide. At the end of September, the price range was $142 to $147 per ton.

World Bauxite Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for Australia and Brazil have been revised based on new information from official country sources.

	Mine production		Reserves[10]	Reserve base[10]
	2001	2002[e]		
United States	NA	NA	20,000	40,000
Australia	53,300	55,000	4,400,000	8,700,000
Brazil	13,900	13,200	1,800,000	2,900,000
China	9,500	10,000	700,000	2,300,000
Guinea	15,700	16,000	7,400,000	8,600,000
Guyana	1,990	1,500	700,000	900,000
India	8,390	9,000	770,000	1,400,000
Jamaica	12,400	13,000	2,000,000	2,500,000
Russia	4,000	3,700	200,000	250,000
Suriname	4,510	4,500	580,000	600,000
Venezuela	4,400	5,000	320,000	350,000
Other countries	9,810	10,400	3,600,000	4,700,000
World total (rounded)	138,000	141,000	22,000,000	33,000,000

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

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

[e]Estimated. NA Not available. — Zero.
[1]See also Aluminum. As a general rule, 4 tons of dried bauxite is required to produce 2 tons of alumina, which, in turn, provides 1 ton of primary aluminum metal.
[2]Includes U.S. Virgin Islands.
[3]Includes all forms of bauxite, expressed as dry equivalent weights.
[4]Calcined equivalent weights.
[5]The sum of U.S. bauxite production and net import reliance.
[6]Defined as imports - exports + adjustments for Government and industry stock changes (all in aluminum equivalents). Treated as separate commodities, the net import reliance equaled 100% for bauxite and 30% for alumina in 2002. For the years 1998-2001, the net import reliance was 100% for bauxite and ranged from 29% to 36% for alumina.
[7]Aluminum equivalents.
[8]See Appendix B for definitions.
[9]Defense Logistics Agency, 2002, FY 2003 Annual Materials Plan announced: Fort Belvoir, VA, Defense Logistics Agency news release, October 1, 2 p.
[10]See Appendix C for definitions.

BERYLLIUM

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

Domestic Production and Use: A company in Utah mined bertrandite ore and recovered beryllium hydroxide from this ore and from imported beryl. The beryllium hydroxide was shipped to a plant in Ohio, where it was converted into beryllium metal, alloys, and oxide. Beryllium consumption of 220 tons was valued at about $80 million, based on the quoted producer price for beryllium-copper master alloy. The use of beryllium (as an alloy, metal, and oxide) in electronic and electrical components and aerospace and defense applications accounted for an estimated 80% of total consumption.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production, mine shipments	243	200	180	100	100
Imports for consumption, ore and metal	50	20	20	115	120
Exports, metal	60	40	35	60	100
Government stockpile releases[e 1]	57	145	220	60	60
Consumption:					
Apparent	320	385	300	230	220
Reported, ore	270	260	240	170	170
Price, dollars (yearend):					
Domestic, metal, vacuum-cast ingot, per pound	327	327	421	338	NA
Domestic, metal, powder blend, per pound	385	385	492	375	375
Domestic, beryllium-copper master alloy, per pound of contained beryllium	160	160	160	160	160
Domestic, beryllium oxide, powder, per pound	77	77	100	100	NA
Stocks, consumer, yearend	80	20	115	100	60
Net import reliance[2] as a percentage of apparent consumption	24	48	37	57	55

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 were not available.

Import Sources (1998-2001): Ore, metal, scrap, and master alloy: Kazakhstan, 37%; Russia, 16%; Brazil, 9%; Philippines, 8%; and other, 30%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Beryllium ores and concentrates	2617.90.0030	Free.
Beryllium oxide or hydroxide	2825.90.1000	3.7% ad val.
Beryllium-copper master alloy	7405.00.6030	Free.
Beryllium:		
Unwrought powders	8112.12.0000	8.5% ad val.
Waste and scrap	8112.13.0000	Free.
Other	8112.19.0000	5.5% ad val.

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

Government Stockpile:

Stockpile Status—9-30-02[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Beryl ore (11% BeO)	227	34	227	145	54
Beryllium-copper master alloy	41	10	41	80	—
Beryllium metal	294	11	249	36	4

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BERYLLIUM

Events, Trends, and Issues: For the first half of 2002, sales of alloy products (strip and bulk) were reported to have decreased compared with those of the previous year, owing to continued weak demand from the telecommunications and computer markets. Sales of beryllium products for defense applications increased. In 2001, mine production was down significantly; a decrease in overall beryllium demand contributed to the decline. Overall beryllium imports increased significantly, owing to a rise in beryl ore imports from Brazil and a significant increase in beryllium-copper master alloy (BCMA) from Russia. In 2002, imports for consumption of beryllium materials continued to increase; Brazil, Germany, Japan, and Nigeria were the leading suppliers. Beryllium exports were up, with Canada, France, Germany, Japan, the Republic of Korea, and the Netherlands the major recipients of the materials.

For fiscal year 2002, the Defense National Stockpile Center (DNSC) sold about 18 tons of beryllium metal valued at about $2.84 million from the National Defense Stockpile. There were no sales of BCMA in fiscal year 2002. For fiscal year 2003, the DNSC proposed maximum disposal limits of about 3,630 tons[4] of beryl ore (about 145 tons of beryllium content), about 907 tons[4] of BCMA (about 36 tons of beryllium content), and about 36 tons of beryllium metal.

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

World Mine Production, Reserves, and Reserve Base:

	Mine production[e]	
	2001	2002
United States	100	100
China	15	15
Kazakhstan	4	4
Russia	40	40
Other countries	2	2
World total (rounded)	160	160

Reserves and reserve base[5]

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 18,000 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. NA Not available. — Zero.
[1]Net quantity (uncommitted inventory).
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.
[4]Actual quantity limited to remaining sales authority or inventory.
[5]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 in 1997. Bismuth is contained in some domestically mined lead ores, but no byproduct bismuth was produced. Forty companies, mostly in the eastern United States, accounted for an estimated three-fourths of the bismuth consumed in 2002. The value of bismuth consumed was estimated at more than $14 million. About 42% of the bismuth was used in fusible alloys, solders, and cartridges; 37% in pharmaceuticals and chemicals; 19% in metallurgical additives; and 2% in other uses.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002**[e]
Production, refinery	—	—	—	—	—
Imports for consumption, metal	2,720	2,110	2,410	2,220	1,600
Exports, metal, alloys, scrap	245	257	491	541	200
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, reported	1,990	2,050	2,130	2,200	2,000
Price, average, domestic dealer, dollars per pound	3.60	3.85	3.70	3.74	3.20
Stocks, yearend, consumer	175	121	118	95	80
Employment, refinery, number of workers	—	—	—	—	—
Net import reliance[1] as a percentage of apparent consumption[e]	95	95	95	95	95

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

Import Sources (1998-2001): Belgium, 32%; Mexico, 23%; China, 18%; United Kingdom, 16%; and other, 11%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/02**
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 in 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. A bismuth-strontium-calcium-copper-oxide superconducting ceramic was installed in part of an electric power transmission system in Detroit, MI. Denmark and Spain have banned the use of lead in certain applications; bismuth could substitute in these cases.

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. But bismuth was also recovered from some copper ores and from tungsten ores, especially in Asia. The dealer price remained fairly steady, about 15% lower than in 2001, throughout the year.

The Bismuth Institute, based in Brussels, Belgium, discontinued all operations and ceased to exist in 2002. For nearly 30 years, the Institute provided bismuth statistics and encouraged research and development as well as new uses for the metal. The Institute helped open trade with China, which is now the world leader in bismuth reserves and production. Moreover, the Institute consistently promoted the environmental advantages offered by bismuth as a substitute for lead in various applications.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates have been revised for China and Japan based on new information from those countries. Significant fluctuations in annual Bolivian bismuth production were caused by withholding of production, shifts in government policy, and work stoppages.

	Mine production		Reserves[2]	Reserve base[2]
	2001	2002[e]		
United States	—	—	9,000	14,000
Australia	—	—	18,000	27,000
Bolivia	5	10	10,000	20,000
Canada	200	300	5,000	30,000
China	1,500	1,500	240,000	470,000
Japan	28	25	6,000	12,000
Kazakhstan	130	130	5,000	10,000
Mexico	1,000	1,000	10,000	20,000
Peru	1,000	800	11,000	42,000
Other countries	137	150	15,000	35,000
World total (may be rounded)	4,000	3,900	330,000	680,000

World Resources: World reserves of bismuth are usually associated with lead deposits, except in China, North Korea, and Vietnam (where economically recoverable bismuth is found with tungsten ores and some copper ores) and in Australia (where bismuth is found with copper-gold ores). Bismuth minerals rarely occur in sufficient quantities to be mined as principal products, except in Bolivia and 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. — Zero.

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

[2]See Appendix C for definitions.

BORON

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

Domestic Production and Use: The estimated value of boric oxide contained in minerals and compounds produced in 2002 was $468 million. Domestic production of boron minerals, primarily as sodium borates, by four companies was centered in southern California. The largest producer operated an open pit tincal and kernite mine and associated compound plants. The majority of the remaining output was produced using saline brines as raw material. A third company continued to process small amounts of calcium and calcium sodium borates, and a fourth company used an in situ process. Principal consumption was in ceramics by firms in the North Central United States and the Eastern United States. The reported distribution pattern for boron compounds consumed in the United States in 2001 was as follows: glass and ceramics, 78%; soaps and detergents, 6%; agriculture, 4%; fire retardants, 3%; and other, 9%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production[1]	587	618	546	536	620
Imports for consumption, gross weight:					
Borax	14	8	1	1	7
Boric acid	23	30	39	56	48
Colemanite	47	42	26	35	11
Ulexite	170	178	127	109	80
Exports, gross weight:					
Boric acid	106	107	119	85	87
Colemanite	17	NA	NA	NA	5
Refined sodium borates	453	370	413	221	153
Consumption:					
Apparent	412	534	356	482	559
Reported	NA	416	360	347	NA
Price, dollars per ton, granulated pentahydrate borax in bulk, carload, works[2]	340	376	376	376	376
Stocks, yearend[3]	NA	NA	NA	NA	NA
Employment, number	900	900	1,300	1,300	1,300
Net import reliance[4] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1998-2001): Boric acid: Turkey, 42%; Chile, 24%; Canada, 12%; Bolivia, 9%; Italy 6%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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 2002, and about one-half of domestic production was exported. The largest company produced ore from an open pit mine with processing also in the State of California. The production of boron, sodium carbonate, and sodium sulfate production from a second company that processed underground brines continued, and the company continued with plans to sell its assets. The domestic underground mine in California continued to process ore in Nevada for overseas export.

The parent company of the largest borate producer in the United States announced plans to invest $2.6 million to construct a new boric acid plant adjacent to its current refinery operations in Campo Quijano, Argentina, which has a workforce of 180 people. Construction, which began in August 2002, was to be completed by early 2003. About $2 million was invested to upgrade equipment that included installing new furnaces, centrifuges, and a magnetic concentration plant to both improve efficiency and lower environmental impact. Market sectors are textile fiberglass, 35%; frits and ceramics, 15%; borosilicate glass, 8%; cellulose insulation, 5%; and other uses, 37%.

The parent company of the largest borate company in the United States and the world's leading talc producer joined to introduce borate autocausticizing technology into the kraft paper process. Borates react with a portion of the sodium carbonate in the recovery boiler to form a borate compound that when hydrated converts to sodium hydroxide. The process reduces lime and energy requirements with little capital investment. Trials have shown no change in viscosity, brightness, or strength of the paper produced. Talc is used as a coating pigment and as a pitch control agent, and is used as a filler in paper.

Exported U.S. borate materials competed with borax, boric acid, colemanite, and ulexite primarily from Turkey, the largest producer of boron ore in the world. A subsidiary of Turkey's largest mining company was building a boric acid plant at Emet that will produce 100,000 tons per year by early 2003. Production at the Bandirma plant was planned to be increased from 45,000 tons per year to 60,000 tons per year during 2002. Turkey is building a 274,000-ton-per-year plant at Bandirma that will use pyrite to supply sulfuric acid for the boric acid plants at Bandirma and Emet.

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

	Production—all forms		Reserves[6]	Reserve base[6]
	2001	2002[e]		
United States	1,050	1,200	40,000	80,000
Argentina	500	500	2,000	9,000
Bolivia	34	35	Moderate	Moderate
Chile	338	330	Large	Large
China	150	150	25,000	47,000
Iran	1	1	1,000	1,000
Peru	30	30	4,000	22,000
Russia	1,000	1,000	40,000	100,000
Turkey	1,500	1,500	60,000	150,000
Yugoslavia	—	—	2,000	7,000
World total (rounded)	4,600	4,800	Large	Large

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 cellulose, foams, and mineral wools.

[e]Estimated. E Net exporter. NA Not available. — Zero.
[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, which was valued at an estimated $223 million. Arkansas, with six plants, continued to be the Nations leading bromine producer, and bromine was the leading mineral commodity in terms of value produced in the State.

Three bromine companies accounted for 78% of world production. Two of these companies are located in the United States and accounted for about 98% of U.S. production.

Bromine was used in fire retardants (40%), drilling fluids (24%), brominated pesticides (12%), water-treatment chemicals (7%), and other products, including photographic chemicals and rubber additives (17%). Other products included intermediate chemicals for the manufacture of products and bromide solutions used alone or in combination with other chemicals.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production[1]	230	239	228	212	225
Imports for consumption, elemental bromine and compounds[2]	10	10	20	11	10
Exports, elemental bromine and compounds	12	10	10	10	10
Consumption, apparent[3]	235	238	238	214	225
Price, cents per kilogram, bulk, purified bromine	70.0	87.0	90.0	67.0	99.2
Employment, number	1,700	1,700	1,700	1,700	1,700
Net import reliance[4] as a percentage of apparent consumption	—	E	4	—	—

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 (1998-2001): Israel, 91%; United Kingdom, 6%; Netherlands, 1%; and other, 2%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
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	8.4% ad val.
Ethylene dibromide	2903.30.0500	5.4% ad val.
Hydrobromic acid	2811.19.3000	Free.
Potassium bromate	2829.90.0500	Free.
Potassium or sodium bromide	2827.51.0000	Free.
Sodium bromate	2829.90.2500	Free.
Tetrabromobisphenol A	2908.10.2500	0.3¢/kg + 8.3% ad val.
Vinyl bromide, methylene dibromide	2903.30.1520	Free.

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

Government Stockpile: None.

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BROMINE

Events, Trends, and Issues: A U.S. company's subsidiary signed a joint-venture agreement with a Jordanian company to build a bromine complex at Safi, Jordan. Construction, which began in 2000 and was completed in October 2002, included a 50,000-ton-per-year bromine plant. Downturns in the world economy, especially in electrical products such as computers and telecommunication equipment, has led to a reduction in the demand for brominated fire retardants. Brominated fire retardants are competitive in terms of cost and performance in these electrical applications. Fire retardants accounted for approximately 40% of all plastic additives consumed in North America.

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. The purchase of the remaining public shareholdings of three subsidiaries, including bromine operations, was completed by the largest chemical company in Israel. Exports are used to produce bromine compounds at a plant in the Netherlands.

Under the Montreal Protocol, the U.S. phase of the global elimination of methyl bromide as a crop pesticide will occur during 2001-05. Imports of crops grown and treated with methyl bromide in Mexico are expected to continue, however, because Mexico is not required to phase out methyl bromide use until 2015.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	2001	2002[e]		
United States[1]	212	225	11,000	11,000
Azerbaijan	2.0	2.0	300	300
China	40.0	40.0	130	3,500
France	2.0	2.0	1,600	1,600
Germany	0.5	0.5	([6])	([6])
India	1.5	1.5	([7])	([7])
Israel	206	206	([8])	([8])
Italy	0.3	0.3	([7])	([7])
Japan	20.0	20.0	([9])	([9])
Spain	0.1	0.1	1,400	1,400
Turkmenistan	0.15	0.15	700	700
Ukraine	3.0	3.0	400	400
United Kingdom	50.0	50.0	([7])	([7])
World total (rounded)	540	550	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 non lead 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. — Zero.
[1]Sold or used by U.S. producers.
[2]Imports calculated from items shown in Tariff section.
[3]Includes recycled product.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.
[6]From waste bitterns associated with potash production.
[7]From waste bitterns associated with solar salt.
[8]From the Dead Sea. See World Resources section.
[9]From seawater. See World Resources section.

CADMIUM

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

Domestic Production and Use: Only two companies produced cadmium in the United States in 2002. One company produced primary cadmium in Tennessee as a byproduct of smelting and refining zinc metal from sulfide ore while the other company produced cadmium from scrap in Pennsylvania, mainly from spent nickel-cadmium (NiCd) batteries. Based on the average New York dealer price, the combined output of primary and secondary metal was valued at about $370,000 in 2002. Consumption of cadmium during the past 3 years declined by about 50% in response to environmental concerns. About 75% of total apparent consumption was for batteries. The remaining 25% was distributed as follows: pigments, 12%; coatings and plating, 8%; stabilizers for plastics, 4%; and nonferrous alloys and other, 1%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, refinery[1]	1,240	1,190	1,890	680	700
Imports for consumption, metal	514	294	425	107	10
Exports of metal, alloys, scrap	180	20	314	272	300
Shipments from Government stockpile excesses	190	550	319	52	50
Consumption, apparent	2,100	1,850	2,010	679	560
Price, metal, dollars per pound[2]	0.28	0.14	0.16	0.15	0.30
Stocks, yearend, producer and distributor	729	893	1,200	1,090	890
Employment, smelter and refinery	NA	NA	NA	NA	NA
Net import reliance[3] as a percentage of apparent consumption	38	9	6	E	E

Recycling: To date, cadmium recycling has been practical only for NiCd batteries, some alloys, and dust from electric arc furnaces (EAF). The exact amount of recycled cadmium is unknown. In 2002, the U.S. steel industry generated more than 0.6 million tons of EAF dust, typically containing 0.003% to 0.07% cadmium.

Import Sources (1998-2001): Metal: Canada, 39%; Australia, 29%; Belgium, 23%; and other, 9%.

Tariff: **Item**	**Number**	**Normal Trade Relations[4] 12/31/02**
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—9-30-02[5]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2002**	**Disposals FY 2002**
Cadmium	269	97	269	544	530

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CADMIUM

Events, Trends, and Issues: Cadmium production remained relatively low in 2002. At the end of 2000, a major zinc producer decided to cease production of primary cadmium, and even after upgrading its facilities in mid-2002, the company chose not to resume production of cadmium due to low prices and loss of the domestic market for NiCd batteries. During the past decade, regulatory pressure to reduce or even eliminate the use of cadmium has gained momentum in many developed countries. In the United States, Federal and State environmental agencies regulate the production and use of heavy metals such as cadmium. To help unify different standards used by these agencies, the U.S. Environmental Protection Agency created a list of persistent and bioaccumulative toxic pollutants. Cadmium is one of 11 metals on the list, and it is targeted for a 50% reduction by 2005. The European Union (EU) is evaluating a proposal to ban all Ni-Cd batteries containing more than 0.002% cadmium beginning on January 1, 2008, and to increase the collection rate for all spent industrial and automotive batteries to 95% by weight by December 31, 2003. According to some cadmium experts, the EU proposal failed to differentiate between different forms of cadmium with disparate toxicity and failed to consider the environmental effect of metals and chemicals that are expected to replace cadmium in all applications.

World Refinery Production, Reserves, and Reserve Base: Reserves and reserve base estimates for China have been significantly increased based on new published information from that country.

	Refinery production		Reserves[6]	Reserve base[6]
	2001	2002[e]		
United States	680	700	90,000	270,000
Australia	378	350	110,000	300,000
Belgium	1,240	1,100	—	—
Canada	1,180	1,250	55,000	150,000
China	2,400	2,450	90,000	380,000
Germany	1,100	1,000	6,000	8,000
Japan	2,490	2,500	10,000	15,000
Korea, Republic of	1,880	1,850	—	—
Mexico	1,420	1,500	35,000	40,000
Russia	950	900	16,000	30,000
Other countries	4,480	5,100	190,000	610,000
World total (may be rounded)	18,200	18,700	600,000	1,800,000

World Resources: Estimated world reserves of cadmium were about 0.6 million tons based on zinc resources containing about 0.3% cadmium. Zinc-bearing coals of the central United States and Carboniferous-age coals of other countries also contain large subeconomic resources of cadmium.

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

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

CEMENT

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: In 2002, about 85 million tons of portland cement and 4 million tons of masonry cement were produced at a total of 115 plants in 36 States, by 1 State agency, and by about 40 companies. There were also two plants in Puerto Rico. The ex-plant value of cement production, excluding Puerto Rico, was about $7 billion, and the value of total sales (including imported cement) was about $8.5 billion. Most of the cement was used to make concrete, worth at least $40 billion. Total cement consumption (sales) fell modestly, but remained at strong levels. Imported cement and clinker (to make cement) accounted for about 22% of the cement sold; total imports declined significantly, owing to higher domestic production capacity and a weakening construction market. Clinker, the main intermediate product in cement manufacture, was produced at 109 plants, with a combined apparent annual capacity of about 99 million tons. Including several facilities that merely ground clinker produced elsewhere, total finished cement (grinding) capacity was about 108 million tons. Texas, California, Pennsylvania, Michigan, Missouri, and Alabama, in descending order, were the six largest producing States and accounted for about one-half of U.S. production. About 75% of cement sales went to ready-mixed concrete producers, 13% to concrete product manufacturers, 6% to contractors (mainly road paving), 3% to building materials dealers, and 3% to other users.

Salient Statistics—United States:[1]	1998	1999	2000	2001	2002[e]
Production:					
Portland and masonry cement[2]	83,931	85,952	87,846	88,900	89,000
Clinker	74,523	76,003	78,138	78,451	82,000
Shipments to final customers, includes exports	103,696	108,862	110,048	113,136	110,000
Imports of hydraulic cement for consumption	19,878	24,578	24,561	23,591	22,500
Imports of clinker for consumption	3,905	4,164	3,673	1,884	1,660
Exports of hydraulic cement and clinker	743	694	738	746	900
Consumption, apparent[3]	103,457	108,862	110,470	112,710	110,000
Price, average mill value, dollars per ton	76.46	78.27	78.56	76.50	77.00
Stocks, mill, yearend	5,393	6,367	7,566	6,600	7,600
Employment, mine and mill, number[e]	17,900	18,000	18,000	18,000	18,000
Net import reliance[4] as a percentage of apparent consumption	19	21	20	21	19

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 (1998-2001):[5] Canada, 20%; Thailand, 15%; China, 13%; Venezuela, 7%; Greece, 7%; and other, 38%. Import sources were diversifying, with China, Colombia, the Republic of Korea, and Thailand becoming major suppliers since 1998. Thailand was actually the single largest source of imported cement and clinker (combined) in 2000, although Canada was the largest source in 2001.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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: Continued very low interest rates and strong public sector construction spending in 2002 mitigated construction declines relative to the much weaker general economy. Cement consumption in 2003 is expected to level off or rise slightly, a key determinant being tenuous State, or offsetting Federal, funding of public sector projects. Cement company ownership continued to consolidate.

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

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CEMENT

per ton of cement rather than by lowering total emissions. Emissions reduction strategies included installation of more fuel efficient kiln technologies, partial substitution of non-carbonate sources of calcium oxide in the kiln raw materials, and partial substitution of cementitious additives for portland cement in the finished cement products.

The continued rise in fossil fuel costs, which started in 2000, was of great 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 toward increased use of waste fuels. Environmental issues common to mining, such as restrictions on silica in dust, also affect cement raw materials quarries.

Although not much used by cement companies in the United States, there is growing direct use by concrete manufacturers of natural and synthetic pozzolans as partial replacements for portland cement. The United States lags behind many foreign countries in pozzolan use. Pozzolans are materials that, in the presence of free lime, have hydraulic cementitious properties; examples include some volcanic ashes and industrial byproducts such as granulated blast furnace slag, fly ash, and silica fume. 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 monetary and environmental costs per ton of cement manufactured.

World Production and Capacity:

	Cement production		Yearend clinker capacity[e]	
	2001	**2002[e]**	**2001**	**2002**
United States (includes Puerto Rico)	90,450	90,600	[6]100,360	102,000
Brazil	39,500	40,000	44,000	45,000
China	626,500	640,000	550,000	550,000
Egypt	24,500	26,000	28,000	35,000
France	19,839	20,000	22,000	22,000
Germany	28,034	28,000	31,000	31,000
India	100,000	100,000	120,000	120,000
Indonesia	31,100	32,000	40,000	40,000
Iran	26,650	28,000	30,000	30,000
Italy	39,804	39,000	46,000	46,000
Japan	76,550	75,000	90,000	90,000
Korea, Republic of	52,012	53,000	58,000	60,000
Mexico	29,966	30,000	37,000	40,000
Russia	35,100	39,000	65,000	65,000
Saudi Arabia	20,608	21,000	24,000	24,000
Spain	40,512	40,000	40,000	40,000
Thailand	27,913	28,000	48,000	50,000
Turkey	30,120	31,000	33,000	33,000
Other countries (rounded)	361,000	360,000	300,000	320,000
World total (rounded)	1,700,000	1,720,000	1,700,000	1,700,000

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 in the construction sector with concrete substitutes such as rammed earth, clay brick, glass, aluminum, steel, fiberglass, wood, stone, and asphalt. Pozzolans and similar materials are being used as partial or complete substitutes for portland cement in some concrete applications.

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

CESIUM[1]

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

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

Salient Statistics—United States: Data on cesium 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 2002, one company offered 1-gram ampoules of 99.98%-grade cesium metal at $50.00. The price for 100 grams of the same material from this company was $1,370.00, or $13.70 per gram.

Recycling: None.

Import Sources (1998-2001): 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 12/31/02
Alkali metals, other	2805.19.9000	5.5% ad val.
Chlorides, other	2827.39.5000	3.7% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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CESIUM

Events, Trends, and Issues: The United States is likely to continue to be dependent upon foreign sources of cesium 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. No significant environmental problems have been associated with cesium.

World Mine Production, Reserves, and Reserve Base: Data on mine production of cesium are not available, and data on resources are incomplete. There has been no production of cesium in Namibia or Zimbabwe for several years, and the reserves for these countries have been revised to zero. The reserve base is derived from known occurrences of pollucite, a cesium aluminosilicate mineral, found in zoned pegmatites along with the lithium minerals lepidolite and petalite. Commercial concentrates of pollucite contain about 20% cesium by weight.

	Reserves[2]	Reserve base[2]
Canada	70,000,000	73,000,000
Namibia	—	9,000,000
Zimbabwe	—	23,000,000
Other countries	NA	NA
World total (may be rounded)	70,000,000	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. — Zero.

[1]Prepared by Robert G. Reese, Jr.

[2]See Appendix C for definitions.

CHROMIUM

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

Domestic Production and Use: In 2002, the United States consumed about 14% of world chromite ore production in various forms of imported materials, such as chromite ore, chromium chemicals, chromium ferroalloys, and chromium metal. Imported chromite was consumed by 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 $317 million.

Salient Statistics—United States:[1]	1998	1999	2000	2001	2002[e]
Production, secondary	104	118	139	122	153
Imports for consumption	385	476	453	239	174
Exports	62	60	86	38	10
Government stockpile releases	93	19	85	9	87
Consumption:					
Reported[2] (excludes secondary)	277	298	206	196	212
Apparent[3] (includes secondary)	531	558	589	332	413
Price, chromite, yearend:					
South African, dollars per metric ton, South Africa	68	63	63	NA	NA
Turkish, dollars per metric ton, Turkey	145	145	145	NA	NA
Unit value, average annual import (dollars per metric ton):					
Chromite ore (gross weight)	74	62	64	61	50
Ferrochromium (chromium content)	1,027	732	797	709	610
Chromium metal (gross weight)	7,569	6,267	5,976	6,116	5,820
Stocks, industry, yearend[4]	56	54	16	17	8
Net import reliance[5] as a percentage of apparent consumption	80	79	67	61	63

Recycling: In 2002, chromium contained in purchased stainless steel scrap accounted for 37% of apparent consumption.

Import Sources (1998-2001): Chromium contained in chromite ore and chromium ferroalloys and metal: South Africa, 50%; Kazakhstan, 20%; Zimbabwe, 9%; Turkey, 7%; Russia, 6%; and other, 8%.

Tariff:[6] Item	Number	Normal Trade Relations 12/31/02
Ore and concentrate	2610.00.0000	Free.
Ferrochromium, high-carbon	7202.41.0000	1.9% ad val.
Chromium metal	8112.29.0000	3% ad val.

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

Government Stockpile: The Defense Logistics Agency, U.S. Department of Defense, submitted the Annual Materials Plan for 2003 in February 2002. Actual quantity available for sale will be limited to sales authority or inventory.

Stockpile Status—9-30-02[7]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002	Average chromium content
Chromite ore:						
Chemical-grade	78.3	4.38	78.3	90.7	114	28.6%
Metallurgical-grade	—	83.4	—	90.7	—	28.6%
Refractory-grade	113	63.4	113	90.7	89.0	[e]23.9%
Chromium ferroalloys:						
Ferrochromium:						
High-carbon	544	10.7	544	136	17.0	71.4%
Low-carbon	234	2.69	234	—	9.30	71.4%
Ferrochromium-silicon	—	—	—	—	9.60	42.9%
Chromium metal	7.22	—	7.22	0.454	—	[e]100%

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CHROMIUM

Events, Trends, and Issues: Chromite ore is not produced in the United States, Canada, or Mexico. Chromite ore is produced in the Western Hemisphere only in Brazil and Cuba. Most of Brazilian production is consumed in Brazil. Cuban production is small. The largest chromite-ore-producing countries (India, Kazakhstan, and South Africa) accounted for about 76% of world production. South Africa alone accounts for more than 45% of world production and has been the major supplier of chromium in the form of chromite ore and ferrochromium to Western industrialized countries.

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

	Mine production		Reserves[8]	Reserve base[8]
	2001	2002[e]	(shipping grade)[9]	
United States	—	—	—	7,000
India	1,680	1,900	18,000	39,000
Kazakhstan	2,050	2,300	410,000	410,000
South Africa	5,500	5,800	790,000	5,500,000
Other countries	2,900	3,000	420,000	1,100,000
World total (rounded)	12,100	13,000	1,600,000	7,100,000

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

Substitutes: 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. NA Not available. — Zero.
[1]Data in thousand metric tons of contained chromium, unless noted otherwise.
[2]The year 1998 includes chromite ore; 1999 through 2002 exclude chromite ore.
[3]Calculated demand for chromium is production + imports - exports + stock adjustment.
[4]Includes producer and consumer stocks before 2000; consumer stocks after 1999.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]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.
[7]See Appendix B for definitions.
[8]See Appendix C for definitions.
[9]Shipping-grade chromite ore is deposit quantity and grade normalized to 45% Cr_2O_3.

CLAYS

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: In 2002, clay and shale production was reported in all States except Alaska, Delaware, Hawaii, Idaho, New Hampshire, New Jersey, Rhode Island, Vermont, and Wisconsin. About 240 companies operated approximately 630 clay pits or quarries. The leading 20 firms supplied about 50% of the tonnage and 79% of the value for all types of clay sold or used in the United States. U.S. production was estimated to be 40.7 million metric tons valued at $1.32 billion. Major domestic uses for specific clays were estimated to be as follows: ball clay—35% floor and wall tile, 22% sanitaryware, and 43% other uses; bentonite—28% pet waste absorbent, 23% foundry sand bond, 19% drilling mud, 16% iron ore pelletizing, and 14% other uses; common clay—56% brick, 20% cement, 16% lightweight aggregate, and 8% other uses; fire clay—72% refractories and 28% other uses; fuller's earth—75% absorbent uses and 25% other uses; and kaolin—53% paper, 12% refractories, and 35% other uses.

Salient Statistics—United States:[1]	1998	1999	2000	2001	2002[e]
Production, mine:					
Ball clay	1,130	1,200	1,140	1,100	1,070
Bentonite	3,820	4,070	3,760	4,290	4,110
Common clay	24,500	24,800	23,700	23,200	24,200
Fire clay[2]	410	402	476	383	355
Fuller's earth	2,350	2,560	2,910	2,890	3,400
Kaolin	9,450	9,160	8,800	8,110	7,450
Total[3]	41,600	42,200	40,800	40,000	40,700
Imports for consumption:					
Artificially activated clay and earth	19	17	18	21	20
Kaolin	53	57	63	114	155
Other	14	16	16	13	49
Total[3]	86	90	96	148	224
Exports:					
Ball clay	140	107	100	174	145
Bentonite	818	719	761	628	723
Fire clay[2]	168	189	216	238	245
Fuller's earth	121	152	136	146	63
Kaolin	3,550	3,310	3,690	3,440	3,350
Clays, not elsewhere classified	432	329	357	344	464
Total[3]	5,230	4,800	5,260	4,970	4,990
Consumption, apparent	36,500	37,500	35,600	35,200	35,900
Price, average, dollars per ton:					
Ball clay	45	40	42	42	40
Bentonite	46	43	41	42	44
Common clay	6	6	6	6	4
Fire clay	18	16	16	16	19
Fuller's earth	109	90	87	89	78
Kaolin	111	104	106	103	97
Stocks, yearend[4]	NA	NA	NA	NA	NA
Employment, number:[e]					
Mine	1,550	1,500	1,500	1,500	1,350
Mill	6,100	5,700	5,800	5,800	5,200
Net import reliance[5] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1998-2001): Brazil, 55%; United Kingdom, 17%; Mexico, 13%; Canada, 5%; and other, 10%.

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CLAYS

Tariff: Item	**Number**	**Normal Trade Relations 12/31/02**
Kaolin and other kaolinitic clays, whether or not calcined	2507.00.0000	Free.
Bentonite	2508.10.0000	Free.
Fuller's and decolorizing earths	2508.20.0000	Free.
Fire clay	2508.30.0000	Free.
Common blue and other ball clays	2508.40.0010	Free.
Other clays	2508.40.0050	Free.
Chamotte or dina's earth	2508.70.0000	Free.
Activated clays and earths	3802.90.2000	2.5% ad val.
Expanded clays and mixtures	6806.20.0000	Free.

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

Government Stockpile: None.

Events, Trends, and Issues: The amount of clay and shale sold or used by domestic producers increased slightly in 2002. Increases were reported for the production of common clay and shale and fuller's earth. Imports for consumption increased 51% to 224,000 tons in 2002. The largest increase was in imports of kaolin from Brazil. Brazil, Mexico, and the United Kingdom were the major sources for imported clays. Exports increased slightly to 4.9 million tons in 2002. Canada, Finland, Japan, the Netherlands, and Taiwan were major markets for exported clays.

World Mine Production, Reserves, and Reserve Base: The 2001 production estimates have been revised for Brazil (kaolin), Germany (kaolin), and Greece (bentonite) based on new information from those countries. Reserves and reserve base are large in major producing countries, but data were not available.

	Mine production					
	Bentonite		Fuller's earth		Kaolin	
	2001	2002[e]	2001	2002[e]	2001	2002[e]
United States (sales)	4,290	4,110	2,890	3,400	8,110	7,450
Brazil (beneficiated)	—	—	—	—	1,800	1,800
Czech Republic (crude)	250	—	—	—	5,500	5,500
Germany (sales)	500	500	500	500	3,770	3,770
Greece (crude)	1,150	1,150	—	—	60	60
Korea, Republic of (crude)	—	—	—	—	2,380	2,380
United Kingdom (sales)	—	—	140	140	2,400	2,400
Former Soviet Union (crude)[6]	750	750	—	—	[7]5,800	[7]5,800
Other countries	3,560	3,500	360	350	14,300	14,000
World total (rounded)	10,500	10,000	3,890	4,390	44,100	43,200

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 1.4 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. — Zero.
[1]Excludes Puerto Rico.
[2]Refractory uses only.
[3]Data may not add to total shown because of independent rounding.
[4]Data on stocks are not available and are assumed to be zero for apparent consumption and net import reliance calculations.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]As constituted before December 1991.
[7]Uzbekistan produced approximately 5.5 million tons of kaolin in 2001 and 2002.

COBALT

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

Domestic Production and Use: The United States did not mine or refine cobalt in 2002; however, negligible amounts of byproduct cobalt were produced as intermediate products from some mining operations. U.S. supply comprised imports, stock releases, and secondary materials, such as superalloy scrap, cemented carbide scrap, and spent catalysts. There were two domestic producers of extra-fine cobalt powder: One produced powder from imported primary metal, and another produced powder from cemented carbide scrap. In addition to the powder producers, six companies were known to be active in the production of cobalt compounds. Nearly 90 industrial consumers were surveyed on a monthly or annual basis. Data reported by these consumers indicate that approximately 51% of U.S. cobalt use was in superalloys, which are used primarily in aircraft gas turbine engines; 8% was in cemented carbides for cutting and wear-resistant applications; 19% was in various other metallic uses; and the remaining 22% was in a variety of chemical uses. The total estimated value of cobalt consumed in 2002 was $150 million.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production:					
Mine	—	—	—	—	—
Secondary	3,080	2,720	2,550	2,740	2,700
Imports for consumption	7,670	8,150	8,770	9,410	9,400
Exports	1,680	1,550	2,630	3,210	2,100
Shipments from Government stockpile excesses	2,310	1,530	2,960	3,050	750
Consumption:					
Reported (includes secondary)	9,380	8,660	8,980	9,490	8,700
Apparent (includes secondary)	11,500	10,700	11,600	11,800	10,800
Price, average annual spot for cathodes, dollars per pound	21.43	17.02	15.16	10.55	6.90
Stocks, industry, yearend	1,000	1,160	1,180	1,370	1,300
Net import reliance[1] as a percentage of apparent consumption	73	75	78	77	75

Recycling: An estimated 2,700 tons of cobalt was recycled from purchased scrap in 2002. This represented 31% of estimated reported consumption for the year.

Import Sources (1998-2001): Cobalt content of metal, oxide, and salts: Finland, 23%; Norway, 19%; Russia, 12%; Canada, 10%; and other, 36%.

Tariff: Item	Number	Normal Trade Relations[2] 12/31/02
Unwrought cobalt, alloys	8105.20.3000	4.4% ad val.
Unwrought cobalt, other	8105.20.6000	Free.
Cobalt mattes and other intermediate products	8105.20.9000	Free.
Cobalt waste and scrap	8105.30.0000	Free.
Wrought cobalt and cobalt articles	8105.90.0000	3.7% ad val.
Chemical compounds:		
Cobalt oxides and hydroxides	2822.00.0000	0.1% ad val.
Cobalt sulfates	2833.29.1000	1.4% ad val.
Cobalt chlorides	2827.34.0000	4.2% ad val.
Cobalt carbonates	2836.99.1000	4.2% ad val.
Cobalt acetates	2915.23.0000	4.2% ad val.
Cobalt ores and concentrates	2605.00.0000	Free.

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

Government Stockpile: Sales of National Defense Stockpile cobalt began in March 1993. The Annual Materials Plan of the Defense Logistics Agency, U.S. Department of Defense, includes a cobalt disposal limit of 2,720 tons (6 million pounds) during fiscal year 2003.

Stockpile Status—9-30-02[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Cobalt	6,640	214	6,640	2,720	1,210

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COBALT

Events, Trends, and Issues: World production of refined cobalt has steadily increased since 1993. Some of the increase has been from new operations and some has been from a net increase in production by established producers. During this period, sales of cobalt from the National Defense Stockpile and cobalt in recycled scrap have also contributed to supply.

World demand for cobalt is strongly influenced by general economic conditions and by demand from industries that consume large quantities of cobalt, such as superalloy melters and manufacturers of rechargeable batteries. In 2002, several factors reduced overall demand for cobalt, including continued weak economic conditions in major consuming countries such as the United States and Japan. Demand for superalloys was down from that in 2001, owing to a decrease in airplane deliveries to financially-stressed U.S. commercial airline companies and a decline in demand for land-based gas turbines for energy generation. By September, however, demand for cobalt from the rechargeable battery sector was reportedly improving from the low levels seen in 2001.

Since 1995, the general trend in cobalt prices has been downward. This trend is likely to continue unless supply is reduced or demand increases. By early October, the price of cobalt cathode had decreased to a range of $6.00 to $6.50 per pound, and as a result a cobalt refinery in Uganda was placed on care and maintenance. However, cobalt production from many other companies during the first half of 2002 was higher than that during the corresponding period in 2001. In most cases this was probably the result of increased production of copper or nickel, the primary metals produced at these operations.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for Congo (Kinshasa) have been increased significantly based on new information from that country. Reserves and reserve base estimates for Canada, Russia, and Zambia also have been revised based on new information.

	Mine production		Reserves[4]	Reserve base[4]
	2001	2002[e]		
United States	—	—	NA	860,000
Australia	6,200	6,600	1,300,000	1,600,000
Canada	5,300	5,300	90,000	300,000
Congo (Kinshasa)	4,700	4,000	3,400,000	4,700,000
Cuba	3,400	3,600	1,000,000	1,800,000
New Caledonia[5]	1,400	1,400	230,000	860,000
Russia[6]	3,800	4,600	250,000	350,000
Zambia	8,000	7,600	270,000	680,000
Other countries	3,800	3,800	150,000	1,600,000
World total (may be rounded)	36,700	36,900	6,700,000	13,000,000

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

Substitutes: 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; iron, manganese, or nickel in batteries; and manganese, iron, cerium, or zirconium in paints.

[e]Estimated. NA Not available. — Zero.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]No tariff for Canada or Mexico.
[3]See Appendix B for definitions.
[4]See Appendix C for definitions.
[5]Overseas territory of France.
[6]Previously unavailable Russian data were used to estimate 2002 production, indicating that the estimate shown for 2001 understates actual production for that year.

COLUMBIUM (NIOBIUM)

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

Domestic Production and Use: There has been no significant domestic columbium mining since 1959. Domestic columbium resources are of low grade, some mineralogically complex, and most are not commercially recoverable. Most metal, ferrocolumbium, other alloys, and compounds were produced by five companies. Feed for these plants included imported concentrates, columbium oxide, and ferrocolumbium. Consumption was mainly as ferrocolumbium by the steel industry and as columbium alloys and metal by the aerospace industry, with plants in the Eastern and Midwestern United States, California, and Washington. The estimated value of reported columbium consumption, in the form of ferrocolumbium and nickel columbium, in 2002, was about $75 million. Major end-use distribution of reported columbium consumption was as follows: carbon steels, 27%; superalloys, 27%; high-strength low-alloy steels, 17%; stainless and heat-resisting steels, 15%; alloy steels, 13%; and other, 1%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, mine	—	—	—	—	—
Imports for consumption:					
Mineral concentrates[e]	200	140	300	290	290
Columbium metal and alloys[e]	563	468	607	1,050	700
Columbium oxide[e]	860	1,200	1.190	1,360	800
Ferrocolumbium[e]	4,900	4,450	4,400	4,480	4,900
Exports, concentrate, metal, alloys[e]	50	160	100	110	100
Government stockpile releases[e 1]	145	280	217	(4)	10
Consumption, reported, ferrocolumbium[e 2]	3,640	3,460	4,090	4,230	3,500
Consumption, apparent	4,150	4,100	4,300	4,400	4,300
Price:					
Columbite, dollars per pound[3]	3.00	3.00	6.25	NA	NA
Ferrocolumbium, dollars per pound[4]	6.88	6.88	6.88	6.88	6.60
Net import reliance[5] as a percentage 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 their columbium content is reused. Detailed data on the quantities of columbium recycled in this manner are not available, but may comprise as much as 20% of apparent consumption.

Import Sources (1998-2001): Brazil, 74%; Canada, 9%; Germany, 4%; Estonia, 3%; and other, 10%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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	8112.92.0500	Free.
Alloys, metal, powders	8112.92.4000	4.9% ad val.
Columbium, other	8112.99.0100	4.0% ad val.

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

Government Stockpile: For fiscal year 2002, the Defense National Stockpile Center (DNSC) sold about 10 tons of columbium contained in columbium carbide powder valued at about $86,000 (which exhausted the DNSC's columbium carbide powder inventory) and about 9 tons of columbium metal ingots valued at about $301,000 from the National Defense Stockpile (NDS). There were no sales of columbium concentrates in fiscal year 2002. The DNSC's ferrocolumbium inventory was exhausted in fiscal year 2001. The DNSC proposed maximum disposal limits in fiscal year 2003 of about 254 tons of columbium contained in columbium concentrates and about 9 tons of columbium metal ingots. The NDS uncommitted inventories shown below include about 244 tons of columbium contained in nonstockpile-grade columbium concentrates.

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COLUMBIUM (NIOBIUM)

Stockpile Status—9-30-02[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Columbium:					
Carbide powder	—	—	—	[7]10	10
Concentrates	594	—	594	254	—
Ferrocolumbium	—	—	—	—	—
Metal	37	—	37	9	9

Events, Trends, and Issues: For the first half of 2002, domestic demand for columbium ferroalloys in steelmaking and demand for columbium in superalloys (mostly for aircraft engine components) were less than in the same period of 2001. For the same period, overall columbium imports decreased; Brazil accounted for more than 50% of quantity and value. Exports also decreased, with Canada, China, Mexico, and the United Kingdom receiving most of the columbium materials. There were no published price quotes for columbium-bearing columbite and pyrochlore concentrates. The published price for standard-grade (steelmaking-grade) ferrocolumbium was quoted at a range of $6.50 to $6.70 per pound of columbium content. The published price for high-purity ferrocolumbium was discontinued in February-March at a range of $17.50 to $18 per pound of columbium content. Industry sources indicated in December 1999 that nickel columbium sold at about $18.50 per pound of columbium content, columbium metal products sold in the range of about $24 to $100 per pound in ingot and special shape forms, and columbium oxide for master alloy production sold for about $8.80 per pound. Public information on current prices for these columbium products was not available.

World Mine Production, Reserves, and Reserve Base: The reserves estimate for Australia has been increased and the reserves estimate for Canada has been decreased based on updated company and/or official country information. Reliable information could not be found to estimate the reserves and reserve base for Nigeria and reserve base for Canada.

	Mine production 2001	Mine production 2002[e]	Reserves[8]	Reserve base[8]
United States	—	—	—	Negligible
Australia	230	300	29,000	NA
Brazil	22,000	22,000	4,300,000	5,200,000
Canada	3,200	3,200	87,000	NA
Congo (Kinshasa)	50	50	NA	NA
Ethiopia	8	8	NA	NA
Nigeria	30	30	NA	NA
Rwanda	120	120	NA	NA
Other countries[9]	—	—	NA	NA
World total (rounded)	25,600	25,700	4,400,000	5,200,000

World Resources: Most of the world's identified resources of columbium are outside the United States and occur mainly as pyrochlore in carbonatite deposits. On a worldwide basis, resources are more than adequate to supply projected needs. The United States has approximately 150,000 tons of columbium resources in identified deposits, all of which were considered uneconomic at 2002 prices for columbium.

Substitutes: The following materials can be substituted for columbium, but a performance or cost penalty may ensue: molybdenum and vanadium as alloying elements in high-strength low-alloy steels; tantalum and titanium as alloying elements in stainless and high-strength steels; and ceramics, molybdenum, tantalum, and tungsten in high-temperature applications.

[e]Estimated. NA Not available. — Zero.
[1]Net quantity (uncommitted inventory). Parentheses indicate negative number (increase in inventory).
[2]Includes nickel columbium.
[3]Yearend average value, contained pentoxides for material having a Nb_2O_5 to Ta_2O_5 ratio of 10 to 1.
[4]Yearend average value, contained columbium, standard (steelmaking) grade.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]See Appendix B for definitions.
[7]Actual quantity limited to remaining sales authority or inventory.
[8]See Appendix C for definitions.
[9]Bolivia, 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 2002 declined to 1.13 million metric tons and was valued at about $1.9 billion. The principal mining States, in descending order, Arizona, Utah, and New Mexico, accounted for 99% of domestic production; copper was also recovered at mines in three other States. Although copper was recovered at 22 mines operating in the United States, just 13 mines accounted for more than 99% of production. Three primary smelters, 4 electrolytic and 3 fire refineries, and 12 solvent extraction-electrowinning facilities operated during the year. Refined copper and direct melt scrap were consumed at about 35 brass mills; 13 rod mills; and 600 foundries, chemical plants, and miscellaneous consumers. Copper and copper alloy products consumed[1] in building construction totaled 44%; electric and electronic products, 25%; transportation equipment, 11%; industrial machinery and equipment, 10%; and consumer and general products, 10%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production:					
Mine	1,860	1,600	1,450	1,340	1,130
Refinery:					
Primary	2,140	1,890	1,590	1,630	1,450
Secondary	349	230	209	172	95
Copper from all old scrap	466	381	357	316	250
Imports for consumption:					
Ores and concentrates	217	143	([2])	46	95
Refined	683	837	1,060	991	900
Unmanufactured	1,190	1,280	1,350	1,400	1,220
Exports:					
Ores and concentrates	37	64	116	45	20
Refined	86	25	94	23	30
Unmanufactured	412	395	650	556	400
Consumption:					
Reported refined	2,890	2,980	3,030	2,620	2,500
Apparent unmanufactured[3]	3,030	3,130	3,100	2,500	2,700
Price, average, cents per pound:					
Domestic producer, cathode	78.6	75.9	88.2	76.9	75
London Metal Exchange, high-grade	75.0	71.3	82.2	71.6	70
Stocks, yearend, refined, held by U.S. producers, consumers, and metal exchanges	532	565	334	952	1,020
Employment, mine and mill, thousands	13.0	10.3	9.1	8.2	7
Net import reliance[4] as a percentage of apparent consumption	14	27	37	22	37

Recycling: Old scrap, converted to refined metal and alloys, provided 250,000 tons of copper, equivalent to 9% of apparent consumption. Purchased new scrap, derived from fabricating operations, yielded 900,000 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 (including aluminum- and nickel-base scrap), brass mills recovered 70%; copper smelters and refiners, 8%; ingot makers, 11%; and miscellaneous manufacturers, foundries, and chemical plants, 11%. Copper in all old and new, refined or remelted scrap contributed 32% of the U.S. copper supply.

Import Sources (1998-2001): Unmanufactured: Canada, 30%; Chile, 23%; Peru, 19%; Mexico, 15%; and other, 13%. Refined copper accounted for 68% of unwrought copper imports.

Tariff: **Item**	**Number**	**Normal Trade Relations[5] 12/31/02**
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. Details on inventories of beryllium-copper master alloys (4% beryllium), can be found in the section on beryllium.

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COPPER

Events, Trends, and Issues: The strong growth trend in world mine production that began in 1995 came to an abrupt halt in 2002 when producers, primarily in the United States and Chile, instituted cutbacks. The reduced output occurred despite a growth of more than 400,000 tons in world mine capacity. According to preliminary data compiled by the International Copper Study Group,[6] however, world refinery production for the first 7 months of 2002 was essentially unchanged from that in 2001. World copper use for the first 7 months of the year, buoyed by a 19% rise in China's apparent consumption, rose by about 1%. The surplus of refined production that saw global inventories rise by 800,000 tons in 2001, continued; inventories rose by an additional 250,000 tons before showing signs of reversing at midyear. Copper prices rose during the first half of the year; the COMEX price averaged $0.76 per pound in June, but by September had fallen back to the December 2001 average of $0.68.

Production cutbacks previously imposed in the United States continued into 2002. In January, Phelps Dodge Corp. implemented most of the cutbacks announced in October 2001, curtailing 165,000 tons per year of production by closing its Miami (AZ) leach operations and halving production at the Sierrita (AZ) and Bagdad (AZ) mines. Its Chino (NM) electrowon operation, however, continued to operate. It also closed its Chino smelter and Miami refinery.[7] Secondary refined production and copper recovery from old scrap fell sharply following the sudden closure of the sole remaining U.S. secondary smelter in November 2001. ASARCO Incorporated, facing cashflow problems and large environmental remediation costs, was seeking to raise capital by selling its share of Southern Peru Copper Corp. to its Mexican-based parent company, but has been temporarily enjoined from doing so following intervention by the U.S. Department of Justice. (For details, see USGS Mineral Industry Surveys, Copper in July 2002.)

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for Australia, Chile, China, and Poland have been revised upward based on new information from official country sources. Revisions to other countries were based on updated tabulations of resources reported by companies or individual properties.

	Mine production		Reserves[8]	Reserve base[8]
	2001	2002[e]		
United States	1,340	1,130	35,000	70,000
Australia	869	850	24,000	43,000
Canada	633	625	10,000	23,000
Chile	4,740	4,450	160,000	370,000
China	590	580	26,000	63,000
Indonesia	1,050	1,100	28,000	38,000
Kazakhstan	470	450	14,000	20,000
Mexico	367	330	27,000	40,000
Peru	722	850	35,000	60,000
Poland	474	500	31,000	50,000
Russia	620	680	20,000	30,000
Zambia	300	320	19,000	35,000
Other countries	1,510	1,500	60,000	110,000
World total (may be rounded)	13,700	13,400	480,000	950,000

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

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

[e]Estimated.
[1]Some electrical components are included in each end use. Distribution by Copper Development Association, 2002.
[2]Less than ½ unit.
[3]Defined as primary refined production + copper from old scrap converted to refined metal and alloys + refined imports - refined exports ± changes in refined stocks. In 1998, 1999, 2000, 2001, and 2002, general imports of 725,000 tons, 915,000 tons, 1,020,000 tons, 1,200,000 tons, and 1,100,000 tons, respectively, were used to calculate apparent consumption.
[4]Defined as imports - exports + adjustments for Government and industry stock changes for refined copper.
[5]No tariff for Canada and Mexico for items shown.
[6]International Copper Study Group, 2002, Copper Bulletin: Lisbon, Portugal, International Copper Study Group, v. 9, no. 10, 46 p.
[7]Phelps Dodge Corp., 2001, Phelps Dodge addresses current economic environment: Phoenix, Phelps Dodge news release, October 23, 3 p.
[8] See Appendix C for definitions.

DIAMOND (INDUSTRIAL)

(Data in million carats, unless otherwise noted)

Domestic Production and Use: In 2002, domestic production was estimated at approximately 310 million carats, and the United States remained the world's largest market for industrial diamond. All domestic output was synthetic grit and powder. Two firms, one in New Jersey and the other in Ohio, accounted for all of the production. Nine firms produced polycrystalline diamond from diamond powder. Four companies recovered used industrial diamond as one of their principal operations. The following industry sectors were the major consumers of industrial diamond: computer chip production, construction, machinery manufacturing, mining services (drilling), stone cutting/polishing, and transportation systems (infrastructure and vehicles). Stone cutting and highway building and repair consumed most of the industrial stone. More than 90% of the industrial diamond market now uses synthetic industrial diamond, whose quality can be controlled and whose properties can be customized to fit specific requirements.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Bort, grit, and dust and powder; natural and synthetic:					
Production:					
Manufactured diamond[e]	140	208	248	308	310
Secondary	10	10	10	10	8.4
Imports for consumption	221	208	291	281	195
Exports[1]	104	98	98	88	81
Sales from Government stockpile excesses	([2])	([2])	—	—	—
Consumption, apparent	267	328	451	511	432
Price, value of imports, dollars per carat	0.44	0.44	0.39	0.31	0.34
Net import reliance[3] as a percentage of apparent consumption	44	36	43	38	27
Stones, natural:					
Production:					
Mine	([2])	([2])	([2])	([2])	—
Secondary	0.5	([2])	([2])	([2])	([2])
Imports for consumption[4]	4.7	3.1	2.5	2.5	2.2
Exports[1]	0.8	0.7	1.6	1.0	1.0
Sales from Government stockpile excesses	0.8	0.6	1.0	0.5	0.4
Consumption, apparent	5.2	3.4	2.2	2.2	1.8
Price, value of imports, dollars per carat	3.92	4.61	5.31	3.54	5.43
Net import reliance[3] as a percentage of apparent consumption	90	88	86	91	89

Recycling: In 2002, the amount of diamond bort, grit, and dust and powder recycled was estimated to be 8.4 million carats. Lower prices and greater competition appear to be reducing the number and scale of diamond stone recycling operations; in 2002, it was estimated that 205 thousand carats of diamond stone were recycled.

Import Sources (1998-2001): Bort, grit, and dust and powder; natural and synthetic: Ireland, 44%; China, 18%; Ukraine, 16%; and other, 22%. Stones, primarily natural: Switzerland, 21%; Russia, 20%; United Kingdom, 17%; Ireland, 13%; and other, 29%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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).

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DIAMOND (INDUSTRIAL)

Government Stockpile:

Stockpile Status—9-30-02[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Industrial stones	0.797	0.219	0.797	1.300	0.412

Events, Trends, and Issues: The United States will continue to be the world's largest market for industrial diamond into the next decade and will remain a significant producer and exporter of industrial diamond as well. Increase in U.S. demand for industrial diamond is likely to continue in the construction sector as the United States builds and repairs the Nation's highway system. Industrial diamond coats the cutting edge of saws used to cut cement in highway construction and repair work.

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]
	2001	2002[e]		
United States	([2])	—	NA	NA
Australia	13.1	13.1	90	230
Botswana	5.1	5.1	130	200
China	1.0	1.0	10	20
Congo (Kinshasa)	9.1	9.1	150	350
Russia	11.6	11.9	40	65
South Africa	6.7	6.7	70	150
Other countries	1.4	2.0	85	210
World total (may be rounded)	48.0	48.9	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. NA Not available. — Zero.
[1]Reexports no longer are combined with exports because increasing amounts of U.S. reexports obscure apparent consumption rates.
[2]Less than ½ unit.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]May include synthetic miners' diamond.
[5]See Appendix B for definitions.
[6]Natural industrial diamond only. Note, however, that synthetic diamond production far exceeds natural industrial diamond output. Worldwide production of manufactured industrial diamond totaled at least 614 million carats in 2001; the largest producers included Ireland, Japan, Russia, and the United States.
[7]See Appendix C for definitions.

DIATOMITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: The estimated value of processed diatomite, f.o.b. plant, was $179 million in 2002. Production was from 7 companies with 12 processing facilities in 4 States. California and Nevada were the principal producing States, and accounted for about 79% of U.S. production in 2002. Estimated end uses of diatomite were filter aids, 63%; absorbents, 13%; fillers, 11%; and other (mostly cement manufacture), 13%.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production[1]	725	747	677	644	700
Imports for consumption	2	2	([2])	([2])	([2])
Exports	138	123	131	148	148
Consumption, apparent	588	625	546	546	554
Price, average value, dollars per ton, f.o.b. plant	248	238	256	270	256
Stocks, producer, yearend	36	36	36	36	36
Employment, mine and plant, number[e]	1,000	1,000	1,000	1,000	1,000
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: None.

Import Sources (1998-2001): Spain, 57%; Italy, 23%; and other, 20%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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 purification of 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 the removal of microbial contaminants, such as bacteria, viruses, and protozoa, in public water systems. D.E. filter aids have been successfully deployed in about 200 locations throughout the United States for the treatment of potable water. Emerging small-scale applications for diatomite include pharmaceutical processing and use as a nontoxic insecticide.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates have been increased significantly based on new information from the mining directorate in China.

	Mine production		Reserves[4]	Reserve base[4]
	2001	2002[e]		
United States[1]	644	700	250,000	500,000
China	350	350	110,000	410,000
Denmark[5]	28	28	NA	NA
France	75	75	—	2,000
Japan	180	190	NA	NA
Korea, Republic of	32	32	NA	NA
Mexico	70	70	—	2,000
Spain	36	36	NA	NA
Former Soviet Union[6]	80	80	NA	NA
Other countries	200	200	550,000	NA
World total (may be rounded)	1,700	1,800	910,000	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. — Zero.
[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 2002 had an estimated value of about $46 million. The three largest producers accounted for about two-thirds of the output, with six other companies supplying the remainder. Operations in North Carolina provided about 40% of the output; facilities in California, Virginia, Georgia, Oklahoma, Idaho, and South Dakota, in estimated descending order of output, produced 60%. Feldspar processors reported coproduct recovery of mica and silica sand.

Feldspar is ground to about 20 mesh for glassmaking and to 200 mesh or finer for most ceramic and filler applications. It was estimated that feldspar shipments went to at least 30 States and to foreign destinations, including Canada and Mexico. In pottery and glass, feldspar functions as a flux. Estimated 2002 end-use distribution of domestic feldspar was glass, 69%, and pottery and other, 31%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, marketable[e]	820	875	790	800	820
Imports for consumption	7	7	7	6	5
Exports	13	10	11	5	8
Consumption, apparent[e]	814	872	786	801	817
Price, average value, marketable production, dollars per ton[e]	50.00	49.00	56.00	55.00	56.00
Stocks, producer, yearend[1]	NA	NA	NA	NA	NA
Employment, mine and preparation plant, number[e]	400	400	400	400	400
Net import reliance[2] as a percentage of apparent consumption	E	E	E	([3])	E

Recycling: Insignificant.

Import Sources (1998-2001): Mexico, 95%; and other, 5%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/02**
Feldspar	2529.10.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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FELDSPAR

Events, Trends, and Issues: Glass containers continued to be the largest end use of feldspar. U.S. shipments of glass containers were about 1% higher in the first 8 months of 2002 than in the comparable period of 2001, according to the U.S. Census Bureau. Beer is the largest product category for glass containers in the United States and Canada. This has been a growing market, partly because of a continuing shift by brewers from cans to glass. In 2001, glass comprised 45% of the packaged beer segment in the United States.[4]

Demand for glass containers in international markets reportedly also continued to grow. Driving factors included the conversion of returnable bottles to recyclable glass bottles and the growth of several regional wine industries, especially in Australia and Italy.[4]

Housing and building construction was the other major market for feldspar, used in ceramic tile, insulation, and vitreous plumbing fixtures. U.S. housing starts for the first 8 months of 2002 were about 5% higher than in the comparable period of 2001, according to the U.S. Census Bureau. The pace of construction may have moderated to some degree in the latter months of 2002, according to the National Association of Home Builders.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	2001	2002[e]	
United States[e]	800	820	Detailed reserve and reserve base information is not available.
Argentina	60	60	
Australia	50	50	
Brazil	60	60	
Czech Republic	300	400	
Colombia	55	55	
Egypt	300	300	
France	650	650	
Germany	450	450	
Greece	95	95	
Iran	250	250	
India	110	110	
Italy	2,600	2,600	
Japan	50	50	
Korea, Republic of	300	390	
Mexico	350	350	
Norway	73	75	
Portugal	120	120	
South Africa	67	82	
Spain	450	450	
Thailand	550	700	
Turkey	1,200	1,200	
Venezuela	140	140	
Other countries	438	440	
World total (may be rounded)	9,500	9,900	

World Resources: Identified and hypothetical resources of feldspar are more than adequate to meet anticipated world demand. Quantitative data on resources of feldspar existing in feldspathic sands, granites, and pegmatites generally have not been compiled. There is ample geologic evidence that resources are large, although not always conveniently accessible to the principal centers of consumption.

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

[e]Estimated. E Net exporter. NA Not available.
[1]Change in stocks assumed to be zero for apparent consumption and net import reliance calculations.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]Less than ½ unit.
[4]Grahl, C.L., 2002, Flat, specialty glass reflect weak economy; container glass markets remain strong: Ceramic Industry, v. 152, no. 9, August, p. 40.
[5]See Appendix C for definitions.

FLUORSPAR

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: There was a small quantity of metallurgical-grade fluorspar mined and some byproduct calcium fluoride was recovered from industrial waste streams, although data are not available on exact quantities. Material purchased from the National Defense Stockpile or imported was screened and dried for resale to customers. Domestically, about 80% of reported fluorspar consumption went into the production of hydrofluoric acid (HF) in Louisiana and Texas and aluminum fluoride in Texas. HF is the primary feedstock for the manufacture of virtually all organic and inorganic fluorine-bearing chemicals, and is also a key ingredient in the processing of aluminum and uranium. The remaining 20% of the reported fluorspar consumption was consumed as a flux in steelmaking, in iron and steel foundries, primary aluminum production, glass manufacture, enamels, welding rod coatings, cement production, and other uses or products. To supplement domestic fluorine supplies, an estimated 71,500 metric tons of fluorosilicic acid (equivalent to126,000 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:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production:					
Finished, all grades[1]	—	—	NA	NA	NA
Fluorspar equivalent from phosphate rock	118	122	119	104	126
Imports for consumption:					
Acid grade	462	419	484	495	466
Metallurgical grade	41	59	39	27	36
Total fluorspar imports	503	478	523	522	502
Fluorspar equivalent from hydrofluoric acid plus cryolite	204	192	208	176	189
Exports[2]	24	55	40	21	25
Shipments from Government stockpile	110	131	106	65	13
Consumption: Apparent[3]	591	615	601	543	472
Reported	538	514	512	536	562
Stocks, yearend, consumer and dealer[4]	468	373	289	221	240
Employment, mine and mill, number	—	—	5	5	5
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: An estimated 8,000 to 10,000 tons per year of synthetic fluorspar is recovered 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 (1998-2001): China, 66%; South Africa, 23%; and Mexico, 11%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/02**
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 2002, there were no fluorspar sales from the Defense National Stockpile. Under the proposed fiscal year 2003 Annual Materials Plan, the Defense National Stockpile Center (DNSC) will be authorized to sell 54,400 metric tons (60,000 short dry tons) of metallurgical grade and 10,900 tons (12,000 short dry tons) of acid grade. In previous Mineral Commodity Summaries nonstockpile-grade materials were not reported in the Stockpile Status table, however, stockpile-grade and nonstockpile-grade material have now been combined. The latest DNSC data classified about 12,600 tons (13,900 short dry tons) of uncommitted inventory for metallurgical-grade fluorspar as being nonstockpile-grade material.

Stockpile Status—9-30-02[6]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2002**	**Disposals FY 2002**
Acid grade	7	109	11	11	—
Metallurgical grade	102	35	54	54	—

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FLUORSPAR

Events, Trends, and Issues: A ban on the production and importation of the widely used foam blowing agent hydrochlorofluorocarbon 141b goes in effect in January 2003. The loss of market share to nonfluorocarbon replacements is expected to be significant and will affect consumption of acid-grade fluorspar. Foam blowing makes up an estimated 18% of the fluorocarbon market, which is the largest market for hydrofluoric acid and acid-grade fluorspar.

Based on recommendations made by the U.S. International Trade Commission, as part of a Section 201 investigation under the Trade Act of 1974, the President imposed tariffs for 3 years ranging from 8% to 30% on various types of imported steel, excluding imports from free-trade partners. As a result of the protections supplied by the tariffs, according to weekly statistics of the American Iron and Steel Institute, the adjusted year-to-date steel production through October 28, 2002, increased by 4.8% compared with the same period in 2001. Sales to the steel industry account for about 50% of the merchant fluorspar market, which is normally a 120,000-ton-per-year market.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7]	Reserve base[7]
	2001	2002[e]		
United States	NA	NA	NA	6,000
China	2,450	2,450	21,000	110,000
France	110	110	10,000	14,000
Italy	45	50	6,000	7,000
Kenya	108	95	2,000	3,000
Mexico	635	640	32,000	40,000
Mongolia	200	200	12,000	16,000
Morocco	75	95	NA	NA
Namibia	[8]83	[8]86	3,000	5,000
Russia	190	190	Moderate	18,000
South Africa	286	240	41,000	80,000
Spain	130	130	6,000	8,000
Other countries	220	240	100,000	170,000
World total (may be rounded)	4,530	4,530	230,000	480,000

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

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

[e]Estimated. NA Not available. — Zero.
[1]Shipments.
[2]Exports are all general imports reexported or National Defense Stockpile material exported.
[3]Excludes fluorspar equivalent of fluorosilicic acid, hydrofluoric acid, and cryolite.
[4]Industry stocks for three largest consumers, fluorspar distributors, and National Defense Stockpile material committed for sale pending shipment.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]See Appendix B for definitions.
[7]See Appendix C for definitions; measured as 100% calcium fluoride.
[8]Data are reported in wet tons.

GALLIUM

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

Domestic Production and Use: No domestic primary gallium recovery was reported in 2002. 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 $6 million, most of which was low-purity material. Gallium arsenide (GaAs) components represented about 98% of domestic gallium consumption. About 34% of the gallium consumed was used in optoelectronic devices, which include light-emitting diodes (LEDs), laser diodes, photodetectors, and solar cells. Integrated circuits represented 65% of gallium demand. The remaining 1% was used in research and development, specialty alloys, and other applications. Optoelectronic devices were used in areas such as aerospace, consumer goods, industrial components, medical equipment, and telecommunications. Integrated circuits were used in defense applications, high-performance computers, and telecommunications.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, primary	—	—	—	—	—
Imports for consumption	26,300	24,100	39,400	27,100	21,000
Exports	NA	NA	NA	NA	NA
Consumption:					
Reported	26,900	29,800	39,900	27,700	21,000
Apparent	NA	NA	NA	NA	NA
Price, yearend, dollars per kilogram, 99.99999%-pure	595	640	640	640	[1]550
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, refinery, number[e]	20	20	20	20	20
Net import reliance[2] as a percentage of 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 (1998-2001): France, 44%; Kazakhstan, 16%; Russia, 12%; China, 8%; and other, 20%.

Tariff:

Item	**Number**	**Normal Trade Relations 12/31/02**
Gallium metal	8112.92.1000	3.0% ad val.
Gallium arsenide wafers, undoped	2851.00.0010	2.8% ad val.
Gallium arsenide wafers, doped	3818.00.0010	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: One of the two refiners in the United States announced that it would exit the gallium business because of a slump in demand by the telecommunications industry. The Oklahoma firm said that it would liquidate its remaining inventory before the end of 2002. This leaves the United States with only one gallium refiner, located in Utah.

Imports continued to supply almost all U.S. demand for gallium and decreased from those in 2001 because of the continued slowdown in the wireless communications industry. Using partial-year data, China, France, and Russia were the principal U.S. gallium suppliers in 2002. Through July, China had supplied nearly 90% of total imports.

Gallium prices remained lower throughout the year because of the decreased demand. The price of low-purity gallium from China was estimated to be about $250 per kilogram at midyear, and prices for high-purity gallium were estimated to be between $400 and $500 per kilogram.

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GALLIUM

Analysts continue to predict significant growth in wireless mobile handset applications, even though demand in 2002 was significantly lower than originally forecast. If demand increases, the main growth driver would be existing subscribers replacing handsets to gain new features and services, such as color screens and data capability. Many of these new platforms are more complex and require additional GaAs content per phone. Despite forecasts of market growth, several companies were consolidating, reducing, or eliminating their GaAs production facilities. Research and development work continued on gallium nitride, primarily to commercialize blue and violet LEDs and laser diodes.

Because of the weak market for gallium, the restart of a 50-metric-ton-per-year gallium facility in Australia that was originally scheduled for the fourth quarter of 2002 has been postponed. The U.S. firm that planned to operate the plant and expand its capacity to 100 metric tons per year has until December 2004 to begin actions to restart that plant without incurring a penalty according to the agreement with the plant's original owners.

Consumption of high-purity gallium in Japan was projected to decrease by 14% to 108 metric tons in 2002. Domestic production of 8 metric tons, imports of 55 metric tons, and scrap recycling of 45 metric tons were the components of Japanese consumption. Scrap consumption dropped sharply in 2002 to 45 metric tons from 67 metric tons in 2001.

World Production, Reserves, and Reserve Base: Data on world production of primary gallium are unavailable because data on the output of the few producers are considered to be proprietary. However, in 2002, world primary production was estimated to have dropped significantly to about 61 metric tons from about 75 metric tons in 2001. China, Germany, Japan, and Russia were the largest producers; countries with smaller output were Hungary, Kazakhstan, Slovakia, and Ukraine. Refined gallium production was estimated to be about 81 metric tons; this figure includes some scrap refining. France was the largest producer of refined gallium, using as feed material crude gallium produced in Germany. Japan and the United States were the other large gallium-refining countries. Gallium was recycled from new scrap in Germany, Japan, the United Kingdom, and the United States.

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

World Resources:[3] Assuming that the average content of gallium in bauxite is 50 parts per million (ppm), U.S. bauxite resources, which are mainly subeconomic deposits, contain approximately 15 million kilograms of gallium. About 2 million kilograms of this metal 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.

Substitutes: Liquid crystals made from organic compounds are used in visual displays as substitutes for LEDs. Researchers are also working to develop organic-based LEDs that may compete with GaAs in the future. Indium phosphide components can be substituted for GaAs-based infrared laser diodes in some specific-wavelength applications, and GaAs competes with helium-neon lasers in visible laser diode applications. Silicon is the principal competitor 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. GaAs heterojunction bipolar transistors are being challenged in some applications by a new material, silicon-germanium.

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

[1]Producer published price series was discontinued. The price shown for 2002 is the estimated average value of U.S. imports for 99.9999%- and 99.99999%-pure gallium.

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

[3]See Appendix C for definitions.

GARNET (INDUSTRIAL)[1]

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

Domestic Production and Use: Garnet for industrial use was mined in 2002 by six firms, three in New York, two in Montana, and one in Idaho. The estimated value of crude garnet production was about $5.3 million, while refined material sold or used had an estimated value of $12.5 million. Major end uses for garnet were waterjet cutting, 35%; abrasive blasting media, 30%; water filtration, 15%; abrasive powders, 10%; and other end uses, 10%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production (crude)	74,000	60,700	60,200	52,700	46,900
Sold by producers	51,900	43,900	51,300	46,200	42,200
Imports for consumption[e]	20,000	12,000	23,000	23,000	23,000
Exports[e]	12,000	10,000	10,000	10,000	10,400
Consumption, apparent[e]	39,900	33,700	66,300	59,300	58,900
Price, range of value, dollars per ton[2]	50-2,000	55-2,000	50-2,000	50-2,000	50-2,000
Stocks, producer[e]	39,900	52,100	50,100	50,000	45,900
Employment, mine and mill, number	230	220	220	220	220
Net import reliance[3] as a percentage of apparent consumption	E	E	23	22	28

Recycling: Small amounts of garnet reportedly are recycled.

Import Sources (1998-2001):[e] Australia, 53%; India, 37%; China, 9%; and other, 1%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
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 2002, U.S. garnet consumption decreased slightly, while domestic production of crude garnet concentrates declined by 11% from that of 2001. In 2002, imports were estimated to have remained about the same as those of 2001, and exports were estimated to have increased slightly from those of 2001. The 2002 domestic sales of garnet declined slightly from the 2001 level. Since 1999, the United States has moved from being a net exporter to being a net importer. Garnet imports have displaced U.S. production in the domestic market, with India becoming a major garnet supplier.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2001	2002[e]		
United States	52,700	46,900	5,000,000	25,000,000
Australia	125,000	127,000	1,000,000	7,000,000
China	25,000	27,000	Moderate to Large	Moderate to Large
India	60,000	63,000	90,000	5,400,000
Other countries	20,000	21,000	6,500,000	20,000,000
World total (rounded)	283,000	285,000	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 $150 per ton, and most refined material is $150 to $450 per ton.

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

[4]See Appendix C for definitions.

GEMSTONES[1]

(Data in million dollars, unless otherwise noted)

Domestic Production and Use: The combined U.S. natural and synthetic gemstone output decreased in 2002 from that of 2001. Production of natural gemstones increased by 12% during 2002, primarily owing to increased tourmaline production in California. Domestic gemstone production included agates, amber, beryl, coral, garnet, jade, jasper, opal, pearl, quartz, sapphire, shell, topaz, tourmaline, turquoise, and many other gem materials. In decreasing order, California, Tennessee, Arizona, Oregon, Arkansas, Idaho, and Montana produced 85% of U.S. natural gemstones. Production of synthetic gemstones decreased by 38% during the year, owing to large decreases in the production of cubic zirconia and moissanite. Reported output of synthetic gemstones was from six firms in North Carolina, New York, Florida, California, Michigan, and Arizona, in decreasing order of production. Major uses were jewelry, carvings, and gem and mineral collections.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production:[2]					
Natural[3]	14.3	16.1	17.2	15.1	16.9
Synthetic	24.2	47.5	37.1	24.7	15.3
Imports for consumption	9,250	10,700	12,900	11,400	12,900
Exports, including reexports[4]	2,980	3,610	4,330	4,330	4,690
Consumption, apparent[5]	6,310	7,150	8,620	7,110	8,240
Price	Variable, depending on size, type, and quality				
Employment, mine, number[e]	1,200	1,200	1,200	1,200	1,200
Net import reliance[6] as a percentage of apparent consumption	99	99	99	99	99

Recycling: Insignificant.

Import Sources (1998-2001): Israel, 42%; Belgium, 20%; India, 20%; and other, 18%. Diamond imports accounted for 94% of the total value of gem imports.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Diamonds, unworked or sawn	7102.31.0000	Free.
Diamond, ½ carat or less	7102.39.0010	Free.
Diamond, cut, more than ½ carat	7102.39.0050	Free.
Precious stones, unworked	7103.10.2000	Free.
Precious stones, simply sawn	7103.10.4000	10.5% ad val.
Rubies, cut	7103.91.0010	Free.
Sapphires, cut	7103.91.0020	Free.
Emeralds, cut	7103.91.0030	Free.
Other precious, cut but not set	7103.99.1000	Free.
Other precious stones	7103.99.5000	10.5% ad val.
Imitation precious stones	7018.10.2000	Free.
Synthetic cut, but not set	7104.90.1000	Free.
Pearls, natural	7101.10.0000	Free.
Pearls, cultured	7101.21.0000	Free.
Pearls, imitation, not strung	7018.10.1000	4.0% ad val.

Depletion Allowance: 14% (Domestic and foreign).

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

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GEMSTONES

Events, Trends, and Issues: In 2002, the U.S. market for unset gem-quality diamonds was estimated to be more than $10.5 billion, accounting for at least one-third of world demand. The domestic market for natural, unset nondiamond gemstones totaled more than $700 million. The United States is expected to dominate global gemstone consumption throughout this decade.

In order to deal with the problem of ?conflict diamonds," which are used to support insurgent forces in Africa, an international system of certification for rough diamond shipments called the Kimberley process was mandated by the United Nations in 2001. This process was implemented during 2002, and along with the apparent end of the conflicts in Angola, Congo (Kinshasa), and Sierra Leone, cleared the way for legitimate diamond trade.

Canada's Ekati Mine completed its third full year in 2001, with diamond production of 3.7 million carats. Canada's Diavik project is expected to come on-stream in 2003 with production of 6 to 8 million carats per year. Canada's first underground diamond mine, the Snap Lake project, is expected to come on-stream in 2005. When the Diavik and Snap Lake mines begin production, Canada will be producing at least 15% to 20% of total world diamond output.

World Mine Production,[7] Reserves, and Reserve Base: Mine production for Angola, Botswana, Brazil, Canada, Congo (Kinshasa), Ghana, Guinea, Sierra Leone, and Tanzania have been revised upward, while production for Australia, Namibia, South Africa, and Venezuela have been revised downward based on new information from official country sources.

	Mine production	
	2001	2002[e]
United States	([9])	([9])
Angola	4,650	4,700
Australia	10,700	12,000
Botswana	20,100	20,100
Brazil	1,000	1,000
Canada	2,600	2,700
Central African Republic	360	400
China	240	250
Congo (Kinshasa)	9,100	7,000
Ghana	700	700
Guinea	270	300
Namibia	1,490	1,600
Russia	11,600	11,900
Sierra Leone	450	500
South Africa	4,470	4,200
Tanzania	300	300
Other countries	500	500
World total (may be rounded)	68,500	68,000

Reserves and reserve base[8]

World reserves and reserve base of gem diamond are substantial. No reserves or reserve base data are available for other gemstones.

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.

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

[e]Estimated.
[1]Excludes industrial diamond and garnet. See Diamond (Industrial) and Garnet (Industrial).
[2]Estimated minimum production.
[3]Includes production of freshwater shell.
[4]Reexports account for about 66% of the totals.
[5]If reexports were not considered, apparent consumption would be significantly greater.
[6]Defined as imports - exports and reexports + adjustments for Government and industry stock changes.
[7]Data in thousands of carats of gem diamond.
[8]See Appendix C for definitions.
[9]Less than ½ unit.

GERMANIUM[1]

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

Domestic Production and Use: The value of domestic refinery production of germanium, based upon the 2002 producer price, was $17 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 2002. The domestic industry was based on two zinc mining operations, one in Tennessee and the other in Alaska. The mining companies at these operations supplied domestic and export markets with germanium-bearing materials generated from the processing of zinc ores. The germanium refinery in Utica, NY, produced germanium tetrachloride for optical fiber production. The refinery in Oklahoma doubled its production of germanium tetrachloride production in response to the growing demand expected in the fiber optics industry. The major end uses for germanium, worldwide, were estimated to be higher in fiber optics than for 2001—fiber-optic systems, 60%; polymerization catalysts, 15%; infrared optics, 15%; electronics/solar electrical applications, 5%; and other (phosphors, metallurgy, and chemotherapy), 5%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, refinery[e]	22,000	20,000	23,000	20,000	20,000
Total imports[2]	14,600	12,400	8,220	8,240	8,250
Exports	NA	NA	NA	NA	NA
Consumption[e]	28,000	28,000	28,000	28,000	28,000
Price, producer, yearend, dollars per kilogram:					
Zone refined	1,700	1,400	1,250	890	850
Dioxide, electronic grade	1,100	900	800	575	500
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant,[3] number[e]	100	85	90	90	85
Net import reliance[4] as a percentage of estimated consumption	NA	NA	NA	NA	NA

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

Import Sources (1998-2001):[5] China, 35%; Belgium, 32%; Taiwan, 10%; Russia, 10%; and other, 13%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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—9-30-02[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Germanium	42,186	—	42,186	8,000	620

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GERMANIUM

Events, Trends, and Issues: Domestic refinery production of germanium remained the same as in 2001; world output also remained the same. Recycling of new scrap continued to grow and remained a significant supply factor. Optical fiber manufacturing stabilized owing to an upturn in the general economy and telecommunications in particular. Higher recycling rates and declining polyethylene terephthalate (PET) plastics demand due to further worsening of economic conditions in Asia caused germanium oxide (a catalyst used in the production of PET) stocks to increase. However, increases in demand for infrared applications in security, new uses as catalysts, and the potential replacement of gallium arsenide devices by silicon-germanium in wireless telecommunications portend a bright long-range future for germanium.

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: Most U.S. reserves and reserve base of germanium are located in the zinc deposits of the Red Dog district in of Alaska, with lesser amounts in the zinc ores of central Tennessee. The quantities are company proprietary data and are not available for publication.

	Refinery production[e]		Reserves[7]	Reserve base[7]
	2001	2002		
United States	20,000	20,000	NA	NA
Other countries	48,000	48,000	NA	NA
World total	68,000	68,000	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. Some 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. — Zero.
[1]Prepared by Earle B. Amey.
[2]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.
[3]Employment related to primary germanium refining is indirectly related to zinc refining.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]Total imports from republics of the former Soviet Union (Russia and Ukraine) accounted for 14% of the imports from 1998 to 2001.
[6]See Appendix B for definitions.
[7]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 52 major lode mines, a dozen or more large placer mines (nearly all in Alaska), and numerous smaller placer mines (mostly in Alaska and in the Western States). In addition, a small amount of domestic gold was recovered as a byproduct of processing base metals, chiefly copper. Thirty mines yielded more than 99% of the gold produced in the United States. In 2002, the value of mine production was more than $2.9 billion. Commercial-grade refined gold came from about two dozen producers. A few dozen companies, out of several thousand companies and artisans, dominated the fabrication of gold into commercial products. U.S. jewelry manufacturing was heavily concentrated in the New York, NY, and Providence, RI; areas with lesser concentrations include California, Florida, and Texas. Estimated uses were: jewelry and arts, 85%; dental, 10%; and electrical and electronics, 5%.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production:					
Mine	366	341	353	335	300
Refinery:					
Primary	277	265	197	191	180
Secondary (new and old scrap)	163	143	82	83	85
Imports[2]	278	221	223	193	125
Exports[2]	522	523	547	489	165
Consumption, reported	219	245	183	179	170
Stocks, yearend, Treasury[3]	8,130	8,170	8,140	8,120	8,140
Price, dollars per ounce[4]	295	280	280	272	305
Employment, mine and mill, number[5]	13,400	10,300	10,400	9,500	9,000
Net import reliance[6] as a percentage of apparent consumption	E	E	E	E	E

Recycling: 85 metric tons of new and old scrap, equal to 50% of reported consumption, was recycled in 2002.

Import Sources (1998-2001):[2] Canada, 46%; Brazil, 14%; Peru, 8%; Australia, 7%; and other, 25%.

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.

Events, Trends, and Issues: Domestic gold mine production in 2002 was estimated at about 10% less than the level of 2001, but high enough to maintain the United States' position as the world's second largest gold-producing nation, after South Africa. Domestic output continued to be dominated by Nevada, where combined production accounted for more than 75% of the U.S. total. Between July 2001 and August 2002, four gold mines were closed in the United States. During this 12-month period, the average output per mine remained about the same, companies merged, and the size of gold mining operations increased. Companies were beginning to have difficulties in successfully replacing annual production with new reserves. Estimates by an industry association indicate that worldwide gold exploration expenditures decreased for the fifth consecutive year, with 1997 marking the peak of exploration spending for the 1990s. The expenditures of U.S. gold producers continued to fall, but at a lesser rate than in 2001 owing to the recovering gold price.

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GOLD

During the first 9 months of 2002, the Englehard Corporation's daily price of gold ranged from a low of about $279 per troy ounce in January to a high of almost $331 in June. For most of the year, this price range was above $300. After terrorists attacked the United States in September 2001, the traditional role of gold as a store of value was able to lift the price of gold out of its low trading range. In 2002, the Swiss National Bank continued selling 1,300 tons of gold (one-half its reserves). Concerns about terrorism, war in the Middle East, and weaknesses in the U.S. dollar, prompted increases in gold prices, which averaged over $300 during the year.

World Mine Production, Reserves, and Reserve Base: Estimated reserves for South Africa have been significantly decreased based on new information from that country. Reserve base estimates for Brazil, China, the Dominican Republic, Ghana, Kazakhstan, and Peru also have been revised based on new information.

	Mine production		Reserves[7]	Reserve base[7]
	2001	2002[e]		
United States	335	300	5,600	6,000
Australia	285	280	5,000	6,000
Canada	160	160	1,300	3,500
China	185	175	1,200	4,100
Indonesia	130	170	1,800	2,800
Peru	138	140	200	650
Russia	152	170	3,000	3,500
South Africa	402	395	8,000	36,000
Other countries	783	740	16,600	26,000
World total (may be rounded)	2,570	2,530	42,500	89,000

Of an estimated 142,600 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 121,000 tons, an estimated 33,000 tons are official stocks held by central banks and about 88,000 tons are privately held as coin, bullion, and jewelry.

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

Substitutes: Base metals clad with gold alloys are widely used in electrical/electronic 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.
[1]Metric ton (1,000 kilograms) = 32,150.7 troy ounces.
[2]Refined bullion, doré, ores, concentrates, and precipitates.
Excludes:
a. Waste and scrap.
b. Official monetary gold.
c. Gold in fabricated items.
d. Gold in coins. In 1991, the last year for which estimates are available, net imports amounted to 3.5 metric tons.
e. Net bullion flow (in tons) to market from foreign stocks at the New York Federal Reserve Bank: 309.9 (1998), 302.7 (1999), 355.8 (2000), 259.5 (2001), and 40.7 (2002 estimated).

[3]Includes gold in Exchange Stabilization Fund. Stocks were valued at the official price of $42.22 per troy ounce.
[4]Englehard Corporation's average gold price quotation for the year.
[5]Data from Mine Safety and Health Administration.
[6]Defined as imports - exports + adjustments for Government and industry stock changes.
[7]See Appendix C for definitions.

GRAPHITE (NATURAL)

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Although natural graphite was not produced in the United States in 2002, approximately 200 U.S. firms, primarily in the Northeastern and Great Lakes regions, used it for a wide variety of applications. The major uses of natural graphite remained the same as in 2000: refractory applications led the way in use categories with 22%; brake linings was second with 21%; dressings and molds in foundry operations, 8%; lubricants, 5%; and other uses made up the remaining 44%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, mine	—	—	—	—	—
Imports for consumption	62	56	61	52	50
Exports	28	29	22	24	23
Consumption, apparent	34	26	39	28	27
Price, imports (average dollars per ton at foreign ports):					
Flake	514	540	550	560	560
Lump and chip (Sri Lankan)	1,200	1,100	1,150	1,200	1,100
Amorphous (Mexican)	192	225	230	230	240
Stocks, yearend	NA	NA	NA	NA	NA
Net import reliance[1] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Refractory brick and linings, alumina-graphite refractories for continuous metal castings, magnesia-graphite refractory brick for basic oxygen and electric arc furnaces, and insulation brick led the way in recycling of graphite products. Primary recycling of refractory articles is growing with the recycling market being principally in less demanding service conditions, such as brake linings and thermal insulation.

Past research has established the technical feasibility of recovering high-quality flake graphite from steelmaking kish.[2] Abundance of graphite in the world market and continuing low prices, however, inhibit increased recycling efforts. Information on the quantity and value of recycled graphite is not available.

Import Sources (1998-2001): China, 30%; Mexico, 27%; Canada, 18%; Brazil, 6%; and other, 19%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/02**
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—9-30-02[3]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2002**	**Disposals FY 2002**
Sri Lanka, amorphous lump	1.70	—	1.70	3.76	1.68
Madagascar, crystalline flake	1.98	—	1.98	—	2.13

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GRAPHITE (NATURAL)

Events, Trends, and Issues: Graphite was near supply-demand balance in 2002. Imports of flake from Canada, China, Madagascar, and Mexico; lump and chip from Sri Lanka; and amorphous graphite from China and Mexico generally met demand. There has been a marked decrease in the consumption of graphite electrodes, owing to development of more efficient iron and steel production techniques during the late 1980s. Use of natural graphite in lubrication applications is also decreasing because of changes in requirements for lubricants and in processing technologies. Advances in thermal technology and acid-leaching techniques that enable the production of higher purity graphite powders are likely to lead to development of new applications for graphite in high-technology fields. Such innovative refining techniques already have enabled the use of improved graphite in carbon-graphite composites, electronics, foils, friction materials, and special lubricant applications. Flexible graphite product lines, such as graphoil (a thin graphite cloth), will probably be the fastest growing market. Large-scale fuel cell applications currently under development could consume as much graphite as all other uses combined.

World Mine Production, Reserves, and Reserve Base: Mine production for Brazil and China have been revised upward, while production for India, Madagascar, and Mexico were revised downward based on new information from those countries. Reserves and reserve base estimates for China and India also have been revised based on new information.

	Mine production		Reserves[4]	Reserve base[4]
	2001	2002[e]		
United States	—	—	—	1,000
Brazil	72	70	360	1,000
Canada	25	25	—	—
China	450	430	64,000	220,000
India	140	130	800	3,800
Madagascar	2	13	940	960
Mexico	21	20	3,100	3,100
Other countries	116	120	5,100	44,000
World total (may be rounded)	826	810	74,000	270,000

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

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

[e]Estimated. NA Not available. — Zero.
[1]Defined as imports - exports + 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]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.
[3]See Appendix B for definitions.
[4]See Appendix C for definitions.

GYPSUM

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: In 2002, domestic production of crude gypsum was estimated at 16.1 million tons with an estimated valued of $117 million. The top producing States were, in descending order, Oklahoma, Iowa, Nevada, Texas, California, and Arkansas, which together accounted for 66% of total output. Overall, 27 companies produced gypsum at 51 mines in 19 States, and 10 companies calcined gypsum at 66 plants in 29 States. Almost 90% of domestic consumption, which totaled approximately 31.8 million tons, was accounted for by manufacturers of wallboard and plaster products. Approximately 2.69 million tons for cement production, 0.84 million tons for agricultural applications, and small amounts of high-purity gypsum for a wide range of industrial processes, such as smelting and glassmaking, accounted for the remaining uses. At the beginning of 2002, capacity of operating wallboard plants in the United States was 36.8 billion square feet[1] per year.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production:					
Crude	19,000	22,400	19,500	16,300	16,100
Synthetic[2]	3,000	5,200	4,950	6,820	7,700
Calcined[3]	19,400	22,300	21,000	19,100	21,100
Wallboard products (million square feet[1])	26,900	28,700	26,100	29,500	30,500
Imports, crude, including anhydrite	8,680	9,340	9,210	8,270	8,330
Exports, crude, not ground or calcined	166	112	161	295	380
Consumption, apparent[4]	30,500	36,800	33,700	31,100	31,800
Price:					
Average crude, f.o.b. mine, dollars per ton	6.92	6.99	8.44	7.31	7.33
Average calcined, f.o.b. plant, dollars per ton	17.02	17.07	16.81	18.42	18.39
Stocks, producer, crude, yearend	1,500	1,500	1,500	1,500	1,500
Employment, mine and calcining plant, number[e]	6,000	6,000	6,000	5,900	5,900
Net import reliance[5] as a percentage of apparent consumption	28	25	27	26	25

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

Import Sources (1998-2001): Canada, 67%; Mexico, 23%; Spain, 9%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Gypsum; anhydrite	2520.10.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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GYPSUM

Events, Trends, and Issues: During 2002 and for the previous 6 years, the U.S. gypsum industry experienced several acquisitions, mergers, bankruptcy reorganization filings, construction of new plants, and expansion of capacity at existing plants; older, less efficient manufacturing facilities were temporarily idled, closed, or dismantled.

Domestic housing and construction starts rose early in 2002, but leveled out and declined slightly during some later months of the year. The net result was a small overall gypsum production increase for the year. If, however, the construction industry resumes its decline, U.S. gypsum consumption is likely to decline as well. Demand for gypsum depends principally on the strength of the construction industry—particularly in the United States, where more than 95% of the gypsum consumed is used for wallboard products, building plasters, and the manufacture of portland cement. Road building and repair will continue to spur gypsum consumption in the cement industry. More large wallboard plants under construction and designed to use 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[6]	Reserve base[6]
	2001	2002[e]		
United States	16,300	16,100	700,000	Large
Australia	3,800	3,800		
Canada	8,560	8,600	450,000	Large
China	6,800	6,800		
Egypt	2,000	1,900		
France	4,500	4,500		
India	2,250	2,300		
Iran	11,000	11,000		
Italy	1,300	1,300	Reserves and reserve base are large in major producing countries, but data are not available.	
Japan	5,900	5,800		
Mexico	7,500	6,300		
Poland	2,000	1,200		
Spain	7,500	7,500		
Thailand	5,900	6,100		
United Kingdom	1,500	1,500		
Other countries	17,200	18,300		
World total (rounded)	104,000	103,000	Large	Large

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

Substitutes: Other construction materials may be substituted for gypsum, especially cement, lime, lumber, masonry, and steel. Gypsum has no practical substitute in the manufacturing of portland cement. Synthetic gypsum generated by various industrial processes, including flue gas desulfurization of stack emissions, is becoming very important as a substitute for mined gypsum in wallboard manufacturing, cement production, and agricultural applications. In 2002, synthetic gypsum accounted for 24% of the total domestic gypsum supply.

[e]Estimated.
[1]The standard unit used in the U.S. wallboard industry is square feet. Multiply square feet by 0.0929 to convert to square meters.
[2]Data refer to amount sold or used, not produced.
[3]From domestic crude.
[4]Defined as crude + total synthetic reported used + net import reliance.
[5]Defined as imports - exports + adjustments for industry stock changes.
[6]See Appendix C for definitions.

HELIUM

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

Domestic Production and Use: During 2002, the estimated value of Grade-A helium (99.995% or better) extracted domestically by private industry was about $250 million. There were 11 industry plants (7 in Kansas and 4 in Texas) that extracted helium from natural gas and produced only a crude helium product that varied from 50% to 80% helium. There were 10 industry plants (4 in Kansas, 2 in Texas, and 1 each in Colorado, Oklahoma, Utah, and Wyoming) that extracted helium from natural gas and produced an intermediate process stream of crude helium (about 70% helium and 30% nitrogen) and continued processing the stream to produce a Grade-A helium product. There were six industry plants (four in Kansas, one in Texas, and one in Oklahoma) that accepted a crude helium product from other producers and the Bureau of Land Management (BLM) pipeline and purified this to a Grade-A helium product. Estimated 2002 domestic consumption of 80 million cubic meters (2.9 billion cubic feet) was used for cryogenic applications, 24%; for pressurizing and purging, 20%; for welding cover gas, 18%; for controlled atmospheres, 16%; leak detection, 6%; breathing mixtures, 3%; and other, 13%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Helium extracted from natural gas[2]	114	114	98	87	85
Withdrawn from storage[3]	(0.7)	3	29	45	40
Grade-A helium sales	112	117	127	132	125
Imports for consumption	—	—	—	—	—
Exports[4]	27.8	26.8	37.0	43.0	40
Consumption, apparent[4]	84.6	90.3	89.6	88.9	80.0
Employment, plant, number[e]	530	500	320	325	325
Net import reliance[5] as a percentage of apparent consumption	E	E	E	E	E

Price: The Government price for crude helium was $1.857 per cubic meter ($51.50 per thousand cubic feet) in fiscal year (FY) 2002. The price for the Government-owned helium is mandated by Public Law 104-273. The estimated price range for private industry's Grade-A gaseous helium was about $1.62 to $1.87 per cubic meter ($45 to $52 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 (1998-2001): None.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
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. The BLM no longer supplies Federal agencies with Grade-A helium. Private firms that sell Grade-A helium to the Federal agencies are required to purchase a like amount of crude helium (in-kind) from the BLM. In FY 2002, privately owned companies purchased nearly 6.32 million cubic meters (228 million cubic feet) of in-kind crude helium. During FY 2002, BLM's Amarillo Field Office, Helium Operations (AMFO) accepted more than 17.5 million cubic meters (630 million cubic feet) of private helium for storage and redelivered nearly 57.0 million cubic meters (2,054 million cubic feet). As of September 30, 2002, 52.3 million cubic meters (1.9 billion cubic feet) of helium was owned by private firms.

Stockpile Status—9-30-02[6]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2002**	**Disposals FY 2002**
Helium	807.2	16.6	807.2	6.66	6.32

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HELIUM

Events, Trends, and Issues: During 2002, BOC Gases, Inc., Air Products and Chemicals Inc., and Praxair, Inc., again announced helium price increases. As in 2001, the price increases were again in response to the continued rising costs of purchasing, producing, and distributing helium. The higher costs for helium are due to the continued increase in worldwide helium demand, which has shifted helium supply to higher cost sources such as the Federal helium reserve. It is anticipated that the trend toward higher costs will continue as the potential for helium shortages increases. Helium shortages will result from continued depletion of U.S. helium reserves as demand for helium continues to escalate. It is anticipated that helium demand will grow at a rate of about 5% per year through 2004; helium demand has risen at this rate for the past 10 years. However, during 2002, there was a slight decrease in helium exports, which could lead to some slowdown in the demand growth.

In 2001, the AMFO initiated work on the drafting of helium regulations to provide guidance for the Federal helium program. Drafting of the regulations continued during 2002.

World Production, Reserves, and Reserve Base:

	Production		Reserves[8]	Reserve base[8]
	2001	2002[e]		
United States	87	85	4,100	[9]8,900
Algeria	14	14	2,000	3,000
Canada	NA	NA	NA	2,000
China	NA	NA	NA	1,100
Poland	1	1	40	280
Russia	4	4	1,700	6,700
Other countries	NA	NA	NA	2,800
World total (rounded)	106	104	NA	25,000

World Resources: The identified helium resources of the United States were estimated to be about 8.9 billion cubic meters (323 billion cubic feet) as of January 1, 2001. This includes 0.95 billion cubic meters (34.3 billion cubic feet) of helium stored in the Cliffside Field, 4.1 billion cubic meters (147 billion cubic feet) of helium in helium-rich natural gas (0.30% helium or more) from which helium is currently being extracted, and 3.1 billion cubic meters (111 billion cubic feet) in helium-lean natural gas (less than 0.30% helium). The Hugoton (Kansas, Texas, and Oklahoma), Panhandle West, Panoma, Riley Ridge, and Cliffside Fields are currently depleting gasfields and contain an estimated 4.0 billion cubic meters (143 billion cubic feet) of helium. Future supplies will probably come from known helium-rich natural gas with little fuel value and from helium-lean resources.

Helium resources of the world exclusive of the United States were estimated to be about 16.1 billion cubic meters (580 billion cubic feet). The locations and volumes of the principal deposits, in billion cubic meters, are Russia, 7; Algeria, 3; Canada, 2; China, 1; and Poland, 0.3. As of December 31, 2002, AMFO had analyzed more than 21,100 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 in cryogenic applications if temperatures below -429° F are required. Argon can be substituted for helium in welding, and hydrogen can be substituted for helium in some lighter-than-air applications in which the flammable nature of hydrogen is not objectionable. Hydrogen is also being investigated as a substitute for helium in deep-sea diving applications below 1,000 feet.

[e]Estimated. E Net exporter. NA Not available. — Zero.
[1]Measured at 101.325 kilopascals absolute (14.696 psia) and 15° C, 27.737 cubic meters of helium = 1 Mcf of helium at 70° F and 14.7 psia.
[2]Helium from both Grade-A and crude helium.
[3]Extracted from natural gas in prior years (injected in parentheses).
[4]Grade-A helium.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]See Appendix B for Definitions.
[7]Team Leader, Resources Evaluation, Bureau of Land Management Amarillo Field Office, Helium Operations, Amarillo, TX.
[8]See Appendix C for definitions.
[9]All domestic measured and indicated helium resources in the United States.

INDIUM[1]

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: Indium was not recovered from ores in the United States in 2002. Domestically produced standard grade indium was derived by upgrading 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 2002. Several additional firms produced high-purity indium shapes, alloys, and compounds from imported indium. Thin-film coatings, which are used in applications such as liquid crystal displays (LCDs) 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 2002 indicated a moderate increase in semiconductors and stable consumption in other sectors: Coatings, 45%; solders and alloys, 30%; electrical components and semiconductors, 15%; and research and other, 10%. The estimated value of primary indium metal consumed in 2002, based upon the annual average price, was about $9.5 million.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, refinery	—	—	—	—	—
Imports for consumption	75	77	69	79	90
Exports	NA	NA	NA	[e]10	NA
Consumption[e]	50	52	55	65	75
Price, annual average, dollars per kilogram (99.97% indium)	296	303	188	120	130
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, number	NA	NA	NA	NA	NA
Net import reliance[2] as a percentage of estimated consumption	100	100	100	100	100

Recycling: Only small amounts of indium are recycled because there is an adequate supply of primary indium as a byproduct of zinc smelting. Compared with previous years, however—when recycling occurred only if the price of indium was very high and/or increasing rapidly—recycling of both new and old scrap is becoming more noteworthy. Most of indium is recycled by countries that have inadequate zinc resources and are dependent on imported zinc, decreasing the possibility of primary indium production. For example, about 42% of Japanese indium consumption is derived from secondary sources, mostly of domestic origin. Recycling of new scrap, the scrap from fabrication of indium products, is only now gaining acceptance in the United States.

Import Sources (1998-2001): China, 40%; Canada, 30%; France, 10%; Russia, 9%; and other, 11%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
Unwrought indium	8112.92.3000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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INDIUM

Events, Trends, and Issues: Estimated domestic indium consumption increased by about 15% to 75 metric tons in 2002. After 3 years of relative stability, the annual average price of indium dropped considerably in 2000 and 2001 and then increased slightly in 2002. Expanding LCD manufacture kept demand strong for indium-tin oxide, and the use of indium phosphide for semiconductors could increase worldwide demand for indium. The ready availability of low-priced indium from China—with increases in capacity, production, and purity—kept world prices down. The long range outlook for the indium market remains promising despite possible near term market fluctuations caused by economic uncertainties.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production[e]		Reserves[3]	Reserve base[3]
	2001	2002		
United States	—	—	300	600
Belgium	40	40	([4])	([4])
Canada	45	45	700	2,000
China	100	85	280	1,300
France	65	65	([4])	([4])
Japan	55	60	100	150
Peru	5	5	100	150
Russia	15	15	200	300
Other countries	20	20	800	1,500
World total (may be rounded)	345	335	2,500	6,000

World Resources: Indium occurs predominantly in solid solution in sphalerite, a zinc-sulfide ore mineral. Large 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. — Zero.
[1]Prepared by Jozef Plachy.
[2]Defined as imports - exports + adjustments for Government and industry stock changes; exports were assumed to be no greater than the difference between imports and consumption.
[3]Estimate based on the indium content of zinc ores. See Appendix C for definitions.
[4]Reserves and reserve base for this country and other European nations are included with "Other countries."

IODINE

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

Domestic Production and Use: Iodine produced in 2002 from three companies operating in Oklahoma accounted for 100% of the elemental iodine value estimated at $18 million. The operation at Woodward, OK, continued production of iodine from subterranean brines. A second company operated a miniplant in Kingfisher County, OK, using waste brine associated with oil. A third company continued production at Vici, OK, for domestic use and export to Germany. Of the consumers that participate in the annual survey, 24 plants reported consumption of iodine in 2001. Major consumers were located in the Eastern United States. December published prices of crude iodine in drums ranged between $13 and $14 per kilogram. The average value of iodine imports through September was $12.78 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:	1998	1999	2000	2001	2002[e]
Production	1,490	1,620	1,470	1,290	1,700
Imports for consumption, crude content	5,960	5,430	5,110	5,370	6,080
Exports	2,790	1,130	886	1,480	790
Shipments from Government stockpile excesses	291	221	949	83	27
Consumption:					
Apparent	4,950	5,990	5,420	5,263	7,020
Reported	4,100	4,540	3,990	3,620	NA
Price, average c.i.f. value, dollars per kilogram, crude	16.45	16.15	14.59	13.94	12.78
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, number	40	40	30	30	30
Net import reliance[1] as a percentage of apparent consumption	70	62	77	73	76

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

Import Sources (1998-2001): Chile, 67%; Japan, 22%; and Russia, 10%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Iodine, crude	2801.20.0000	Free.
Iodide, calcium or of copper	2827.60.1000	Free.
Iodide, potassium	2827.60.2000	2.8% ad val.
Iodides and iodide oxides, other	2827.60.5000	4.2% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: In October, the Defense National Stockpile Center announced the fiscal year 2003 Annual Materials Plan would include sales of 454 tons (1,000,000 pounds) of crude iodine.

Stockpile Status—9-30-02[2]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Stockpile-grade	1,674	12	1,674	454	27

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IODINE

Events, Trends, and Issues: Chile was the largest producer of iodine in the world, and production was a coproduct from surface mineral deposits used to produce nitrate fertilizer. The two of the largest companies in the world are located in Chile. The largest company in Chile was owned 37.5% each by a Canadian company and a Chilean company. An 18% portion of the Chilean company was owned by a Norwegian company. Product from the second largest company in the world was marketed exclusively by a United States company. Japan was the second largest producer and its production was associated with gas brines.

A Canadian company in a joint venture with an existing Chilean iodine producer constructed a plant to produce iodine from nitrate deposits in the Atacama Desert of Chile. The plant came online in April 2001. Full first-phase production of 720 tons of iodine was achieved in January 2002. Sales in July 2002 were reported to be in excess of $1.5 million. The company continued to expand its evaporation ponds during 2002 as part of an expansion plan for iodine, potassium nitrate, and sodium sulfate, which will increase iodine production to 1,100 tons per year.

The largest inorganic chemical complex in Asia at Mithapur, Gujarat, India, continued to produced iodized vacuum salt and was the largest producer of iodized salt in India. The Boyadag and Balkan iodine plants in western Turkmenistan were reported to be extracting iodine from waters associated with oil and gas fields. The former Cheleken plant in Turkmenistan is now the Khazar chemical plant, with iodine production of 40 tons per year.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for China have been significantly decreased based on new information from that country.

	Mine production		Reserves[3]	Reserve base[3]
	2001	2002[e]		
United States	1,290	1,700	250,000	550,000
Azerbaijan	300	300	170,000	340,000
Chile	10,500	10,500	9,000,000	18,000,000
China	500	500	4,000	120,000
Indonesia	75	75	100,000	200,000
Japan	6,100	6,100	4,900,000	7,000,000
Russia	300	300	120,000	240,000
Turkmenistan	150	150	170,000	350,000
World total (rounded)	19,200	19,600	15,000,000	27,000,000

World Resources: In addition to the fields listed in the reserve base, seawater contains 0.05 part per million iodine, or approximately 34 million tons. Seaweeds of the Laminaria family are able to extract and accumulate up to 0.45% iodine on a dry basis. Although not as economical as the production of iodine as a byproduct of gas, 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.

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 two other States in 2002 was estimated at $1.2 billion. Eleven iron ore production complexes with 11 mines, 8 concentration plants, and 8 pelletizing plants were in operation during the year. The mines included 11 open pits and no underground operations. Virtually all ore was concentrated before shipment. Eight mines operated by five companies accounted for 99% of production. The United States produced 4% of the world's iron ore output and consumed about 6%.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production, usable	62.9	57.7	63.1	46.2	50.0
Shipments	63.2	60.7	61.0	50.6	50.0
Imports for consumption	16.9	14.3	15.7	10.7	10.0
Exports	6.0	6.1	6.1	5.6	6.0
Consumption:					
Reported (ore and total agglomerate)[3]	78.2	75.1	76.5	67.3	60.0
Apparent	71.1	70.1	70.2	62.0	56.0
Price,[4] U.S. dollars per metric ton	31.14	25.52	25.57	23.87	23.00
Stocks, mine, dock, and consuming plant, yearend, excluding byproduct ore	30.6	26.4	28.8	18.0	16.0
Employment, mine, concentrating and pelletizing plant, quarterly average, number	7,290	6,820	6,814	5,017	5,000
Net import reliance[5] as a percentage of apparent consumption (iron in ore)	12	18	10	28	11

Recycling: None.

Import Sources (1998-2001): Canada, 49%; Brazil, 38%; Australia, 5%; Venezuela, 3%; and other, 5%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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, as an example, steelmaking accounts for about 98% of iron ore consumption. Annual world production of iron ore is usually about a billion tons and, although iron ore was produced in about 50 countries, the 7 largest of these countries produced more than 80% of the world total, and no other country had as much as a 5% share.

A large portion, about 475 million tons per year, of world iron ore production is exported because much iron ore is not consumed in the country in which it is produced. Australia and Brazil, for example, rank first and second, respectively, in world production (Fe content) but 6th and 15th, respectively, in pig iron production (China produces more ore than any other nation, but its ore is low grade). The vast majority of exports are seaborne.

Iron ore consumption data are available for the United States, but not for the rest of the world. Because almost all iron ore is consumed in blast furnaces, the product of the blast furnace, pig iron, is used as the indicator of iron ore consumption. Iron ore consumption, as well as production, is concentrated in a few countries. Pig iron production also is concentrated in a few countries. Pig iron was produced in more than 50 countries with the top 5 pig iron producing countries accounting for almost 60% of world production. No other country has as much as 5%. World pig iron production was about 580 metric million tons in 2001.

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IRON ORE

China has been the world's largest iron ore consuming nation since 1992 and, in recent years, has attained a dominant position. In 1990, Japan, China, and the United States, in that order, were the largest consumers. From 1990 through 2001, United States annual apparent consumption of iron ore fell from 71 million tons to 51 million tons. For that same period, Japan's apparent consumption increased slightly, rising from 125 million tons to 126 million tons. China's apparent consumption of iron ore, however, rose from 98 million tons to 194 million tons, a 97% increase. Chinese iron ore imports have also grown enormously, rising from 41 million tons in 1995 to 92 million tons in 2001. Moreover, Chinese consumption is expected to continue growing. According to various forecasts by organizations in the iron ore industry and the iron and steel industry, Chinese annual imports in 2005 should be at least 45 million tons higher than the 92 million tons imported in 2001.

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

	Mine production		Crude ore		Iron content	
	2001	2002[e]	Reserves	Reserve base	Reserves	Reserve base
United States	46	50	6,900	15,000	2,100	4,600
Australia	180	190	18,000	40,000	11,000	25,000
Brazil	210	220	7,600	19,000	4,800	12,000
Canada	29	35	1,700	3,900	1,100	2,500
China	220	230	21,000	46,000	7,000	15,000
India	79	80	6,600	9,800	4,200	6,200
Kazakhstan	14	16	8,300	19,000	3,300	7,400
Mauritania	10	10	700	1,500	400	1,000
Russia	83	88	25,000	56,000	14,000	31,000
South Africa	35	37	1,000	2,300	650	1,500
Sweden	20	20	3,500	7,800	2,200	5,000
Ukraine	55	60	30,000	68,000	9,000	20,000
Other countries	78	80	17,000	38,000	10,000	23,000
World total (rounded)	1,060	1,100	150,000	330,000	70,000	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]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 $57 billion. The steel industry consisted of about 90 companies that produced raw steel at about 139 locations, with combined raw steel production capability of about 114 million tons. Indiana accounted for about 22% of total raw steel production, followed by Ohio, 14%, Michigan, 7%, and Pennsylvania, 7%. Pig iron was produced by 11 companies operating integrated steel mills, with about 33 blast furnaces in continuous operation. The distribution of steel shipments was estimated as follows: Warehouses and steel service centers, 24%; transportation (predominantly for automotive production), 14%; construction, 16%; cans and containers, 3%; and others, 43%. Ferrous foundries, numbering about 1,100, continued to be importers of pig iron into the United States, mainly from Brazil, Russia, and Ukraine.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Pig iron production[2]	48.2	46.3	47.9	42.1	39.4
Steel production:	98.6	97.4	102	90.1	92.0
Basic oxygen furnaces, percent	54.9	53.7	53.0	52.6	49.0
Electric arc furnaces, percent	45.1	46.3	47.0	47.4	51.0
Continuously cast steel, percent	95.5	95.9	96.4	97.2	97.2
Shipments:					
Steel mill products	92.9	96.3	99	89.7	89.6
Steel castings[3]	1.3	1.2	1.0	0.8	1.0
Iron castings[3]	9.8	9.8	9.4	8.3	9.0
Imports of steel mill products	37.7	32.4	34.4	27.3	28.3
Exports of steel mill products	5.0	4.9	5.9	5.6	5.3
Apparent steel consumption[4]	118	116	119	107	107
Producer price index for steel mill products (1982=100)[5]	113.8	105.3	108.4	101.3	102.3
Steel mill product stocks at service centers yearend[6]	7.7	7.7	7.8	7.1	7.3
Total employment, average, number[7]					
Blast furnaces and steel mills	160,000	153,000	151,000	141,000	140,000
Iron and steel foundries[e]	133,000	127,000	125,000	117,000	116,000
Net import reliance[8] as a percentage of apparent consumption	22	17	18	16	14

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

Import Sources (1998-2001): European Union, 19%; Canada, 14%; Japan, 10%; Mexico, 9%; and other, 48%.

Tariff: Item	Number	Normal Trade Relations[9] 12/31/02	Mexico 12/31/02
Pig iron	7201.10.0000	Free	Free.
Carbon steel:			
Semifinished	7207.12.0050	0.8% ad val.	0.4% ad val.
Structural shapes	7216.33.0090	0.2% ad val.	Free.
Bars, hot-rolled	7213.20.0000	0.4% ad val.	0.1% ad val.
Sheets, hot-rolled	7208.39.0030	1.0% ad val.	0.4% ad val.
Hot-rolled, pickled	7208.27.0060	1.0% ad val.	0.5% ad val.
Cold-rolled	7209.18.2550	0.6% ad val.	0.3% ad val.
Galvanized	7210.49.0090	1.3% ad val.	0.6% ad val.
Stainless steel:			
Semifinished	7218.91.0015	1.0% ad val.	0.5% ad val.
	7218.99.0015	1.0% ad val.	0.5% ad val.
Bars, cold-finished	7222.20.0075	2.1% ad val.	1.0% ad val.
Pipe and tube	7304.41.3045	1.5% ad val.	Free.
Cold-rolled sheets	7219.33.0035	2.0% ad val.	1.0% ad val.

Depletion Allowance: Not applicable.

Government Stockpile: None.

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IRON AND STEEL

Events, Trends, and Issues: During the first 7 months of 2002, monthly pig iron production fluctuated near 3.6 million tons and monthly raw steel production fluctuated near 8.2 million tons. Production totals during these periods decreased about 12% for pig iron and 4% for steel from those of 2001. Shipments of steel mill products during the first 5 months of 2002 were down 3% compared with those of 2001. Raw steel production was beginning an upward trend during the second half of 2002.

The U.S. steel industry has been seriously distressed since the Asian financial crisis of 1998. By early 2002, about 29 U.S. steel companies were bankrupt and 13 integrated and non-integrated steelmakers closed. Two of the companies, Bethlehem Steel Corp. and LTV Steel Corp., represent about half of the steelmaking capacity and jobs in the industry. Excessive steel importation allegedly has adversely affected the income of U.S. integrated steelmakers and their ability to pay health and pension benefits to retired workers.

The International Trade Commission's (ITC) Section 201 investigation under the Trade Act of 1974 determined that the U.S. steel industry has been significantly harmed by excessive steel importation. The ITC decided that U.S. makers of 16 of 33 steel product categories were injured by imports and these 16 products were eligible for trade restraints. Before the Section 201 investigation, the U.S. industry had filed 159 antidumping and countervailing duty cases to combat alleged unfair trade practices and succeeded in getting as much as 79% of steel imports under antidumping orders. ITC recommendations in December 2001 led to a March 2002 imposition of 8% to 30% duties on a wide range of products; the action led to a protectionist movement among foreign countries to repel cheaper steel no longer allowed in the United States.

World Production:

	Pig iron		Raw steel	
	2001	2002[e]	2001	2002[e]
United States	42.1	39.4	90.1	90.0
Brazil	27.8	28.0	27.5	27.0
China	145	160	149	170
European Union	91.9	84.7	161	161
Japan	78.8	80.5	103	106
Korea, Republic of	25.9	26.0	43.9	44.0
Russia	45.0	46.0	59.0	57.8
Ukraine	26.4	27.0	33.1	33.5
Other countries	98.0	110	180	180
World total (may be rounded)	581	600	851	870

World Resources: Not applicable. See Iron Ore.

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

[e]Estimated.
[1]Production and shipments data source is the American Iron and Steel Institute; see also Iron Ore and Iron and Steel Scrap.
[2]More than 95% of iron made is transported molten to steelmaking furnaces located at the same site.
[3]U.S. Department of Commerce, Census Bureau.
[4]Defined as steel shipments + imports - exports + adjustments for industry stock changes + adjustment for imports of semifinished steel products.
[5]Bureau of Labor Statistics.
[6]Steel Service Center Institute.
[7]Bureau of Labor Statistics. Blast furnaces and steel mills: SIC 3312; Iron and steel foundries: NAICS 331511.
[8]Defined as imports - exports + adjustments for Government and industry stock changes.
[9]No tariff for Canada, Israel, and certain Caribbean and Andean nations.

IRON AND STEEL SCRAP[1]

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

Domestic Production and Use: Total value of domestic purchases (receipts of ferrous scrap by all domestic consumers from brokers, dealers, and other outside sources) and exports was estimated at $5.7 billion in 2002, up about 30% from that of 2001. 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 2002 was an estimated 92 million tons, about the same as that of 2001; capacity utilization exceeded that of 2001. Net shipments of steelmill products were estimated at about 90.7 million tons compared with 89.7 million tons for 2001. The domestic ferrous castings industry shipped an estimated 9 million tons of all types of iron castings in 2002 and an estimated 1.0 million tons of steel castings, including investment castings.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production:					
Home scrap	20	19	20	18	14
Purchased scrap[2]	56	53	56	55	58
Imports for consumption[3]	3	4	4	3	3
Exports[3]	6	6	6	7	9
Consumption, reported	73	71	74	71	72
Price, average, dollars per metric ton delivered, No. 1 Heavy Melting composite price, Iron Age Average, Pittsburgh, Philadelphia, Chicago	104.07	90.98	92.61	73.84	85.00
Stocks, consumer, yearend	5.2	4.8	5.3	4.9	4.3
Employment, dealers, brokers, processors, number[4]	37,000	37,000	37,000	37,000	37,000
Net import reliance[5] as a percentage of reported consumption	E	E	E	E	E

Recycling: Recycled iron and steel scrap is a vital raw material for the production of new steel and cast iron products. The steel and foundry industries in the United States have been structured to recycle scrap, and, as a result, are highly dependent upon scrap. The steel industry in North America has been recycling steel scrap for over 200 years. The automotive recycling industry alone recycled about 14 million vehicles in 2001 through more than 200 car shredders to supply more than 14 million tons of shredded steel scrap to the steel industry for recycling. More than 12,000 vehicle dismantlers throughout North America resell parts. In the United States alone, an estimated 72 million tons of steel was recycled in steel mills and foundries in 2002. 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 29% home scrap (recirculating scrap from current operations), 23% prompt scrap (produced in steel-product manufacturing plants), and 48% post-consumer (old) scrap.

Import Sources (1998-2001): Canada, 59%; United Kingdom, 19%; Netherlands, 5%; Sweden, 5%; and other, 12%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
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: Although the official end of the longest economic expansion in U.S. history was in March 2001, according to the National Bureau of Economic Research, industrial production had been declining since June 2000, and by the end of 2000, the U.S. scrap metal industry was seriously concerned. Decreasing demand for vehicles and consumer goods and the steel to make them caused U.S. manufacturing operating capacity to decline during 2001—a year of recession for the U.S. and the global economies, which adversely affected the steelmaking and ferrous scrap industries. Optimism about the timing and strength of any recovery during 2002 was not strong throughout the U.S. scrap industry, although scrap prices and steel mill capacity utilization were increasing relative to those of 2001.

Ferrous scrap prices were higher, on average, during 2002 than in 2001. 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 $85 per metric ton in 2002. As reported by Iron Age Scrap Price Bulletin, the average price for nickel-bearing stainless steel scrap delivered to purchasers in Pittsburgh was about $695 per ton in 2002, which was significantly higher than the 2001 average price of $652 per ton. Exports of ferrous scrap increased from 7.4 million tons during 2001 to about 9.2 million tons in 2002. Export scrap value increased from $0.5 billion in 2001 to an estimated $1.3 billion in 2002.

In the United States, the primary source of obsolete steel scrap is the automobile. The recycling rate for automobiles in 2001, the latest year for which statistics are available, was 102%. The recycling rates for appliances and steel cans in 2001 were 85% and 58%, respectively. Recycling rates for construction materials in 2001 were about 95% for plates and beams and 48% for rebar and other materials. The recycling rates for appliance, can, and construction steel are expected to increase not only in the United States, but also in emerging industrial countries. As environmental regulations increase, recycling becomes more profitable and convenient, and public interest in recycling continues to grow.

World Mine Production, Reserves, and Reserve Base: Iron and steel scrap is not a mined material, and world production data for iron and steel scrap are not available. However, it is estimated that annual output is about 404 million tons, based on world steel production.

World Resources: Not applicable.

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

[e]Estimated. E Net exporter.
[1]See also Iron Ore and Iron and Steel.
[2]Receipts - shipments by consumers + exports - imports.
[3]Includes used rails for rerolling and other uses, and ships, boats, and other vessels for scrapping.
[4]Estimated, based on 1992 Census of Wholesale Trade.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.

IRON AND STEEL SLAG

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Ferrous slags are valuable coproducts of ironmaking and steelmaking. In 2001, about 19 million tons of domestic iron and steel slag, valued at about $165 million[1] (f.o.b.), were consumed. Iron or blast furnace slag accounted for about 65% of the tonnage sold and was worth about $127 million. Steel slag, produced from basic oxygen, electric arc, and open hearth furnaces[2] accounted for the remainder. There were 18 slag-processing companies servicing either iron and steel or just steel facilities at about 100 locations, iron slag at about 30 sites in a dozen States, and steel slag at about 90 sites in about 30 States. The north-central region (Illinois, Indiana, Michigan, and Ohio) accounted for 58% of blast furnace slag sold or used in the United States, and the mid-Atlantic region (Maryland, New York, Pennsylvania, and West Virginia) accounted for 30% of the sales.

The major uses of iron slag were for road bases, 33%; asphaltic aggregates 23%; cement and concrete applications, 22%; and fill, 7%. Steel slags were mainly used for road bases, 37%; fill, 22%; and asphaltic aggregates, 22%. About 79% of iron and steel slag shipments was by truck, generally to customers within approximately 80 kilometers of the plant. Waterway and rail transport accounted for about 15% and 6% of shipments, respectively; these shipments were to more distant markets.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, marketed[3]	18,400	17,000	16,300	16,900	16,500
Imports for consumption	700	920	1,200	2,600	2,500
Exports	10	12	20	([4])	([4])
Consumption, apparent[5]	19,000	18,000	20,200	19,500	19,000
Price average value, dollars per ton, f.o.b. plant	8.00	8.80	8.60	8.05	8.10
Stocks, yearend	NA	NA	NA	NA	NA
Employment, number[e]	2,700	2,750	2,750	2,700	2,700
Net import reliance[6] as a percentage of apparent consumption	4	5	10	8	6

Recycling: Ferrous slags are viewed as valuable byproducts of ironmaking and steelmaking. Apart from the large outside markets for slag in the construction sector, some iron and steel slags are used in the furnaces as 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 (1998-2001): Year-to-year import data for ferrous slags show variations in both tonnage and unit value; most of the data contain unresolved discrepancies. Slag was imported from 1998 to 2001 mainly from Italy, Japan, Canada, and Brazil; prior sources were mainly Canada and Japan. Data, estimated for 2002 only, are Italy, 37%; Japan, 27%; Canada, 14%; and other, 22%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
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: In the construction sector, natural aggregates are the main competitors of iron and steel slag. Where crushed stone or sand and gravel are readily available and reasonably priced, iron and steel slag typically are not preferred. Demand for granulated blast furnace slag (as a pozzolan or cement additive) has been increasing steadily in the United States. This material makes up the bulk of slag imports. The future availability of iron slag in the United States may show a decline owing to closing of aging blast furnaces. No new blast furnaces are under construction or planned. Domestic decline, if it takes place, will be balanced by increased imports. Iron and steel slag has 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 in keeping iron and steel slag exempt from such regulation. No new Government regulation is pending.

World Mine Production, Reserves, and Reserve Base: Slag is not a mined material. Production data for the world are unavailable, but it is estimated that annual world iron and steel slag output is on the order of 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; about 2 million tons of fly is ash used in cement manufacture, either as raw feed or cement additive.

[e]Estimated. NA Not available.

[1]The reported value of $157 million (obtained from annual survey of processors) represents the quantities sold rather than processed; it excludes the value of any entrained metal that may be recovered during slag processing and returned to 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 2002.

[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]Less than ½ unit.

[5]Defined as production + imports - exports.

[6]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. Another company produced synthetic mullite in Georgia. Of the kyanite-mullite output, 90% was estimated to have been used in refractories and 10% in other uses. Of the refractory usage, an estimated 60% to 65% was used in ironmaking and steelmaking and the remainder in the manufacture of chemicals, glass, nonferrous metals, and other materials.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production:					
Mine[e]	90	90	90	90	90
Synthetic mullite[e]	39	39	40	40	40
Imports for consumption (andalusite)	10	6	6	3	5
Exports[e]	35	35	35	35	35
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent[e]	104	100	101	100	100
Price, average, dollars per metric ton:					
U.S. kyanite, raw	157	158	165	165	165
U.S. kyanite, calcined	267	268	279	279	279
Andalusite, Transvaal, South Africa, 57%[1] Al_2O_3	190	200	161	162	176
Andalusite, Transvaal, South Africa, 58%[2] Al_2O_3	230	225	189	210	206
Stocks, producer	NA	NA	NA	NA	NA
Employment, kyanite mine and plant, number[e]	150	150	150	150	150
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1998-2001): South Africa, 100%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Andalusite, kyanite, and sillimanite	2508.50.0000	Free.
Mullite	2508.60.0000	Free.

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

Government Stockpile:

Stockpile Status—9-30-02[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Kyanite, lump	0.1	—	0.1	—	—

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KYANITE AND RELATED MINERALS

Events, Trends, and Issues: Consumption of kyanite and related minerals has decreased somewhat, partly because of an overall decline in refractory raw materials consumption. Higher performance refractory products are lasting longer. Consumption of refractories in steelmaking, the largest end-use market, has decreased in the last two decades from about 20 to 25 kilograms per ton of steel produced to 10 kilograms per ton.[5]

In South Africa, the market for andalusite also has experienced some decrease. Reasons for this include changes in slag types and temperatures in new metal making technology and the use of imported Chinese refractory products. Another example of changed refractory requirements was a steel plant in the Netherlands, where alumina spinel rather than andalusite bricks was used in steel ladles for the production of a certain type of steel. However, this was not seen to be an overall industry trend from andalusite to alumina spinel.[5]

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[6]
	2001	2002[e]	
United States	[e]90	90	Large in the United States. South Africa reports reserve base of about 51 million tons of aluminosilicates ore (andalusite and sillimanite).
France	65	65	
India	19	20	
South Africa	[e]170	170	
Other countries	11	10	
World total	355	355	

World Resources: Large resources of kyanite and related minerals are known to exist in the United States. The chief resources are in deposits of micaceous schist and gneiss mostly in the Appalachian Mountains area and in Idaho. Other resources are in aluminous gneiss in southern California. These resources are not economical to mine at present, 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. — Zero.
[1]From 1998-99, 57.5% Al_2O_3.
[2]From 1998-99, 59.5% Al_2O_3.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]O'Driscoll, Mike, 2002, Irons in the fire: Industrial Minerals, no. 417, June, p. 45.
[6]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 2002, based on the average U.S. producer price, was $415 million. Six lead mines in Missouri plus lead-producing mines in Alaska, Idaho, and Montana yielded most of the total. Primary lead was processed at two smelter-refineries in Missouri. Of the 24 plants that produced secondary lead, 15 had annual capacities of 15,000 tons or more and accounted for more than 99% of secondary production. Lead was consumed at about 130 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:	1998	1999	2000	2001	2002[e]
Production:					
Mine, lead in concentrates	493	520	465	466	450
Primary refinery	337	350	341	290	260
Secondary refinery, old scrap	1,060	1,060	1,080	1,050	1,040
Imports for consumption, lead in concentrates	33	12	31	2	5
Exports, lead in concentrates	72	94	117	181	120
Imports for consumption, refined metal, wrought and unwrought	275	323	366	284	255
Exports, refined metal, wrought and unwrought	40	37	49	35	30
Shipments from Government stockpile excesses, metal	50	61	32	41	30
Consumption:					
Reported	1,630	1,680	1,720	1,590	1,510
Apparent	1,690	1,760	1,740	1,650	1,580
Price, average, cents per pound:					
North American Producer	45.3	43.7	43.6	43.6	44
London Metal Exchange	24.0	22.8	20.6	21.6	21
Stocks, metal, producers, consumers, yearend	89	91	124	100	80
Employment:					
Mine and mill (peak), number	1,200	1,100	1,100	1,100	900
Primary smelter, refineries	450	450	450	400	320
Secondary smelters, refineries	1,800	1,700	1,700	1,600	1,600
Net import reliance[1] as a percentage of apparent consumption	18	20	18	19	18

Recycling: About 1.1 million tons of secondary lead were produced, an amount equivalent to 69% of domestic lead consumption. Nearly all of it was recovered from old (post-consumer) scrap. About 1 million tons (equivalent to 63% of domestic lead consumption) was recovered from used batteries alone.

Import Sources (1998-2001): Lead in concentrates: Peru, 26%; Mexico, 18%; Canada, 8%; Australia, 3%; and other, 45%. Metal, wrought and unwrought: Canada, 62%; Mexico, 10%; Australia, 6%; Peru, 2%; and other, 20%. Total lead content: Canada, 60%; Mexico, 11%; Australia, 6%; Peru, 3%; and other, 20%.

Tariff: Item	Number	Normal Trade Relations[2] 12/31/02
Unwrought (refined)	7801.10.0000	2.5% ad val.

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

Government Stockpile:

Stockpile Status—9-30-02[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Lead	164	14	164	54	17

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LEAD

Events, Trends, and Issues: During 2002, the price for refined lead decreased in the United States and world markets. The average North American Producer and London Metal Exchange prices for the first 9 months of the year were 0.1% and 3.7%, respectively, below the averages for the previous year. Worldwide demand for lead remained essentially unchanged in 2002, as the decline in demand for batteries, particularly in the United States, was countered by rising demand for batteries and other lead products in Asia, driven mainly by further industrial growth in China. Total output of refined lead worldwide decreased by about 1% in 2002. Production cutbacks in Europe, Japan, and the United States were nearly offset by increases in production of lead in Australia, Canada, and the Republic of Korea. A modest excess of refined lead was anticipated in the industrialized world in 2002, according to a report issued by the International Lead and Zinc Study Group at its 47th Session in Stockholm, Sweden, in October.

U.S. mine production declined by about 3% as a result of temporary closures or production cutbacks, prompted mainly by the continuation of low prices for lead during the year, and secondary refinery production declined by about 1%. U.S. apparent consumption of lead decreased by about 7% compared with the previous year, as economic recovery continued at a slow pace. Consequently, the demand for industrial-type lead acid batteries declined further as a result of stalled investment plans in the telecommunications industry. Demand for automotive-type batteries in new vehicles also remained weak; however, the decline in demand was countered somewhat by sales incentives provided by the automobile producers. In addition, demand for replacement batteries in automobiles and light trucks was slowed by the lack of sustained temperature extremes that would have increased automotive battery failures.

A major U.S. producer of recycled lead and manufacturer of lead acid batteries received approval in May from the U.S. Bankruptcy Court to use its $250 million debtor-in-possession financing facility to fund normal operations and to pay obligations to employees and suppliers. The company had filed for Chapter 11 bankruptcy protection in mid-April. Also, bondholders for a major U.S. producer of refined lead accepted an arrangement in October that would secure additional financing and enable the company to restructure its outstanding debt. The holders of notes due in 2003 and 2005 could either exchange the notes for new ones or return them for cash, at a reduced value.

A lead industries association, founded in 1928, closed down in April and filed for Chapter 7 bankruptcy liquidation. According to an official, the association closed because of "a lack of insurance to cover litigation in which the association had been a defendant starting 14 years ago." Also, the association had accumulated additional litigation in recent years, most being related to lead in paint, in which the association was named as one of many defendants.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for China, Kazakhstan, and Peru have been revised upward based on new information from official country sources.

	Mine production		Reserves[4]	Reserve base[4]
	2001	2002[e]		
United States	466	450	8,100	20,000
Australia	714	715	15,000	28,000
Canada	149	100	2,000	9,000
China	600	650	11,000	36,000
Kazakhstan	38	38	5,000	7,000
Mexico	135	140	1,500	2,000
Morocco	83	80	500	1,000
Peru	271	295	3,500	4,000
South Africa	51	49	2,000	3,000
Sweden	95	36	500	1,000
Other countries	480	345	19,000	30,000
World total (rounded)	3,100	2,900	68,000	140,000

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

Substitutes: Substitution of plastics has reduced the use of lead in building construction, electrical cable covering, cans, and containers. Aluminum, 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 Mexico and Canada 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 2002, 18.4 million metric tons (20.3 million short tons) of quicklime and hydrate was produced (excluding commercial hydrators) in 34 States and Puerto Rico. Production was valued at about $1.18 billion, an apparent increase of about $20 million from 2001 levels. Five companies accounted for about 70% of the total output. Principal producing States, each with production over 1 million tons, were Alabama, Kentucky, Missouri, Nevada, Ohio, Pennsylvania, and Texas. These seven States produced about 11.6 million tons (12.8 million short tons), or 63% of the total output. Major markets for lime were steelmaking, flue gas desulfurization, mining, construction, pulp and paper, precipitated calcium carbonate, and water treatment.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production[3]	20,100	19,700	19,600	18,900	18,400
Imports for consumption	231	140	113	115	176
Exports	56	59	73	96	101
Consumption, apparent	20,300	19,800	19,600	19,000	18,500
Quicklime average value, dollars per ton at plant	57.60	57.30	57.50	58.10	60.60
Hydrate average value, dollars per ton at plant	78.90	80.20	85.00	80.70	90.00
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and plant, number	5,600	5,600	5,600	5,500	5,400
Net import reliance[4] as a percentage of apparent consumption	1	([5])	([5])	([5])	([5])

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

Import Sources (1998-2001): Canada, 89%; Mexico, 9%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Quicklime	2522.10.0000	Free.
Slaked lime	2522.20.0000	Free.
Hydraulic lime	2522.30.0000	Free.
Calcined dolomite	2518.20.0000	3% ad. val.

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

Government Stockpile: None.

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LIME

Events, Trends, and Issues: In response to recommendations made by the U.S. International Trade Commission, as part of a Section 201 investigation under the Trade Act of 1974, the President imposed tariffs for 3 years ranging from 8% to 30% on various types of imported steel, excluding imports from free-trade partners. As a result of the protections supplied by the tariffs, according to weekly statistics of the American Iron and Steel Institute, adjusted year-to-date steel production through October 28, 2002, increased by 4.8% compared with the same period in 2001. The capability utilization rate of steel mills was 90.1% compared with 76.8% in the same period in 2001. This higher rate of utilization despite the modest gains in production indicates that a significant amount of steelmaking capacity has been lost or is idle. The steel industry is lime's largest market at about 29% of consumption.

World Lime Production and Limestone Reserves and Reserve Base:

	Production		Reserves and reserve base[6]
	2001	2002[e]	
United States	18,900	18,400	Adequate for all countries listed.
Belgium	1,750	1,700	
Brazil	6,270	6,300	
Canada	2,550	2,200	
China	22,000	23,000	
France	2,400	2,400	
Germany	7,000	7,000	
Italy[7]	3,500	3,500	
Japan (quicklime only)	8,100	7,500	
Mexico	6,500	6,500	
Poland	2,200	2,200	
Romania	1,700	1,700	
Russia	8,000	8,000	
South Africa (sales)	1,606	1,600	
United Kingdom	2,500	2,500	
Other countries	23,000	21,500	
World total (rounded)	118,000	116,000	

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

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

[e]Estimated. NA Not available.
[1]Data are for quicklime, hydrated lime, and refractory dead-burned dolomite. Excludes Puerto Rico, unless noted.
[2]To convert metric tons to short tons, multiply metric tons by 1.1023.
[3]Sold or used by producers.
[4]Defined as imports - exports + adjustments for Government and industry stock changes; stock changes are assumed to be zero for apparent consumption and net import reliance calculations.
[5]Less than ½ unit.
[6]See Appendix C for definitions.
[7]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:	**1998**	**1999**	**2000**	**2001**	**2002**[e]
Production	W	W	W	W	W
Imports for consumption	2,590	2,640	2,880	1,990	2,500
Exports	1,340	1,330	1,310	1,480	1,500
Consumption:					
Apparent	W	W	W	W	W
Estimated	2,800	2,800	2,800	1,400	1,600
Price, yearend, dollars per kilogram:					
Lithium carbonate	4.47	4.47	4.47	NA	NA
Lithium hydroxide, monohydrate	5.74	5.74	5.74	NA	NA
Employment, mine and mill, number[e]	100	100	100	100	100
Net import reliance[1] as a percentage of apparent consumption	E	<50%	>50%	<50%	>50%

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

Import Sources (1998-2001): Chile, 80%; Argentina, 16%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Other alkali metals	2805.19.0000	5.3% 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 with the costs for hard rock ores. Two brine operations in Chile dominate the world market; a facility at a brine deposit in Argentina produced lithium chloride and a limited quantity of lithium carbonate. Most of the lithium minerals mined in the world were consumed as ore concentrates rather than feedstock for lithium carbonate and other lithium compounds.

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

When a Chilean fertilizer producer entered the lithium carbonate market in 1997, it undercut 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 and 2001, although U.S. price lists are no longer published.

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

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

	Mine production		Reserves[2]	Reserve base[2]
	2001	2002[e]		
United States	W	W	38,000	410,000
Argentina[e]	200	200	NA	NA
Australia[e]	2,000	2,000	160,000	260,000
Bolivia	—	—	—	5,400,000
Brazil	220	220	190,000	910,000
Canada	700	700	180,000	360,000
Chile	6,800	6,800	3,000,000	3,000,000
China	2,400	2,400	540,000	1,100,000
Portugal	200	200	NA	NA
Russia[e]	2,000	2,000	NA	NA
Zimbabwe	700	560	23,000	27,000
World total (may be rounded)	[3]15,100	[3]15,100	4,100,000	11,000,000

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

Substitutes: Substitutes for lithium compounds are possible in manufactured glass, ceramics, greases, and batteries. Examples are sodic and potassic fluxes in ceramics and glass manufacture; calcium and aluminum soaps as substitutes for stearates in greases; and calcium, magnesium, mercury, and zinc as anode material in primary batteries. Lithium carbonate is not considered to be an essential ingredient in aluminum potlines. Substitutes for aluminum-lithium alloys as structural materials are composite materials consisting of boron, glass, or polymer fibers in engineering resins.

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix C for definitions.
[3]Excludes U.S. production.

MAGNESIUM COMPOUNDS[1]

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

Domestic Production and Use: Seawater and natural brines accounted for about 60% of U.S. magnesium compounds production. Magnesium oxide and other compounds were recovered from seawater by two companies in Delaware and Florida, from well brines by three companies in Michigan, and from lake brines by two companies in Utah. Magnesite was mined by one company in Nevada, brucite was mined by one company in Nevada and one company in Texas, and olivine was mined by two companies in North Carolina and Washington. About 65% of the magnesium compounds consumed in the United States was used for refractories. The remaining 35% was used in agricultural, chemical, construction, environmental, and industrial applications.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production	374	395	370	388	395
Imports for consumption	344	321	395	307	280
Exports	49	52	56	62	65
Consumption, apparent	669	664	709	634	610
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant, number[e]	600	550	450	450	450
Net import reliance[2] as a percentage of apparent consumption	44	41	48	39	35

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

Import Sources (1998-2001): China, 65%; Australia, 10%; Canada, 9%; Israel, 3%; and other, 13%.

Tariff:[3] Item	Number	Normal Trade Relations 12/31/02
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: Consumption of magnesia in refractory applications continued to decline in 2002, mainly because U.S. steel production declined. Although the drop in U.S. steel production from 2001 to 2002 was not as great as that in the previous year, steel production through July 2002 was 3.7% less than that in the first 7 months of 2002. One of the largest U.S. magnesia refractories manufacturers filed for chapter 11 bankruptcy in early 2002, although the company plans to reorganize and continue operating. Although the total quantity of magnesia imported from China declined, China remained the largest magnesia supplier to the United States.

The proposed 50,000-ton-per-year seawater magnesia plant in Western Australia, which was scheduled to be completed by 2004, was delayed because the magnesia market in Australia has not developed as quickly as expected. The magnesia was expected to be used as a neutralizing agent in the country's emerging lateritic nickel industry, but development of new lateritic nickel projects was behind schedule.

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

	Magnesite production		Magnesite reserves and reserve base[4]	
	2001	2002[e]	Reserves	Reserve base
United States	W	W	10,000	15,000
Australia	156	160	77,000	95,000
Austria	202	200	15,000	20,000
Brazil	81	80	45,000	65,000
China[e]	749	750	380,000	860,000
Greece	144	140	30,000	30,000
India	107	110	14,000	55,000
Korea, North[e]	288	290	450,000	750,000
Russia[e]	288	290	650,000	730,000
Slovakia[e]	288	100	41,000	319,000
Spain	156	150	10,000	30,000
Turkey	576	580	65,000	160,000
Other countries	132	130	390,000	440,000
World total (may be rounded)	[5]3,170	[5]2,980	2,100,000	3,600,000

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

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

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

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

MAGNESIUM METAL[1]

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: In 2002, magnesium was produced by one company in Utah by an electrolytic process that recovered magnesium from brines from the Great Salt Lake. The largest use for magnesium, which accounted for 46% of apparent consumption, was as a constituent of aluminum-base alloys that were used for packaging, transportation, and other applications. Structural uses of magnesium (castings and wrought products) accounted for 32% of domestic metal use. Desulfurization of iron and steel accounted for 13% of U.S. consumption of primary metal; use as a reducing agent in nonferrous metals production, 2%; and other uses, 7%.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
U.S. primary production capacity, yearend	145	80	83	45	45
Production:					
Primary	106	W	W	W	W
Secondary (new and old scrap)	77	86	82	66	65
Imports for consumption	83	91	91	69	90
Exports	35	29	24	20	27
Consumption:					
Reported, primary	107	131	104	96	100
Apparent	185	179	[2]160	[2]120	[2]120
Price, yearend:					
Metals Week, U.S. spot Western, dollars per pound, average	1.57	1.48	1.27	1.25	1.20
Metal Bulletin, European free market, dollars per metric ton, average	1,975	2,500	2,000	1,825	1,875
Stocks, producer and consumer, yearend	22	W	W	W	W
Employment, number[e]	700	700	700	375	375
Net import reliance[3] as a percentage of apparent consumption	25	38	43	44	54

Recycling: In 2002, about 27,000 tons of the secondary production was recovered from old scrap.

Import Sources (1998-2001): Canada, 42%; China, 20%; Russia, 16%; Israel, 11%; and other, 11%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Unwrought metal	8104.11.0000	8.0% ad val.
Unwrought alloys	8104.19.0000	6.5% ad val.
Wrought metal	8104.90.0000	14.8¢/kg on Mg content + 3.5% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: On June 4, a U.S. bankruptcy court gave final approval for the sale of the U.S. magnesium producer for $24 million. The company was purchased by the principal individual owner of the holding company that had owned the plant previously. The new owner planned to continue installing new electrolytic cells that are larger, more energy efficient, and generate fewer emissions and would increase the plant's capacity to 60,000 tons per year from its current level of 45,000 tons per year.

Two primary magnesium plants were closed in Europe during 2002—a 42,000-ton-per-year plant in Norway was closed in April and a 17,000-ton-per-year plant in France was closed in July. The plant in Norway continued to operate its casthouse. The casthouse has a capacity of 20,000 tons per year and was operating on imported pure metal from China and returned scrap from customers in Europe. The plant in France was expected to be converted into a 5,000-ton-per-year magnesium recycling operation, which would produce niche products including turnings and granules from scrap feedstock from France, Italy, and Spain. The antidumping duty on Chinese magnesium imported into the European Union was expected to be removed in 2003 because after the plant in France was closed, there was no domestic industry to protect.

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MAGNESIUM METAL

In Australia, owners of a proposed 97,000-ton-per-year primary magnesium plant in Queensland signed an engineering, procurement, and construction contract for an estimated $1 billion. Site clearing began in June, and initial magnesium production was scheduled for the end of 2004 with production at full capacity by the end of 2005. A feasability study was completed for a proposed plant in South Australia. The feasibility study recommended a 71,000-ton-per-year plant, with a capital cost of A$761 million and an operating cost of A$1.06 per pound (US$0.59 per pound). Construction of the proposed plant, based on Dow magnesium technology, would be completed in 28 months. Based on the result of the feasibility study, the company plans project financing in the range of A$250 to A$300 million. Another feasibility study for a 100,000-ton-per-year plant to recover magnesium from coal fly ash was completed. Capital cost of the plant was estimated to be A$857 million, and the direct operating cost would be A$0.705 per pound.

China continued to plan additional magnesium capacity at many of its existing plants and propose new magnesium plants. The expansions and new capacity were expected to add about 60,000 tons per year of production capacity for magnesium ingot and about 20,000 tons per year of alloy capacity by yearend. In Congo (Brazzaville), a memorandum of understanding was signed for a long-term power contract for a planned 60,000-ton-per-year primary magnesium project. The owners also signed an off-take agreement with a German firm whereby the company will market up to 100% of the magnesium and magnesium alloys produced at the plant. Because investors have shown no interest in financing the project, a proposal to construct a 50,000-ton-per-year plant to recover magnesium from asbestos tailings in Russia has been indefinitely postponed. Magnesium production is expected to restart by the end of 2002 at the Kalush plant in Ukraine. The plant's holding company plans to produce 500 tons of magnesium in December and 10,000 tons in 2003. The plant has been closed since 1999.

Production at a new 10,000-ton-per-year magnesium recycling plant in the Czech Republic began in May, and a 10,000-ton-per-year recycling plant began operating in China at the beginning of 2002. Construction of a 10,000-ton-per-year magnesium recycling plant in the Netherlands is scheduled to begin in the fourth quarter of 2002, with production to start about October 2003. Raw material for the plants will be mainly from European die casters.

New magnesium alloy components continued to be specified for applications in new North American-produced vehicles, including large components such as dashboard panels and instrument support panels. The automotive industry and the magnesium industry are working together to develop new magnesium alloys for higher wear applications.

World Primary Production, Reserves, and Reserve Base:

	Primary production 2001	Primary production 2002[e]
United States	W	W
Brazil	6	7
Canada	83	88
China	[e]200	210
France	4	—
Israel	32	35
Kazakhstan	16	19
Norway	36	10
Russia	[e]48	52
Yugoslavia	1	1
World total[5]	426	422

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.

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. W Withheld to avoid disclosing company proprietary data. — Zero.

[1]See also Magnesium Compounds.

[2]Rounded to two significant digits to protect proprietary data.

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

[4]See Appendix C for definitions.

[5]Excludes the United States.

MANGANESE

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

Domestic Production and Use: Manganese ore containing 35% or more manganese was not produced domestically in 2002. Manganese ore was consumed mainly by about 15 firms with plants principally in the Eastern United States and the Midwestern United States. Most ore consumption was related to steel production, directly in pig iron manufacture and indirectly through upgrading ore to ferroalloys and metal. Additional quantities of ore were used for such nonmetallurgical purposes as production of dry cell batteries, as an ingredient in plant fertilizers and animal feed, and as a colorant for brick. Manganese ferroalloys were produced at one smelter. Leading identifiable end uses of manganese were in products for construction, machinery, and transportation, which were estimated to be 29%, 11%, and 12%, respectively, of total manganese demand. Most of the rest went to a variety of other iron and steel applications. The value of domestic consumption, estimated from foreign trade data, was about $265 million.

Salient Statistics—United States:[1]	1998	1999	2000	2001	2002[e]
Production, mine[2]	—	—	—	—	—
Imports for consumption:					
Manganese ore	332	460	430	358	550
Ferromanganese	339	312	312	249	220
Silicomanganese[3]	346	301	378	269	200
Exports:					
Manganese ore	8	4	10	9	16
Ferromanganese	14	12	8	9	10
Shipments from Government stockpile excesses:[4]					
Manganese ore	97	76	63	37	27
Ferromanganese	37	35	33	2	13
Consumption, reported:[5]					
Manganese ore[6]	499	479	486	425	301
Ferromanganese	290	281	300	266	275
Consumption, apparent, manganese[7]	776	719	768	692	700
Price, average value, 46% to 48% Mn metallurgical ore, dollars per mtu cont. Mn, c.i.f. U.S. ports	2.40	2.26	2.39	2.44	2.30
Stocks, producer and consumer, yearend:					
Manganese ore[6]	163	172	226	138	161
Ferromanganese	26	40	31	25	21
Net import reliance[8] as a percentage of apparent consumption	100	100	100	100	100

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

Import Sources (1998-2001): Manganese ore: Gabon, 70%; South Africa, 10%; Australia, 9%; Mexico, 5%; and other, 6%. Ferromanganese: South Africa, 47%; France, 22%; Mexico, 8%; Australia, 8%; and other, 15%. Manganese contained in all manganese imports: South Africa, 31%; Gabon, 21%; Australia, 13%; Mexico, 8%; and other, 27%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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: An uncommitted inventory of 331,000 tons of nonstockpile-grade metallurgical ore is contained in the data tabulated, all of which was authorized for disposal.

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MANGANESE

Stockpile Status—9-30-02[9]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Battery:					
Natural ore	76	27	76	27	27
Synthetic dioxide	3	—	3	3	—
Chemical ore	84	29	84	36	50
Metallurgical ore	689	322	689	227	158
Ferromanganese, high-carbon	742	43	742	68	29
Electrolytic metal	2	0.2	2	2	2

Events, Trends, and Issues: Through September, steel production, the principal determinant of manganese demand, was at about the same record level globally as in 2000 and 2001, but it remained significantly down in the United States. However, ferromanganese prices in the United States trended upward from those at the end of 2001 owing to shortages in supply. Manganese ore prices decreased as a result of a decrease in the international benchmark price for metallurgical-grade ore set between Japan and major suppliers in June 2002. Manganese is an essential nutritional 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): Reserves and reserve base estimates for Brazil have been revised upward while estimates for India and South Africa have been revised downward based on information reported by the Governments of Brazil and India and the major manganese producers of South Africa.

	Mine production 2001	Mine production 2002[e]	Reserves[10]	Reserve base[10]
United States	—	—	—	—
Australia	948	890	32,000	82,000
Brazil	[e]1,430	1,500	25,000	52,000
China	[e]500	500	40,000	100,000
Gabon	[e]830	860	20,000	160,000
India	[e]600	630	15,000	33,000
Mexico	100	100	4,000	9,000
South Africa	1,479	1,300	18,000	[11]4,000,000
Ukraine	[e]930	960	140,000	520,000
Other countries	[e]750	860	Small	Small
World total (rounded)	[e]7,600	7,600	300,000	5,000,000

World Resources: Land-based resources are large but irregularly distributed; those of the United States are very low grade and have potentially high extraction costs. South Africa and Ukraine 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 Ukraine.

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

[e]Estimated. — Zero.
[1]Manganese content typically ranges from 35% to 54% for manganese ore and from 74% to 95% for ferromanganese.
[2]Excludes insignificant quantities of low-grade manganiferous ore.
[3]Imports more nearly represent amount consumed than does reported consumption; internal evaluation indicates that reported consumption of silicomanganese is considerably understated.
[4]Net quantity.
[5]Total manganese consumption cannot be approximated from consumption of manganese ore and ferromanganese because the ore is used to produce manganese ferroalloys and metal.
[6]Exclusive of ore consumed at iron and steel plants.
[7]Thousand tons, manganese content; based on estimates of average content for all significant components except imports, for which content is reported.
[8]Defined as imports - exports + adjustments for Government and industry stock changes.
[9]See Appendix B for definitions.
[10]See Appendix C for definitions.
[11]Includes inferred resources.

MERCURY[1]

(Data in metric tons of mercury content, unless otherwise noted)[2]

Domestic Production and Use: Recovery of mercury from obsolete or wornout items remains the principal 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, chloralkali 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 Western State gold mines. The manufacture of chlorine and caustic soda, along with its use in electrical and electronic applications probably accounted for two-thirds to three-fourths of the mercury consumed domestically. The remainder was used in other applications such as measuring and control instruments and dental amalgams.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production:					
Mine	NA	NA	NA	NA	NA
Secondary, industrial	NA	NA	NA	NA	NA
Imports for consumption (gross weight)	128	62	103	100	100
Exports (gross weight)	63	181	182	108	300
Price, average value, dollars per flask, free market	139.84	140.00	155.00	155.00	140.00

Recycling: Recycling of old scrap represented essentially all of domestic mercury production in 2002.

Import Sources (1998-2001): United Kingdom, 30%; Chile,15%; Kazakhstan, 13%; Germany, 13%; and other, 29%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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—9-30-02[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Mercury	4,435	—	4,435	—	—

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MERCURY

Events, Trends, and Issues: Federal, State, and local governments are concerned about the toxic effects of mercury and therefore regulate mercury emissions and/or the final disposition of mercury-bearing products. As a result, stringent environmental standards 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 remained suspended.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2001	2002[e]		
United States	NA	NA	—	7,000
Algeria	240	220	2,000	3,000
Italy	—	—	—	69,000
Kyrgyzstan	300	300	7,500	13,000
Spain	500	500	76,000	90,000
Other countries	360	400	38,000	61,000
World total (may be rounded)	1,400	1,400	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. — Zero.
[1]Prepared by Robert G. Reese, Jr.
[2]One metric ton (1,000 kilograms) = 29.0082 flasks.
[3]See Appendix B for definitions.
[4]See Appendix C for definitions.

MICA (NATURAL), SCRAP AND FLAKE[1]

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Scrap and flake mica production, excluding low-quality sericite, was estimated to be 84,000 metric tons in 2002. North Carolina accounted for about 47% 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 2002 scrap mica production was estimated at $7.6 million. Ground mica sales in 2001 were valued at $28.1 million. There were nine domestic producers of scrap and flake mica.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production:[2 3]					
Mine	87	95	101	98	84
Ground	104	111	112	89	76
Imports, mica powder and mica waste	23	21	29	32	37
Exports, mica powder and mica waste	8	11	10	9	11
Consumption, apparent[4]	137	125	119	121	111
Price, average, dollars per ton, reported:					
Scrap and flake	87	148	136	82	100
Ground:					
Wet	909	849	751	771	800
Dry	179	192	169	147	150
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine, number[5]	367	NA	NA	NA	NA
Net import reliance[6] as a percentage of apparent consumption	13	10	15	19	24

Recycling: None.

Import Sources (1998-2001): Canada, 66%; India, 20%; China, 6%; Finland, 2%; and other, 6%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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 decreased in 2002. The decrease primarily resulted from reduced production in Georgia, New Mexico, North Carolina, South Carolina, and South Dakota. Development continued at a newly opened mica operation in Arizona, and the associated processing plant produced several wet ground mica products. The United States remained a major world producer of scrap and flake mica. Imported mica scrap and flake is primarily used for making mica paper and as a filler and reinforcer in plastics.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7]	Reserve base[7]
	2001	2002[e]		
United States[2]	98	84	Large	Large
Brazil	4	4	Large	Large
Canada	17	17	Large	Large
India	2	2	Large	Large
Korea, Republic of	40	40	Large	Large
Russia	100	100	Large	Large
Other countries	35	35	Large	Large
World total (rounded)	300	280	Large	Large

World Resources: Resources of scrap and flake mica are available in granite, pegmatite, schist, and clay deposits and are considered more than adequate to meet anticipated world demand in the foreseeable future.

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

[e]Estimated. NA Not available.
[1]See also Mica (Natural), Sheet.
[2]Sold or used by producing companies.
[3]Excludes low-quality sericite used primarily for brick manufacturing.
[4]Based on ground mica.
[5]Total employment at mines and mills where mica was produced and processed, excluding feldspar companies with byproduct production. Employees were not assigned to specific commodities in calculating employment.
[6]Defined as imports - exports + adjustments for Government and industry stock changes.
[7]See Appendix C for definitions.

MICA (NATURAL), SHEET[1]

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: A minor amount of sheet mica was produced in 2002, 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 2002, an estimated 1,140 tons of unworked mica split block and mica splittings valued at $0.6 million was consumed by five companies in four States, mainly in the East and Midwest. Most was fabricated into parts for electronic and electrical equipment. An additional estimated 1,080 tons of imported worked mica valued at $11.4 million was also consumed.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production, mine[e]	([2])	([2])	([2])	([2])	([2])
Imports, plates, sheets, strips; worked mica; split block; splittings; other > $1.00/kg	4,380	4,550	5,430	4,290	2,220
Exports, plates, sheets, strips; worked mica; crude and rifted into sheet or splittings > $1.00/kg	1,280	1,290	1,150	1,160	695
Shipments from Government stockpile excesses	557	708	1,230	1,860	4,600
Consumption, apparent	3,660	3,980	5,500	4,990	6,120
Price, average value, dollars per kilogram, muscovite and phlogopite mica, reported:					
Block	26	20	23	55	50
Splittings	1.67	1.67	1.81	1.67	1.70
Stocks, fabricator and trader, yearend	NA	NA	NA	NA	NA
Net import reliance[3] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1998-2001): India, 66%; Belgium, 13%; Germany, 6%; China, 4%; and other, 11%.

Tariff:

Item	Number	Normal Trade Relations 12/31/02
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—9-30-02[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Block:					
Muscovite (stained and better)	10	34	10	([5])	901
Phlogopite	—	([2])	—	—	([2])
Film, muscovite	0.5	—	0.5	([5])	([2])
Splittings:					
Muscovite	—	2,407	—	([5])	3,555
Phlogopite	132	119	132	([5])	99

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MICA (NATURAL), SHEET

Events, Trends, and Issues: Demand for sheet mica increased in 2002. The increase in apparent consumption was primarily the result of increased shipments from the U.S. Government stockpile. Imports of mica splittings from India decreased substantially as the result of these stockpile shipments. U.S. imports of split block mica from India also decreased. Imports remained a 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		Reserves[6]	Reserve base[6]
	2001[e]	2002[e]		
United States	([2])	([2])	Very small	Small
India	3,500	3,500	Very large	Very large
Russia	1,500	1,500	Moderate	Large
Other countries	200	200	Moderate	Large
World total	5,200	5,200	Large	Large

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

Substitutes: Many materials can be substituted for mica in numerous electrical 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. — Zero.
[1]See also Mica (Natural), Scrap and Flake.
[2]Less than ½ unit.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]The total disposal plan for all categories of mica in the National Defense Stockpile is undifferentiated at 3,856 metric tons (8,500,000 pounds).
[6]See Appendix C for definitions.

MOLYBDENUM

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

Domestic Production and Use: In 2002, molybdenum, valued at about $270 million (based on average oxide price), was produced by six mines. Molybdenum ore was produced at three mines, one each in Colorado, Idaho, and New Mexico, whereas three mines in Arizona 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, cast and wrought alloy, and superalloy producers accounted for about 70% of the molybdenum consumed.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production, mine	53,300	42,400	40,900	37,600	32,600
Imports for consumption	14,300	14,000	15,000	13,400	9,800
Exports	46,600	32,700	27,900	31,500	23,100
Consumption:					
Reported	18,800	18,700	18,300	16,200	13,400
Apparent	16,200	32,500	34,200	22,300	19,900
Price, average value, dollars per kilogram[1]	5.90	5.90	5.64	5.20	8.30
Stocks, mine and plant concentrates, product, and consumer materials	16,200	12,000	11,400	10,700	9,600
Employment, mine and plant, number	740	610	470	380	360
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: Secondary molybdenum in the form of molybdenum metal or superalloys was recovered, but the amount was small. Although molybdenum is not recovered from scrap steel, recycling of steel alloys is significant, and molybdenum content is reutilized. Quantities of molybdenum recycled from new and old scrap are estimated to be 30% of apparent supply of molybdenum.

Import Sources (1998-2001): China, 30%; Mexico, 29%; Canada, 19%; United Kingdom, 11%; Chile, 8%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Molybdenum ore and concentrates, roasted	2613.10.0000	12.8¢/kg + 1.8% ad val.
Molybdenum ore and concentrates, other	2613.90.0000	17.8¢/kg.
Molybdenum chemicals:		
Molybdenum oxides and hydroxides	2825.70.0000	3.2% ad val.
Molybdates of ammonium	2841.70.1000	4.3% ad val.
Molybdates, all others	2841.70.5000	3.7% ad val.
Molybdenum pigments:		
Molybdenum orange	3206.20.0020	3.7% ad val.
Ferroalloys:		
Ferromolybdenum	7202.70.0000	4.5% ad val.
Molybdenum metals:		
Powders	8102.10.0000	9.1¢/kg + 1.2% ad val.
Unwrought	8102.94.0000	13.9¢/kg + 1.9% ad val.
Wrought bars and rods	8102.95.3000	6.6% ad val.
Wrought plates, sheets, strips, etc.	8102.95.6000	6.6% ad val.
Wire	8102.96.0000	4.4% ad val.
Waste and scrap	8102.97.0000	Free.
Other	8102.99.0000	3.7% ad val.

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

Government Stockpile: None.

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MOLYBDENUM

Events, Trends, and Issues: U.S. mine output of molybdenum in 2002 decreased an estimated 13% from that of 2001. U.S. imports for consumption decreased an estimated 26% from those of 2001, while the U.S. exports decreased 27% from those of 2001. U.S. reported consumption decreased 17% from that of 2001. Mine capacity utilization was about 40%.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for Armenia and China have been revised upward based on new information from official country sources.

	Mine production		Reserves[3]	Reserve base[3]
	2001	2002[e]	(thousand metric tons)	
United States	37,600	32,600	2,700	5,400
Armenia	3,300	3,000	200	400
Canada	7,000	8,200	450	910
Chile	33,000	34,000	1,100	2,500
China	28,200	28,000	3,300	8,300
Iran	1,600	2,000	50	140
Kazakhstan	230	200	130	200
Kyrgyzstan	250	200	100	180
Mexico	7,000	5,500	90	230
Mongolia	1,500	1,500	30	50
Peru	7,500	9,500	140	230
Russia[e]	2,600	2,600	240	360
Uzbekistan[e]	500	500	60	150
World total (rounded)	130,000	128,000	8,600	19,000

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

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

[e]Estimated. E Net exporter.

[1]Major producer price per kilogram of molybdenum contained in technical-grade molybdic oxide.

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

[3]See Appendix C for definitions.

NICKEL

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

Domestic Production and Use: The United States did not have any active nickel mines in 2002. Limited amounts of byproduct nickel, though, were recovered from copper and palladium-platinum ores mined in the Western United States. On a monthly or annual basis, 145 facilities reported nickel consumption. The principal consuming State was Pennsylvania, followed by West Virginia, Indiana, and Illinois. Approximately 42% of the primary nickel consumed went into stainless and alloy steel production, 38% into nonferrous alloys and superalloys, 14% into electroplating, and 6% into other uses. Ultimate end uses were as follows: transportation, 32%; chemical industry, 13%; electrical equipment, 10%; construction, 9%; fabricated metal products, 8%; household appliances, 7%; petroleum industry, 6%; machinery, 6%; and other, 9%. Estimated value of apparent primary consumption was $775 million.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production: Mine	—	—	—	—	—
Plant	4,290	—	—	—	—
Shipments of purchased scrap:[1]	89,700	93,000	123,000	141,000	145,000
Imports: Ore	1,420	—	—	—	—
Primary	148,000	139,000	156,000	136,000	122,000
Secondary	8,500	9,480	10,700	8,760	8,920
Exports: Primary	8,440	7,440	8,150	8,450	7,000
Secondary	35,100	31,400	49,900	48,600	43,200
Consumption: Reported, primary	116,000	116,000	115,000	98,800	84,600
Reported, secondary	63,100	71,000	84,000	101,000	111,000
Apparent, primary	149,000	140,000	147,000	129,000	114,000
Total[2]	212,000	211,000	231,000	230,000	225,000
Price, average annual, London Metal Exchange:					
Cash, dollars per metric ton	4,630	6,011	8,638	5,945	6,776
Cash, dollars per pound	2.100	2.727	3.918	2.696	3.074
Stocks: Government, yearend	2,600	—	—	—	—
Consumer, yearend	15,900	10,000	14,300	13,900	12,500
Producer, yearend[3]	13,100	12,700	12,300	12,600	12,400
Employment, yearend, number: Mine	7	5	1	—	—
Smelter and port	7	7	—	—	—
Net import reliance[4] as a percentage of apparent consumption	64	63	56	46	43

Recycling: About 111,000 tons of nickel was recovered from purchased scrap in 2002. This represented about 57% of total reported consumption for the year.

Import Sources (1998-2001): Canada, 40%; Norway, 13%; Russia, 12%; Australia, 10%; and other, 25%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Nickel oxide, chemical grade	2825.40.0000	Free.
Ferronickel	7202.60.0000	Free.
Nickel oxide, metallurgical grade	7501.20.0000	Free.
Unwrought nickel, not alloyed	7502.10.0000	Free.

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

Government Stockpile: The U.S. Government sold the last of the nickel in the National Defense Stockpile in 1999. The U.S. Department of Energy is holding 6,000 tons of nickel scrap contaminated by low-level radioactivity.

Events, Trends, and Issues: Stainless steel accounts for two-thirds of the primary nickel consumed in the world. U.S. production of austenitic (i.e., nickel bearing) stainless steel was up 30% from the 1.01 million tons of 2001. The increase occurred after recessionary forces began weakening in mid-2002 and the economic disruption created by the terrorist attacks of September 11, 2001, had partially subsided. Imported steels accounted for 22% of total U.S. stainless steel consumption in 2002, down slightly from 24% for the previous year. On March 5, 2002, the U.S. Government temporarily raised tariffs on some forms of stainless steel. The new tariffs were part of a much larger trade action taken to slow dumping of excess foreign steel products at below market prices. The new tariffs were to decrease annually over 3 years and then drop back down to 2001 levels.

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NICKEL

World nickel supply grew faster than demand in the second half of 2001, causing a gradual buildup of stocks in London Metal Exchange (LME) approved warehouses. By June 2002, LME stocks had climbed back above the 20,000-ton level from a 10-year low of 9,000 tons in March 2001. Producer stock levels were significantly higher than those controlled by the LME but more stable—fluctuating between 87,000 and 104,000 tons. World mine production was at an alltime high in 2001. In early 2002, prices began to rise despite the increase in mine production but peaked in mid-year. For the week ending November 29, 2002, the LME cash price for 99.8%-pure nickel averaged $7,390 per metric ton ($3.35 per pound). Twelve months earlier, the cash price was $5,314 per ton ($2.41 per pound). In April 2002, the Government of Newfoundland and a major Canadian nickel producer came to terms on developing the Voisey's Bay sulfide deposit in northeastern Labrador. The agreement ended a 3-year impasse over key economic and environmental issues. Mine construction began in mid-2002. The same company also was developing a laterite deposit at the southeastern tip of New Caledonia. The New Caledonian nickel was to be recovered onsite using advanced pressure acid leach (PAL) technology. In Australia, three laterite mining and processing complexes incorporating similar technology were commissioned between 1998 and 1999, and a second generation of PAL projects was in varying stages of development. Competitors were considering employing some form of acid leach technology to recover nickel at greenfield sites in Cuba, Indonesia, and the Philippines. Several automobile manufacturers were using nickel-metal hydride (NiMH) batteries to power their gasoline-electric hybrid and pure electric vehicles for the 2004 and 2005 model years. In the first quarter of 2002, more than 41,300 hybrid automobiles were operating on U.S. highways. An additional 5,200 battery electric automobiles, vans, and light trucks have been leased or sold in the United States since 1996. One Japanese-based automobile manufacturer was ramping up operations to produce 300,000 hybrid vehicles per year by 2007. A multimillion-dollar NiMH battery production facility was under construction at Springboro, OH, and was expected to be operational by May 2003.

World Mine Production, Reserves, and Reserve Base: Reserves estimates for Botswana, Philippines, South Africa, and Zimbabwe have been revised based on new information from the mining industry.

	Mine production		Reserves[5]	Reserve base[5]
	2001	2002[e]		
United States	—	—	—	—
Australia	197,000	186,000	22,000,000	27,000,000
Botswana	26,200	23,200	490,000	920,000
Brazil	45,400	44,900	670,000	6,000,000
Canada	193,361	188,000	5,200,000	15,000,000
China	51,500	55,700	3,600,000	7,600,000
Colombia	52,962	55,400	900,000	1,100,000
Cuba	70,662	73,100	5,600,000	23,000,000
Dominican Republic	31,000	24,300	690,000	1,000,000
Greece	20,830	22,400	490,000	900,000
Indonesia	102,000	105,000	3,200,000	13,000,000
New Caledonia	117,554	98,200	4,400,000	12,000,000
Philippines	27,359	31,800	940,000	5,200,000
Russia	325,000	328,000	6,600,000	9,200,000
South Africa	36,443	38,000	3,700,000	12,000,000
Venezuela	13,600	20,600	610,000	610,000
Zimbabwe	8,145	9,690	15,000	260,000
Other countries	9,240	13,700	1,300,000	5,100,000
World total (rounded)	1,330,000	1,320,000	61,000,000	140,000,000

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

Substitutes: With few exceptions, substitutes for nickel would result in increased cost or 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. — Zero.
[1]Scrap receipts - shipments by consumers + exports - imports + adjustments for consumer stock changes.
[2]Apparent primary consumption + reported secondary consumption.
[3]Stocks of producers, agents, and dealers held only in the United States.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.

NITROGEN (FIXED)—AMMONIA

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

Domestic Production and Use: Ammonia was produced by 19 companies at 37 plants in the United States during 2002. Fifty-three percent of total U.S. ammonia production capacity was centered in Louisiana, Oklahoma, and Texas because of their large reserves of natural gas, the dominant domestic feedstock. In 2002, U.S. producers operated at about 57% of their rated capacity. The United States remained the world's second largest ammonia producer and consumer following China. Urea, ammonium nitrate, ammonium phosphates, nitric acid, and ammonium sulfate were the major derivatives of ammonia in the United States, in descending order of importance.

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

Salient Statistics—United States:[1]	1998	1999	2000	2001	2002[e]
Production[2]	13,800	12,900	12,500	9,730	9,500
Imports for consumption	3,460	3,890	3,880	4,550	4,600
Exports	614	562	662	647	650
Consumption, apparent	17,100	16,300	15,600	13,800	13,500
Stocks, producer, yearend[3]	1,050	996	1,120	916	900
Price, dollars per ton, average, f.o.b. Gulf Coast[3]	121	109	169	183	140
Employment, plant, number[e]	2,500	2,200	2,000	1,800	1,700
Net import reliance[4] as a percentage of apparent consumption	19	21	20	30	29

Recycling: None.

Import Sources (1998-2001): Trinidad and Tobago, 59%; Canada, 24%; Ukraine, 5%; and other, 12%. U.S. Census Bureau data for Russia and Ukraine were included only in 2001.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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: Low ammonia prices and high inventory levels in the first part of the year led some ammonia producers to temporarily idle a significant portion of their ammonia production capacity. One company closed its 93,000-ton-per-year ammonia plant in Pocatello, ID, in August, citing global competition as the reason for the closure. In order to remain competitive, the company either would have had to upgrade its existing plant or construct a new plant. By the fourth quarter, much of the idled capacity came back on-stream as ammonia prices began to climb, reflecting an increase in natural gas prices. The largest ammonia producer in the United States filed for Chapter 11 bankruptcy protection in June, citing adverse market conditions in the nitrogen fertilizer market and cash demands. The producer, a co-op, operates seven ammonia plants in Iowa, Kansas, Louisiana, Nebraska, and Oklahoma, with a total capacity of 3,040,000 tons per year of ammonia; two plants, with a total capacity of 890,000 tons per year, were closed throughout 2002.

Ammonia imports continued to increase to replace declining U.S. production, but less dramatically than in 2001 because the drop in domestic production was not as large. Based on partial-year data, Trinidad and Tobago (50%), Canada (18%), and Ukraine (11%) were the largest source countries.

In October, the International Trade Administration, U.S. Department of Commerce, announced preliminary antidumping duties on urea ammonium nitrate (UAN) solutions imported into the United States from Belarus, Russia, and Ukraine. For Belarus, the duty was 190.34% ad val.; for Russia, 138.95% to 233.85% ad val.; and for Ukraine, 193.58% ad val. The investigation of UAN imports began in April when U.S. producers claimed that unusually high levels of low-cost imports from the three countries began in 2000 and were damaging domestic UAN operating rates.

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NITROGEN (FIXED)—AMMONIA

According to the U.S. Department of Agriculture, for the eight major U.S. field crops (corn, soybeans, wheat, cotton, sorghum, barley, oats, and rice), planting intentions for the 2002-03 crop year are nearly identical to the actual planted acreage in the 2001-02 crop year. Corn growers intend to plant 4% more than last year's planted acreage, primarily because of lower per-acre costs of fertilizer and fuel for corn production than last year and a switch from cotton acres in the south as cotton's producer incentive prices declined. Because corn is the most nitrogen-intensive of the major field crops, an increase in corn plantings should translate to an increase in ammonia demand in the United States.

A new 645,000-ton-per-year ammonia plant began operating on a commercial scale in Trinidad and Tobago in July. Much of this plant's output was targeted to the U.S. market. Progress continued on planned ammonia plants in Australia, Egypt, Oman, and Trinidad and Tobago. The following were closed in 2002: a 140,000-ton-per-year plant in France , a 120,000-ton-per-year plant in India, a 530,000-ton-per-year plant in Ireland, and two plants totaling 660,000 tons per year of capacity in the Republic of Korea. New ammonia plants were proposed in Bangladesh, Iran, Saudi Arabia, Trinidad and Tobago, and Turkmenistan.

After its acceptance into the World Trade Organization (WTO) in December 2001, China delayed implementation of its tariff rate quota system (TRQ) for fertilizers until April 2002; publication of a draft regulation was supposed to have been completed by mid-October 2001. By mid-2002, the United States, Japan, and Canada had complained to the WTO that China was adopting tax policies that were inconsistent with its TRQ commitments and it was not reallocating unused TRQs. China contended that actual imports should depend on market demand; therefore, imports may not reach the totals specified under the TRQs. Although fertilizer imports were estimated to have increased by 1 million tons from 2001 to 2002, the total quantity permitted under the TRQs was 5.67 million tons.

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

World Ammonia Production, Reserves, and Reserve Base:

	Plant production		Reserves and reserve base[5]
	2001	2002[e]	
United States	9,730	9,500	Available atmospheric nitrogen and sources of natural gas for production of ammonia are considered adequate for all listed countries.
Canada	3,440	3,300	
China	28,100	30,000	
Egypt	1,800	1,950	
France	1,580	1,600	
Germany	2,730	2,520	
India	10,100	9,220	
Indonesia	3,700	4,150	
Netherlands	1,940	1,980	
Pakistan	1,970	2,000	
Poland	1,740	1,900	
Russia	8,690	8,700	
Saudi Arabia	1,770	1,400	
Trinidad and Tobago	3,040	3,000	
Ukraine	3,700	3,700	
Other countries	22,000	22,000	
World total (rounded)	106,000	107,000	

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

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

[e]Estimated.

[1]U.S. Department of Commerce (DOC) data unless otherwise noted.

[2]Annual and preliminary data as reported in Current Industrial Reports MA325B and MQ325B (DOC).

[3]Source: Green Markets.

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

[5]See Appendix C for definitions.

PEAT

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

Domestic Production and Use: The estimated f.o.b. plant value of marketable peat production in the conterminous United States was about $18.8 million in 2002. Peat was harvested and processed by about 60 producers in 16 of the conterminous States; several other producers in Alaska were canvassed independently by the Alaska Department of Natural Resources. Florida, Michigan, and Minnesota were the largest producing States, in order of quantity produced. Reed-sedge peat accounted for 78% of the total volume produced, followed by sphagnum moss, 10%, hypnum moss, 7%, and humus, 5%. More than 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, mushroom culture, mixed fertilizers, and packing for flowers and plants. In the industrial sector, peat was used as an oil absorbent and as an efficient filtration medium for the removal of waterborne contaminants in mine waste streams and municipal storm drainage.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production	685	731	792	870	760
Commercial sales	791	834	847	998	940
Imports for consumption	761	752	786	776	800
Exports	30	40	37	31	34
Consumption, apparent[2]	1,430	1,580	1,530	1,640	1,540
Price, average value, f.o.b. mine, dollars per ton	24.26	26.48	26.85	24.82	24.60
Stocks, producer, yearend	408	272	279	257	275
Employment, mine and plant, number[e]	800	800	800	800	800
Net import reliance[3] as a percentage of apparent consumption	52	54	48	47	50

Recycling: None.

Import Sources (1998-2001): Canada, 99%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Peat	2703.00.0000	Free.

Depletion Allowance: 5% (Domestic).

Government Stockpile: None.

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PEAT

Events, Trends, and Issues: Development of new horticultural peat operations or expansion of existing operations has become increasingly difficult in the United States. Numerous Federal, State, and local wetlands protection regulations apply to permitting, harvesting, and reclamation of peat bogs and often overlap. The cost of compliance and the time required to obtain the proper permits have led some smaller companies to stop harvesting peat.

Domestic peat demand is anticipated to continue to grow at a steady rate for the near future, with Canadian peat accounting for a greater percentage of apparent consumption. Soil blending companies that import peat from Canada stand to benefit from growing demand for high-quality sphagnum moss. The outlook for domestic peat producers will by governed by several variables, chiefly, the ability to permit new bogs, the level of Canadian competition, and competition from composted yard wastes.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	2001	2002[e]		
United States	870	760	15,000	6,400,000
Belarus	2,100	2,100	([5])	([5])
Canada	1,187	1,200	22,000	30,000,000
Estonia	800	800	([5])	([5])
Finland	6,500	5,500	64,000	3,000,000
Germany	4,250	4,000	42,000	450,000
Ireland	5,500	5,500	160,000	820,000
Latvia	400	500	([5])	([5])
Lithuania	280	300	([5])	([5])
Moldova	475	475	([5])	([5])
Russia	2,100	2,000	([5])	([5])
Sweden	1,100	1,000	([5])	([5])
Ukraine	1,000	1,000	([5])	([5])
United Kingdom	500	500	([5])	([5])
Other countries	660	630	4,900,000	160,000,000
World total (rounded)	27,900	26,500	5,200,000	200,000,000

World Resources: U.S. resources of peat were estimated at more than 110 billion tons, with more than 50% located in undisturbed areas of Alaska. World resources of peat were estimated to be 2 trillion tons, of which the former Soviet Union[6] has about 770 billion tons and Canada about 510 billion tons.

Substitutes: Natural organic materials may be composted and compete in certain applications. Shredded paper is used to hold moisture for some grass-seeding applications. The superior water-holding capacity and physiochemical properties of peat limit substitution alternatives.

[e]Estimated.
[1]See Appendix A for conversion to short tons.
[2]Defined as production + imports - exports + adjustments for industry stocks.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions.
[5]Included with "Other countries."
[6]As constituted before December 1991.

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 2002 was $18.5 million. Crude ore production came from 10 mines operated by 8 companies in 7 Western States. New Mexico continued to be the major producing State. Processed ore was expanded at 61 plants in 31 States. The principal end uses were building construction products, 67%; horticultural aggregate,12%; filter aid, 8%; fillers, 8%; and other, 5%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production[1]	685	711	672	588	548
Imports for consumption[e]	150	144	180	175	210
Exports[e]	42	47	43	43	45
Consumption, apparent	793	808	809	720	713
Price, average value, dollars per ton, f.o.b. mine	31.91	33.40	33.78	36.31	33.74
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill	140	150	150	145	145
Net import reliance[2] as a percentage of apparent consumption	14	12	17	18	23

Recycling: Not available.

Import Sources (1998-2001): Greece, 100%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/02**
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: Production[1] of domestic perlite decreased about 7% and imports of perlite increased 20% compared with that of 2001. Domestic production decreased for the third year in a row while imports reached an all time high.

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

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

Research for new uses of perlite may increase domestic consumption.

World Processed Perlite Production, Crude Ore Reserves, and Reserve Base: The world total reserve base has been increased significantly based on new information from official government sources in Turkey.

	Production		Reserves[3]	Reserve base[3]
	2001	2002[e]		
United States	588	548	50,000	200,000
Greece	360	500	50,000	300,000
Hungary	150	150	3,000	([4])
Japan	250	250	([4])	([4])
Turkey	150	150	([4])	5,700,000
Other countries	210	200	600,000	1,500,000
World total (may be rounded)	1,710	1,800	700,000	7,700,000

World Resources: Insufficient information is available to provide a reliable estimate of resources in perlite-producing countries.

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

[e]Estimated. NA Not available.
[1]Processed perlite sold and used by producers.
[2]Defined as imports - exports + adjustments for Government and industry stock changes; changes in stocks not available and assumed to be zero for apparent consumption and net import reliance calculations.
[3]See Appendix C for definitions.
[4]Included with "Other countries."

PHOSPHATE ROCK

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Phosphate rock ore was mined by nine firms in four States, and upgraded to an estimated 35.8 million tons of marketable product valued at $990 million, f.o.b. mine. Florida and North Carolina accounted for 83% of total domestic output, with the remainder produced in Idaho and Utah. More than 95% of the U.S. phosphate rock ore mined was used to manufacture wet-process phosphoric acid and superphosphoric acid, which were used as intermediates in the manufacture of granular and liquid ammonium phosphate fertilizers and animal feed supplements. More than 50% of the wet-process phosphoric acid produced was exported in the form of upgraded granular diammonium and monoammonium phosphate (DAP and MAP, respectively) fertilizer, triple superphosphate fertilizer, and merchant-grade phosphoric acid. The balance of the phosphate rock mined was used to manufacture elemental phosphorus, which was used to produce high-purity phosphoric acid and phosphorus compounds for use in a variety of industrial and food-additive applications.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, marketable	44,200	40,600	38,600	31,900	35,800
Sold or used by producers	43,700	41,600	37,400	32,800	35,000
Imports for consumption	1,760	2,170	1,930	2,500	2,700
Exports	378	272	299	111	—
Consumption[1]	45,000	43,500	39,000	35,200	37,700
Price, average value, dollars per ton, f.o.b. mine[2]	25.46	30.56	24.14	26.82	27.69
Stocks, producer, yearend	7,920	6,920	8,170	7,510	8,000
Employment, mine and beneficiation plant, number[e]	7,700	7,200	6,300	6,000	6,000
Net import reliance[3] as a percentage of apparent consumption	3	7	1	9	6

Recycling: None.

Import Sources (1998-2001): Morocco, 99%; and other, 1%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
Natural calcium phosphates:		
Unground	2510.10.0000	Free.
Ground	2510.20.0000	Free.

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

Government Stockpile: None.

Events, Trends, and Issues: The United States is the largest producer and consumer of phosphate rock in the world and the leading producer and supplier of phosphate fertilizers in the world. After falling to 35-year lows in 2001, production and sales of phosphate rock improved in 2002 owing to higher production of phosphoric acid, primarily for manufacturing of DAP. Several phosphoric acid and DAP plants that were closed temporarily in 2001, reopened during 2002 and production rates increased at phosphate rock mines and phosphoric acid plants. Phosphate rock imports reached another record high, with three companies along the Gulf of Mexico accounting for most of the purchases. No exports of phosphate rock were reported by producers in 2002. Previous years statistics were from U.S. Census Bureau data, which included exports of previously imported material.

Exports of DAP increased on the strength of sales to China, which were nearly double that of 2001 and accounted for more than 60% of U.S. DAP exports. Sales to China started to increase in December 2001, after the country was admitted to the World Trade Organization (WTO). As part of its accession agreement, China instituted a fixed 4% tariff on import quotas for fertilizers. The tariff rate quota began at 5.4 million metric tons (Mt) in 2002 and will increase 5% annually to 7.98 Mt in 2010.

A phosphate fertilizer producer in Florida filed for Chapter 11 bankruptcy protection in 2002 about a year after it had submitted a proposal to open its own phosphate rock mine. This followed the bankruptcy of another company in Florida during 2001. Both companies were in negotiations to sell some of their assets to other U.S. producers.

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PHOSPHATE ROCK

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. Projections by various analysts and international organizations indicate that consumption of phosphate in fertilizer could increase by 2.5% in 2003 based upon possible growth in China, India, and North America. For the period 2003-07, world phosphate consumption is forecasted to increase by 2.6% annually. Domestic fertilizer consumption is projected to increase slightly in 2002 because of higher fertilizer application rates and a projected increase in planted corn acreage. Greater foreign competition has diminished a significant portion of U.S. phosphate fertilizer sales, especially to Australia and India. Anticipated higher exports to China and Latin America are encouraging signs for improvement in the industry. Phosphate rock production is likely to remain below capacity in the Florida and North Carolina region, as companies adjust production to meet demand and prolong reserves. The several new mines that are planned to open in the next 5 years would primarily be replacements for existing mines and probably would not have a significant impact on annual production capacity. Phosphate rock and fertilizer production is expected to remain steady in Idaho and Utah because output in the region only is used domestically.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for China have been revised significantly based on new information from official country sources.

	Mine production		Reserves[4]	Reserve base[4]
	2001	2002[e]		
United States	31,900	35,800	1,000,000	4,000,000
Australia	1,890	1,800	77,000	1,200,000
Brazil	4,700	4,700	330,000	370,000
Canada	800	1,000	25,000	200,000
China	21,000	21,000	6,600,000	13,000,000
Israel	3,510	3,500	180,000	800,000
Jordan	5,840	7,000	900,000	1,700,000
Morocco and Western Sahara	21,800	24,000	5,700,000	21,000,000
Russia	10,500	10,500	200,000	1,000,000
Senegal	1,700	1,500	50,000	160,000
South Africa	2,550	2,800	1,500,000	2,500,000
Syria	2,040	2,400	100,000	800,000
Togo	1,060	1,100	30,000	60,000
Tunisia	8,000	7,500	100,000	600,000
Other countries	8,710	8,000	1,000,000	2,000,000
World total (rounded)	126,000	133,000	17,000,000	50,000,000

World Resources: Foreign reserve data were derived from information received from Government sources, individual companies, and independent sources. Reserve data for China were based on official government data and include deposits of low-grade ore. Domestic reserve data were based on U.S. Geological Survey and individual company information. Phosphate rock resources occur principally as sedimentary marine phosphorites. The largest deposits are found in northern Africa, China, the Middle East, and the United States. Significant igneous occurrences are found in Brazil, Canada, Russia, and South Africa. Large phosphate resources have been identified on the continental shelves and on seamounts in the Atlantic Ocean and the Pacific Ocean, but cannot be recovered economically with current technology.

Substitutes: There are no substitutes for phosphorus in agriculture.

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

PLATINUM-GROUP METALS

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

Domestic Production and Use: The Stillwater Mine is the only primary platinum-group metals (PGM) producer in the United States. The mine, near Nye, MT, processed more than 820,000 metric tons of ore and recovered more than 16,000 kilograms of palladium and platinum in 2002. Small quantities of PGM were also recovered as byproducts of copper refining by two companies in Texas and Utah. Catalysts for air pollution abatement continued to be the largest demand sector for PGM. In the United States, more than 100,000 kilograms of PGM were used by the automotive industry in the manufacture of catalytic converters. Catalysts were also used in other air-pollution-abatement processes to remove organic vapors, odors, and carbon monoxide. Chemical uses include catalysts for organic synthesis, production of nitric acid, and fabrication of laboratory equipment. Platinum alloys, in cast or wrought form, are commonly used for jewelry. Platinum, palladium, and a variety of complex gold-silver-copper alloys are used as dental restorative materials.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Mine production:[1]					
Platinum	3,240	2,920	3,110	3,610	3,900
Palladium	10,600	9,800	10,300	12,100	13,000
Imports for consumption:					
Platinum	96,700	125,000	93,700	84,200	105,000
Palladium	176,000	189,000	181,000	160,000	75,800
Rhodium	13,500	10,300	18,200	12,400	7,560
Ruthenium	8,880	11,400	20,900	8,170	10,800
Iridium	1,950	2,270	2,700	3,110	2,060
Osmium	71	23	133	77	6
Exports:					
Platinum	14,300	19,400	25,000	31,300	30,500
Palladium	36,700	43,800	57,900	37,000	41,600
Rhodium	811	114	797	982	226
Price,[2] dollars per troy ounce:					
Platinum	374.61	378.94	549.30	533.29	558.75
Palladium	289.76	363.20	691.84	610.71	330.50
Rhodium	619.83	904.35	1,990.00	1,598.67	750.75
Ruthenium	47.95	40.70	129.76	130.67	60.00
Employment, mine, number	620	954	1,290	1,320	1,400
Net import reliance as a percentage of apparent consumption:[e]					
Platinum	94	96	78	90	93
Palladium	90	92	84	87	69

Recycling: An estimated 6,000 kilograms of PGM was recovered from new and old scrap in 2001.

Import Sources (1998-2001): Platinum: South Africa, 55%; United Kingdom,15%; Germany, 9%; Russia, 4%; and other, 17%. Palladium: Russia, 44%; South Africa, 14%; United Kingdom, 13%; Belgium, 10%; and other, 19%.

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

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

Government Stockpile:

Stockpile Status—9-30-02[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Platinum	649	—	649	4,354	4,055
Palladium	7,027	241	16,714	18,662	9,687
Iridium	784	—	784	187	—

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PLATINUM-GROUP METALS

Events, Trends, and Issues: During the first 9 months of 2002, the average price of PGM returned to more traditional levels. Palladium's rise to more than $1,000 per ounce during 2000 prompted the substitution of silver and base metals along with a reduction in the palladium content of its major end-use applications. Lower consumption by automobile manufacturers, a slowdown in the electronics sector, and increased production by Russia and South Africa caused palladium prices to fall to about $450 per ounce by September 2001 and to $330 per ounce in September 2002. Lower demand by the automobile industry and the slumping global economy caused platinum prices to fall but not nearly as precipitously as prices for palladium. Ruthenium was able to sustain its $130 per ounce price (up from $40 per ounce) through September 2001, but eventually fell back to $60 per ounce in September 2002. Russia accounted for more than 45% of U.S. palladium supply and about 5% of U.S. platinum supply in 2002. Higher PGM prices in 2000-01 were followed by an increase in the pace of exploration for PGM, and a growing number of joint ventures were signed in recognition of the strong fundamentals for these metals. Exploration activities continued despite lower prices. Most producers think that developing technology, such as fuel cells, will eventually increase demand for these metals.

World Mine Production, Reserves, and Reserve Base:

	Mine production				PGM	
	Platinum		Palladium		Reserves[4]	Reserve base[4]
	2001	2002[e]	2001	2002[e]		
United States	3,610	3,900	12,100	13,000	900,000	2,000,000
Canada	5,500	7,000	8,800	11,000	310,000	390,000
Russia	29,000	29,000	90,000	99,500	6,200,000	6,600,000
South Africa	120,000	126,000	61,000	59,900	63,000,000	70,000,000
Other countries	2,000	5,400	7,400	10,000	800,000	850,000
World total (rounded)	160,000	171,000	179,000	193,000	71,000,000	80,000,000

World Resources: World resources of PGM in mineral concentrations that can be mined economically are estimated to total more than 100 million kilograms. The largest reserves are in the Bushveld Complex in South Africa. In 2002, there were 10 producing mines in the Bushveld Complex; of these, 9 produced from the Merensky Reef and UG2 Chromite Layer and 1 produced from the Platreef, on the northern limb of the Complex.

Substitutes: Some motor vehicle manufacturers have substituted platinum for the more expensive palladium in catalytic converters. In addition, electronic parts manufacturers are reducing the average palladium content of the conductive pastes used to form the electrodes of multilayer ceramic capacitors by substituting base metals or silver-palladium pastes that contain significantly less palladium.

[e]Estimated. — Zero.
[1]Estimates from published sources.
[2]Handy & Harman quotations.
[3]See Appendix B for definitions.
[4]See Appendix C for definitions.

POTASH

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

Domestic Production and Use: In 2002, the value of production of marketable potash, f.o.b. mine, was about $280 million; sales decreased relative to 2001. Prices declined for New Mexico producers in the first half of the year, but demand increased in the second half due to smaller crop harvests, which led to small price increases. Domestic potash was produced from Michigan, New Mexico, and Utah. Most of the production was from southeastern New Mexico, where two companies operated three mines. New Mexico sylvinite and langbeinite ores were beneficiated by flotation, heavy media separation, dissolution-recrystallization, or combinations of these processes, and provided more than 70% of U.S. producer total sales.

In Utah, which has three potash operations, one company extracted underground potash by solution mining. The potash was recovered from brine solution by solar evaporation, and a standard flotation process separated the resulting potash crystals from sodium chloride crystals. Another Utah company collected subsurface brines from an interior basin for solar evaporation and standard flotation. The third Utah company collected lake brines for solar evaporation to form crystals, followed by flotation, and dissolution-recrystallization. In Michigan, a company used deep well solution mining and mechanical evaporation for crystallization of potash and byproduct sodium chloride.

The fertilizer industry used about 80% of U.S. potash sales, and the chemical industry used the remainder. More than 60% 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:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, marketable[1]	1,300	1,200	1,300	1,200	1,200
Imports for consumption	4,780	4,470	4,600	4,500	4,700
Exports	477	459	367	410	400
Consumption, apparent[2]	5,600	5,100	5,600	5,400	5,600
Price, dollars per metric ton of K_2O, average, muriate, f.o.b. mine[3]	145	145	155	155	155
Employment, number:					
Mine	730	660	610	585	540
Mill	780	725	665	670	645
Net import reliance[4 5] as a percentage of apparent consumption	80	80	80	80	80

Recycling: None.

Import Sources (1998-2001): Canada, 92%; Russia, 4%; Belarus, 2%; Germany, 1%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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. Again, this was accomplished through extended summer vacations and turnarounds at the mines and mills of Canada and the former Soviet Union. The Canadian potash industry operated for the first half of the year at above 70% of capacity, which was a increase from the first half of 2001; one company operated at about 65% of capacity. At the end of 2001, North American producer stocks were slightly less than 2 million tons and potash prices declined slightly. By the end of August 2002, North American potash stocks were down to about 1.6 million tons and potash prices were firming. On the consumption side, southern hemisphere and Asian-Pacific region potash purchases rose in the first half of 2002 and into the third quarter owing to rising world grain prices. Belarus, Germany, and Russia faced nearly unchanged potash demand in their home markets, but were important exporters to Asian-Pacific farmers. Many other potash producers around the world operated at normal capacity. Grain prices and some other crop prices rose on the world market, which increased the demand for potash in grain-producing countries.

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POTASH

Early in 2002, the largest Canadian potash firm reported the completion of startup for a smaller iodine and potassium nitrate producer in Chile. In March of 2002, the sole domestic potassium nitrate producer idled its plant and filed for Chapter 11 bankruptcy protection as a subsidiary of a company that filed for Chapter 11 bankruptcy protection in New York Federal Courts. In August, the sole domestic potassium nitrate producer reportedly was shutting down. A Spanish fertilizer manufacturer announced the permanent shutdown of its 96-year-old sulfate of potash plant in Cartagena at about the same time.

Based on data from the first half of 2002, estimated potash consumption in Africa, the Middle East, and Oceania increased by about 10% and may have accounted for about 5% of world consumption in 2002. On the same basis, potash consumption in Asia may have accounted for about 29% of the world total and declined by about 9%. Potash consumption in Central Europe, Eastern Europe, and Central Asia may have accounted for about 8% of the world total and declined by about 6%. Potash consumption in Latin America may have account for about 17% of the world total and increased by about 8%, while potash consumption in North America may have accounted for about 23% of the world total and declined by less than 4%. Western European potash consumption may have accounted for about 18% of the world total and declined by more than 9%.

World Mine Production, Reserves, and Reserve Base: The production estimate for China has been significantly increased based on new information from that country. Reserves estimates for China also have been revised based on new information.

	Mine production		Reserves[6]	Reserve base[6]
	2001	2002[e]		
United States	[1]1,200	[1]1,200	90,000	300,000
Azerbaijan	[e]5	5	NA	NA
Belarus	3,700	4,000	750,000	1,000,000
Brazil	352	370	300,000	600,000
Canada	8,200	8,760	4,400,000	9,700,000
Chile	390	390	10,000	50,000
China	385	420	8,000	450,000
France	300	150	500	NA
Germany	3,550	3,350	710,000	850,000
Israel	1,774	1,930	[7]40,000	[7]580,000
Jordan	1,178	1,200	[7]40,000	[7]580,000
Russia	4,300	4,340	1,800,000	2,200,000
Spain	525	510	20,000	35,000
Ukraine	25	30	25,000	30,000
United Kingdom	500	500	22,000	30,000
Other countries	—	—	50,000	140,000
World total (may be rounded)	26,400	27,000	8,300,000	17,000,000

World Resources: Estimated domestic potash resources total about 6 billion tons. Most of this lies at depths between 1,830 and 3,050 meters in a 3,110-square-kilometer area of Montana and North Dakota as an extension of the Williston Basin deposits in Saskatchewan, Canada. The Paradox Basin in Utah contains approximately 2 billion tons, mostly at depths of more than 1,220 meters. A large potash resource lies about 2,130 meters under central Michigan. The U.S. reserves 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 and Thailand contain large amounts of carnallite; it is not clear if this can be mined in a free market, competitive economy.

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

[e]Estimated. NA Not available. — Zero.
[1]Rounded to the nearest 0.1 million ton to protect proprietary data.
[2]Rounded to the nearest 0.2 million ton 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 arbitrarily divided equally between Israel and Jordan for inclusion in this tabulation.

PUMICE AND PUMICITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: The estimated value of pumice and pumicite sold or used in 2002 was about $23 million. Domestic output came from 16 producers in 6 States. Pumice and pumicite was mined in Arizona, California, Idaho, Kansas, New Mexico, and Oregon. Just over 65% of production came from Arizona and Oregon. About 56% of the pumice was consumed for building blocks, and the remaining 44% was used in abrasives, concrete, horticulture, landscaping, stone-washing laundries, and other applications.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, mine[1]	870	1,000	1,050	920	950
Imports for consumption	288	354	385	379	400
Exports[e]	22	23	27	27	30
Consumption, apparent	1,140	1,330	1,410	1,270	1,320
Price, average value, dollars per ton, f.o.b. mine or mill	21.59	27.69	24.27	29.19	24.00
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number	95	105	105	100	100
Net import reliance[2] as a percentage of apparent consumption	23	25	25	28	28

Recycling: Not available.

Import Sources (1998-2001): Greece, 81%; Italy, 13%; Turkey, 5%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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: A large integrated pumice and block producing company that was not included in previous years was added for this preliminary survey. Previous years' production, consumption, and net import reliance were revised to include this operation. The amount of domestically produced pumice and pumicite sold or used in 2002 increased 3.2%. Imports increased about 5.5% compared with those of 2001 as more Greek and Italian pumice was brought into the eastern half of the United States. Total apparent consumption in 2002 rose about 3.9% compared with that of 2001. Stone-washing laundry use of pumice continued to decline in 2002.

In 2003, domestic mine production of pumice and pumicite is expected to be about 1 million tons, with U.S. apparent consumption at approximately 1.35 million tons. Imports, mainly from Greece, will continue to supply markets primarily in the U.S. East Coast and Gulf Coast States.

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

All domestic mining of pumice in 2002 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 geographic area.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	2001	2002[e]		
United States[1]	920	950	Large	Large
Chile	800	750	NA	NA
Ecuador	350	270	NA	NA
France	450	450	NA	NA
Germany	500	500	NA	NA
Greece	1,600	1,600	NA	NA
Guadeloupe	210	210	NA	NA
Guatemala	420	420	NA	NA
Italy	4,600	4,600	NA	NA
New Zealand	500	500	NA	NA
Spain	600	600	NA	NA
Turkey	800	600	NA	NA
Other countries	1,050	1,000	NA	NA
World total (rounded)	12,800	12,500	NA	NA

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

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

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

QUARTZ CRYSTAL (INDUSTRIAL)

(Data in metric tons, unless otherwise noted)

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

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

Salient Statistics—United States: Production statistics for cultured quartz crystals were withheld to avoid disclosing company proprietary data. Trade data for cultured quartz crystal and devices with mounted quartz crystal are available, but lascas import data are not available. Exports of cultured quartz crystals totaled about 38 tons, and imports were about 14 tons in 2002. The average value of exports and imports was $279,000 per ton and $599,000 per ton, respectively. Other salient statistics were not available.

Recycling: None.

Import Sources (1998-2001): The United States is 100% import reliant. Brazil, Germany, and Madagascar are reportedly the major sources for lascas with Canada becoming an increasingly important supplier. Other possible sources of lascas include China, South Africa, and Venezuela.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Sands:		
95% or greater silica	2505.10.10.00	Free.
Less than 95% silica	2505.10.50.00	Free.
Quartz (including lascas)	2506.10.00.50	Free.
Piezoelectric quartz	7104.10.00.00	3% ad val.

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

Government Stockpile:

Stockpile Status—9-30-02[2]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
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: Information is unavailable, but the world reserve base for lascas is thought to be large.

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

Substitutes: Quartz crystal is the best material for frequency-control oscillators and frequency filters in electronic circuits. Other materials, such as aluminum orthophosphate (e.g., the very rare mineral berlinite) and lithium tantalate, which have larger piezoelectric coupling constants, have been studied.

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

RARE EARTHS[1]

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

Domestic Production and Use: Rare earths were mined by one company in 2002. Bastnäsite, a rare-earth fluocarbonate mineral, was mined as a primary product at 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 $28 million. The estimated value of refined rare earths consumed in the United States was more than $1 billion. The approximate distribution in 2001 by end use was as follows: glass polishing and ceramics, 34%; petroleum refining catalysts, 16%; automotive catalytic converters, 15%; metallurgical additives and alloys, 14%; rare-earth phosphors for lighting, televisions, computer monitors, radar, and X-ray intensifying film, 9%; permanent magnets, 8%; and other, 4%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, bastnäsite concentrates[e]	5,000	5,000	5,000	5,000	5,000
Imports:[2]					
Thorium ore (monazite)	—	—	—	—	—
Rare-earth metals, alloy	953	1,780	2,470	1,420	1,520
Cerium compounds	4,940	3,990	4,310	3,850	2,660
Mixed REO's	2,530	5,980	2,190	2,040	1,130
Rare-earth chlorides	1,680	1,530	1,330	2,590	1,620
Rare-earth oxides, compounds	3,720	7,760	11,200	9,150	6,930
Ferrocerium, alloys	117	120	118	118	100
Exports:[2]					
Rare-earth metals, alloys	724	1,600	1,650	884	1,160
Cerium compounds	4,640	3,960	4,050	4,110	2,980
Other rare-earth compounds	1,630	1,690	1,650	1,600	1,300
Ferrocerium, alloys	2,460	2,360	2,250	2,500	2,950
Consumption, apparent	11,500	11,500	12,100	15,100	10,600
Price, dollars per kilogram, yearend:					
Bastnäsite concentrate, REO basis[e]	4.19	4.85	5.51	5.51	5.51
Monazite concentrate, REO basis	0.73	0.73	0.73	0.73	0.73
Mischmetal, metal basis, metric ton quantity[3]	6-8	5-7	5-7	5-7	5-6
Stocks, producer and processor, yearend	W	W	W	W	W
Employment, mine and mill, number	183	78	78	90	95
Net import reliance[4] as a percentage of apparent consumption	56	70	71	67	53

Recycling: Small quantities, mostly permanent magnet scrap.

Import Sources (1998-2001): Rare-earth metals, compounds, etc.: China, 66%; France, 27%; Japan, 3%; Estonia, 2%; and other, 2%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
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); bastnäsite 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 2002 was lower than that of 2001. U.S. imports of rare earths decreased in most trade categories as a result of decreased demand in the United States in 2002. Although the rare-earth separation plant at Mountain Pass, CA, is still closed, it is expected to resume operations, possibly in 2004. The mine at Mountain Pass continued to produce bastnäsite concentrates and cerium concentrates. The trend is for continued increased use of the rare earths in many applications, especially automotive catalytic converters, permanent magnets, and rechargeable batteries.

The *23rd Rare Earth Research Conference* was held in Davis, CA, during July 13-18, 2002. The *Fifth International Conference on f-Elements (ICFE-5)* is planned for August 24-29, 2003, in Geneva, Switzerland. The first *Scandium Symposium* is scheduled for August 17-23, 2003, in Oslo, Norway. *The International Conference on Magnetism (ICM 2003)* is to be held in Rome, Italy, July 27-August 1, 2003. The conference *Rare Earths '04* is planned for November 7-12, 2004, in Nara, Japan.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for China have been revised based on new information from that country.

	Mine production[e]		Reserves[5]	Reserve base[5]
	2001	2002		
United States	5,000	5,000	13,000,000	14,000,000
Australia	—	—	5,200,000	5,800,000
Brazil	200	200	110,000	310,000
Canada	—	—	940,000	1,000,000
China	73,000	75,000	27,000,000	89,000,000
India	2,700	2,700	1,100,000	1,300,000
Malaysia	450	450	30,000	35,000
South Africa	—	—	390,000	400,000
Sri Lanka	120	120	12,000	13,000
Former Soviet Union[6]	2,000	2,000	19,000,000	21,000,000
Other countries	—	—	21,000,000	21,000,000
World total (rounded)	83,500	85,500	88,000,000	150,000,000

World Resources: Rare earths are relatively abundant in the Earth's crust, but discovered minable concentrations are less common than for most other ores. U.S. and world resources are contained primarily in bastnäsite and monazite. Bastnäsite deposits in China and the United States constitute the largest percentage of the world's rare-earth economic resources, while monazite deposits in Australia, Brazil, China, India, Malaysia, South Africa, Sri Lanka, Thailand, and the United States constitute the second largest segment. 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. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]Data includes lanthanides and yttrium, but excludes most scandium. See also Scandium and Yttrium.
[2]REO equivalent or contents of various materials were estimated. Data from U.S. Census Bureau.
[3]Price range from Elements—Rare Earths, Specialty Metals and Applied Technology, Trade Tech, Denver, CO, and web-based High Tech Materials, Longmont, CO.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.
[6]As constituted before December 1991.

RHENIUM

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

Domestic Production and Use: During 2002, 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 2002 was $22 million.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production[1]	14,000	12,000	12,400	11,800	9,400
Imports for consumption, gross weight	25,200	15,600	18,200	24,800	13,600
Exports	NA	NA	NA	NA	NA
Consumption:					
Estimated	28,600	32,500	32,000	35,000	23,000
Apparent	NA	NA	NA	NA	NA
Price, average value, dollars per kilogram, gross weight:					
Metal powder, 99.99% pure	960	1,100	1,010	910	1,060
Ammonium perrhenate	370	610	510	790	840
Stocks, yearend, consumer, producer, dealer	NA	NA	NA	NA	NA
Employment, number	Small	Small	Small	Small	Small
Net import reliance[2] as a percentage of estimated consumption	88	48	57	71	59

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 (1998-2001): Chile, 61%; Kazakhstan, 15%; Germany, 10%; Russia, 5%; and other, 9%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Other inorganic acids, other—rhenium, etc.	2811.19.6050	4.2% ad val.
Salts of peroxometallic acids, other—ammonium perrhenate	2841.90.2000	3.1% ad val.
Rhenium, etc., (metals) waste and scrap	8112.92.0500	Free.
Rhenium, (metals) unwrought; powders	8112.92.5000	3% ad val.
Rhenium, etc., (metals) wrought; etc.	8112.99.0100	4% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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RHENIUM

Events, Trends, and Issues: During 2002, the average rhenium prices were $1,060 per kilogram for metal and $840 per kilogram for ammonium perrhenate. The supply decreased by 22%, and imports of rhenium decreased by about 43%. Decreased rhenium recovery in the United States was due to reduced production of molybdenum concentrates from porphyry copper deposits in 2002. The United States relied on imports for much of its supply of rhenium. Chile and Kazakhstan supplied the majority of the rhenium imported.

Owing to the scarcity and minor output of rhenium, its production and processing pose no known threat to the environment. In areas where it is recovered, pollution control equipment for sulfur dioxide also prevents most of the rhenium from escaping into the atmosphere.

World Mine Production, Reserves, and Reserve Base:

	Mine production[3]		Reserves[4]	Reserve base[4]
	2001	2002		
United States	11,800	9,400	390,000	4,500,000
Armenia	750	700	95,000	120,000
Canada	1,700	1,700	—	1,500,000
Chile	2,000	2,000	1,300,000	2,500,000
Kazakhstan	2,500	2,500	190,000	250,000
Peru	5,000	5,000	45,000	550,000
Russia	1,200	1,200	310,000	400,000
Other countries	590	600	91,000	360,000
World total (rounded)	26,000	23,100	2,400,000	10,000,000

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

Substitutes: Substitutes for rhenium in platinum-rhenium catalysts are being evaluated continually. Iridium and tin have achieved commercial success in one such application. Other metals being evaluated for catalytic use include gallium, germanium, indium, selenium, silicon, tungsten, and vanadium. The use of these and other metals in bimetallic catalysts may decrease rhenium's share of the catalyst market. Materials that can substitute for rhenium in various end uses are as follows: cobalt and tungsten for coatings on copper x-ray targets, rhodium and rhodium-iridium for high-temperature thermocouples, tungsten and platinum-ruthenium for coatings on electrical contacts, and tungsten and tantalum for electron emitters.

[e]Estimated. NA Not available. — Zero.
[1]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]Estimated amount of rhenium extracted in association with copper and molybdenum production. Rhenium recovery is unknown.
[4]See Appendix C for definitions.

RUBIDIUM[1]

(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 varies inversely with the quantity of material purchased. For example, in 2002, one company offered 1-gram ampoules of 99.8%-grade rubidium metal at $52.00; the price for 100 grams of the same material from this company was $998.00, or $9.98 per gram.

Recycling: None.

Import Sources (1998-2001): 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 12/31/02
Alkali metals, other	2805.19.9000	5.5% ad val.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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RUBIDIUM

Events, Trends, and Issues: Consumption of rubidium and its compounds was of little commercial significance. No major breakthroughs or developments are anticipated that would change rubidium production or consumption patterns. Domestic rubidium production is entirely dependent upon imported lepidolite ores. Because of the small scale output of rubidium products, no significant environmental problems have been encountered.

World Mine Production, Reserves, and Reserve Base: 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, a cesium aluminosilicate mineral, may contain up to 1.35% rubidium. Rubidium-bearing minerals are mined as byproducts or coproducts with other pegmatite minerals.

World Resources: Total world resources of rubidium are unknown.

Substitutes: 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.

[1]Prepared by Robert G. Reese, Jr.

SALT

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Domestic production of salt decreased slightly in 2002, with total value estimated at $1 billion. Thirty companies operated 68 plants in 15 States. The estimated percentage of salt sold or used, by type, was salt in brine, 48%; rock salt, 35%; vacuum pan, 10%; and solar salt, 7%.

The chemical industry consumed about 41% of total salt sales, with salt in brine representing about 90% 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 34% of U.S. demand. The remaining markets for salt, in declining order, were distributors, 8%; industrial, 6%; agricultural, 4%; food, 4%; other combined with exports, 2%; and primary water treatment, 1%.

Salient Statistics—United States:[1]	**1998**	**1999**	**2000**	**2001**	**2002**[e]
Production	41,200	44,900	45,600	44,800	43,900
Sold or used by producers	40,800	44,400	43,300	42,200	41,200
Imports for consumption	8,770	8,870	8,960	12,900	10,000
Exports	731	892	642	1,120	1,000
Consumption:					
Reported	44,200	50,000	54,000	48,700	50,200
Apparent	48,800	52,400	51,600	54,000	50,200
Price, average value of bulk, pellets and packaged salt, dollars per ton, f.o.b. mine and plant:					
Vacuum and open pan salt	114.93	112.49	113.95	120.02	122.00
Solar salt	37.56	52.08	50.46	52.33	45.00
Rock salt	21.90	22.55	20.67	21.84	20.00
Salt in brine	5.93	6.65	5.70	6.26	6.00
Stocks, producer, yearend[e 2]	400	500	2,300	—	—
Employment, mine and plant, number	4,150	4,100	4,100	4,100	4,000
Net import reliance[3] as a percentage of apparent consumption	17	15	16	22	18

Recycling: None.

Import Sources (1998-2001): Canada, 41%; Chile, 21%; Mexico, 13%; The Bahamas, 9%; and other, 16%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/02**
Iodized salt	2501.00.0000	Free.

Depletion Allowance: 10% (Domestic and foreign).

Government Stockpile: None.

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SALT

Events, Trends, and Issues: A cost/benefit analysis by a government agency in Switzerland and a university in Germany concluded that using sand as a road deicer was six times more costly than using deicing salt. Their study stated that sand, which had been assumed to be environmentally acceptable because it did not contain any salt, was more detrimental to the environment. As a result, several European cities are reducing their use of sand.

Three new salt plants, two in Spain and one in Portugal, were constructed using new proprietary technology that involves hydromilling, elutriation, hydroclassification, and hydroextraction. The plants in Spain are in Súria and Cardona, and the one in Portugal is near Pombal. Salt is recovered as a byproduct from potassium chloride at the Súria facility and from a salt dome at Cardona. In Pombal, salt is obtained as brine from the solution mining of underground halite in which large cavities are developed to store natural gas.

A major European salt producer announced the closure of its evaporative salt plant in Stade, Germany. The company cited overcapacity, low prices, and rising energy costs as the reasons for the closure. It had also cut back on production and employment at its other salt facility in Hengelo, Netherlands.

In the Ust'-Vym district of the Komi Republic of Russia, construction began on a new $70 million salt brine and evaporative salt facility. About 350,000 tons of high-grade salt are to be produced annually from a solution mining network that uses an interconnected ten-well system.

Domestic consumption of salt in 2003 is expected to be higher than that of 2002. However, weather forecasters indicated that the winter of 2002–03 may be relatively mild because of an El Niño weather episode developing in late 2002. If this occurs, consumption of salt for highway deicing may be less than normal.

World Production, Reserves, and Reserve Base:

	Production		Reserves and reserve base[4]
	2001	2002[e]	
United States[1]	44,800	43,900	Large. Economic and subeconomic deposits of salt are substantial in principal salt-producing countries. The oceans contain an inexhaustible supply of salt.
Australia	9,500	10,000	
Brazil	6,000	7,000	
Canada	12,500	13,000	
China	31,000	35,000	
France	7,000	7,100	
Germany	15,700	15,700	
India	14,500	14,800	
Italy	3,600	3,600	
Mexico	8,900	8,700	
Poland	4,200	4,300	
Russia	2,800	3,000	
Spain	3,200	3,200	
Ukraine	2,300	2,400	
United Kingdom	5,800	5,800	
Other countries	53,200	48,000	
World total (may be rounded)	225,000	225,000	

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. — Zero.
[1]Excludes Puerto Rico production.
[2]Reported stock data are incomplete. For apparent consumption and net import reliance calculations, changes in annual stock totals are assumed to be the difference between salt produced and salt sold or used.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions.

SAND AND GRAVEL (CONSTRUCTION)[1]

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

Domestic Production and Use: Construction sand and gravel valued at $5.8 billion was produced by an estimated 4,000 companies from 6,300 operations in 50 States. Leading States, in order of decreasing tonnage, were California, Texas, Michigan, Arizona, Ohio, Minnesota, Washington, Colorado, and Wisconsin, which together accounted for about 51% of the total output. It is estimated that about 51% of the 1.13 billion metric tons of construction sand and gravel produced in 2002 was for unspecified uses. Of the remaining total, about 45% was used as concrete aggregates; 22% for road base and coverings and road stabilization; 13% as asphaltic concrete aggregates and other bituminous mixtures; 13% as construction fill; 2% for concrete products, such as blocks, bricks, pipes, etc.; 1% for plaster and gunite sands; and the remaining 4% for snow and ice control, railroad ballast, roofing granules, filtration, and other miscellaneous uses.

The estimated output of construction sand and gravel in the 48 conterminous States shipped for consumption in the first 9 months of 2002 was about 847 million tons, unchanged from the revised total for the same period of 2001. Additional production information by quarter for each State, geographic region, and the United States is published by the U.S. Geological Survey in the Mineral Industry Surveys for Crushed Stone and Sand and Gravel (quarterly).

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production	1,070	1,110	1,120	1,130	1,130
Imports for consumption	1	2	3	4	4
Exports	2	2	2	3	3
Consumption, apparent	1,070	1,110	1,120	1,130	1,130
Price, average value, dollars per ton	4.57	4.73	4.81	5.02	5.14
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e]	35,600	37,800	37,800	37,500	35,300
Net import reliance[3] as a percentage of apparent consumption	—	—	([4])	([4])	([4])

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

Import Sources (1998-2001): Canada, 66%; Mexico, 19%; The Bahamas, 4%; and other, 11%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/02**
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 remained at approximately 1.13 billion tons, about equal to that of 2001. It is estimated that 2003 domestic production and U.S. apparent consumption will be about 1.2 billion tons each, a slight increase. Aggregate consumption is expected to continue to grow slowly in response to the slowing economy and reductions in outlays for road and other construction. Although some areas of the country should experience increased sales and consumption of sand and gravel and other areas will have decreases, overall growth should be slightly positive.

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

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	2001	2002[e]	
United States	1,130	1,130	The reserves and reserve base are controlled largely by land use and/or environmental constraints.
Other countries[6]	NA	NA	
World total	NA	NA	

World Resources: Sand and gravel resources of the world are large. However, because of their geographic distribution, environmental restrictions, and quality requirements for some uses, 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. — Zero.
[1]See also Sand and Gravel (Industrial).
[2]See Appendix A for conversion to short tons.
[3]Defined as imports - exports + adjustments for Government and industry stock changes; changes in stocks not available and assumed to be zero.
[4]Less than ½ unit.
[5]See Appendix C for definitions.
[6]No reliable production information for other countries is available, owing to a wide variation of ways in which countries report their sand and gravel production. Some countries do not report production for this mineral commodity. Production information for some countries is available in the country chapters of the USGS Minerals Yearbook.

SAND AND GRAVEL (INDUSTRIAL)

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Industrial sand and gravel valued at about $566 million was produced by 70 companies from 160 operations in 36 States. Leading States, in order of tonnage, were Illinois, Michigan, California, Texas, North Carolina, Wisconsin, New Jersey, and Oklahoma. Combined production from these States represented 61% of the domestic total. About 37% of the U.S. tonnage was used as glassmaking sand, 21% as foundry sand, 6% as hydraulic fracturing sand, 5% as abrasive sand, and 31% was for other uses.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production	28,200	28,900	28,400	27,900	28,000
Imports for consumption	44	211	247	172	170
Exports	2,400	1,670	1,660	1,540	1,540
Consumption, apparent	26,200	27,400	27,400	26,500	26,600
Price, average value, dollars per ton	18.19	18.64	19.58	20.64	20.20
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e]	1,400	1,400	1,400	1,400	1,400
Net import reliance[1] as a percentage of apparent consumption	E	E	E	E	E

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

Import Sources (1998-2001): Canada, 87%; Trinidad and Tobago, 5%; China, 3%; and other, 5%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
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 2002 decreased by about 2% compared with those of 2001. U.S. apparent consumption was 26.6 million tons in 2002, increasing slightly over the previous year. Imports remained about the same as those of 2001. Imports of silica are generally of two types: small-quantity shipments of very-high-purity silica or a few large shipments of lower grade silica that were shipped only under special circumstances (e.g., very low freight rates).

The United States was the world's largest producer and consumer of industrial sand and gravel based on estimated world production figures. It was difficult to collect definitive numbers on silica sand and gravel production in most nations because of the wide range of terminology and specifications 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 for a large variety of grades of silica, meeting virtually every specification for silica sand and gravel.

Domestic production and apparent consumption is estimated to be about 28 million tons and 27 million tons, respectively, in 2003.

The industrial sand and gravel industry continued to be concerned with safety and health regulations and environmental restrictions in 2002. Local shortages were expected to continue to increase owing to local zoning regulations and land development alternatives. These situations are expected to cause future sand and gravel operations to be located farther from high-population centers.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e]		Reserves and reserve base[2]
	2001	2002	
United States	27,900	28,000	
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	5,800	5,800	
Belgium	2,400	2,400	
Brazil	2,700	2,700	
Canada	2,000	2,000	
France	6,600	6,600	
Germany	6,800	6,800	
India	1,400	1,400	
Italy	3,000	3,000	
Japan	2,500	2,500	
Mexico	1,700	1,800	
Netherlands	3,000	3,000	
South Africa	2,100	2,100	
Spain	6,000	6,000	
United Kingdom	4,000	4,000	
Other countries	15,000	15,000	
World total (rounded)	95,000	96,000	

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; alternatives are zircon, olivine, staurolite, and chromite sands.

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

SCANDIUM[1]

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

Domestic Production and Use: Demand for scandium increased slightly in 2002. Although scandium was not mined domestically in 2002, quantities sufficient to meet demand were available in domestic tailings. Principal sources were imports from China, Russia, and Ukraine. Companies with scandium processing capabilities 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 2002 were aluminum alloys for sporting equipment, metallurgical research, high-intensity metal halide lamps, analytical standards, electronics, and laser research.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Price, yearend, dollars:					
Per kilogram, oxide, 99.0% purity	1,100	900	700	700	700
Per kilogram, oxide, 99.9% purity	2,300	2,000	2,000	2,300	2,000
Per kilogram, oxide, 99.99% purity	3,400	3,000	3,000	2,700	2,500
Per kilogram, oxide, 99.999% purity	5,750	4,000	6,000	4,100	3,200
Per gram, dendritic, metal[2]	285.00	270.00	270.00	279.00	178.00
Per gram, metal, ingot[3]	172.00	175.00	175.00	198.00	198.00
Per gram, scandium bromide, 99.99% purity[4]	90.00	91.80	91.80	94.60	94.60
Per gram, scandium chloride, 99.9% purity[4]	38.80	39.60	39.60	40.80	40.80
Per gram, scandium fluoride, 99.9% purity[4]	78.50	80.10	80.10	173.00	173.00
Per gram, scandium iodide, 99.999% purity[4]	148.00	151.00	151.00	156.00	156.00
Net import reliance[5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1998-2001): Not available.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Mineral substances not elsewhere specified or included:		
Including scandium ores	2530.90.8050	Free.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed including scandium	2805.30.0000	5.0% ad val.
Mixtures of rare-earth oxides except cerium oxide, including scandium oxide mixtures	2846.90.2010	Free.
Rare-earth compounds, including individual rare-earth oxides, hydroxides, nitrates, and other individual compounds, including scandium oxide	2846.90.8000	3.7% ad val.
Aluminum alloys, other:		
Including scandium-aluminum	7601.20.9090	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Nominal prices for domestically produced scandium compounds decreased from the previous year. The supply of domestic and foreign scandium remained strong despite increased demand. Although demand increased in 2002, the total market remained very small. Domestic increases in demand were primarily from recently developed applications in welding wire, scandium-aluminum baseball and softball bats, scandium-aluminum bicycle frames, and high-strength, lightweight handgun frames and cylinders. New demand is expected in future fuel cell markets.

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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 simulate 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 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:[6] 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 2002. Scandium occurs in many ores in trace amounts, but has not been found in sufficient quantities to be considered as a reserve or reserve base. As a result of its low concentration, scandium has been produced exclusively as a byproduct during processing of various ores or recovered from previously processed tailings or residues.

World Resources: Resources of scandium are abundant, especially when considered in relation to actual and potential demand. Scandium is rarely concentrated in nature due to its lack of affinity to combine with the common ore forming anions. It is widely dispersed in the lithosphere and forms solid solutions in over 100 minerals. In the Earth's crust, scandium is primarily a trace constituent of ferromagnesium minerals. Concentrations in these minerals (amphibole-hornblende, 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. 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 thortveitite and 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, cobalt, iron, molybdenum, nickel, phosphate, tantalum, tin, titanium, tungsten, zinc, and zirconium. Process residues from tungsten operations in the United States also contain significant amounts of scandium.

Foreign resources are known in Australia, China, Kazakhstan, Madagascar, Norway, Russia, and Ukraine. Resources in Australia are contained in nickel and cobalt deposits in Syerston and Lake Innes, New South Wales. China's resources are in 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]See also Rare Earths.
[2]Less than 250 micron, 99.9% purity, 1995 through 2000 prices converted from 0.5-gram price, from Alfa Aesar, a Johnson Matthey company. Metal pieces, distilled dendritic, 99.9% purity.
[3]Lump, sublimed dendritic 99.99% purity, from Alfa Aesar, a Johnson Matthey company, 1997 through 2000. Metal pieces 99.9% purity for 2001 through 2002.
[4]Bromide, chloride, and fluoride in crystalline or crystalline aggregate form and scandium iodide as ultradry powder from Alfa Aesar, a Johnson Matthey company.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]See Appendix C for definitions.

SELENIUM[1]

(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, 12%; and other, including agriculture and metallurgy, 33%. 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 because selenium has been supplanted by newer materials in currently manufactured copiers.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, refinery	W	W	W	W	W
Imports for consumption, metal and dioxide	339	326	452	500	365
Exports, metal, waste and scrap	151	233	89	75	94
Consumption, apparent[2]	W	W	W	W	W
Price, dealers, average, dollars per pound, 100-pound lots, refined	2.49	2.55	3.82	3.85	3.88
Stocks, producer, refined, yearend	W	W	W	W	W
Employment, number	NA	NA	NA	NA	NA
Net import reliance[3] as a percentage of apparent consumption	W	W	W	W	W

Recycling: There was no domestic production of secondary selenium. Scrap xerographic materials were exported for recovery of the contained selenium. An estimated 25 tons of selenium metal was recovered from imported scrap in 2002.

Import Sources (1998-2001): Canada, 36%; Philippines, 31%; Belgium, 7%; United Kingdom, 4%; and other, 22%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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: In 2002, domestic consumption of selenium decreased slightly when compared with that of 2001. The average annual global consumption of selenium over the past 4 years is estimated to have been about 1,900 tons per year. Production of selenium was expected to decrease in 2002 owing to the use of ores with lower selenium content, the use of solvent extraction instead of older slime-producing technology, and the closure of some copper operations. The price of selenium was nearly constant at $3.50-$4.00 per pound for the first half of 2002. Concern over supply caused the price to increase to $3.75-$4.25 per pound in the second half of the year.

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 were met (ordinary free-machining brass contains up to 7% lead). Alloys with bismuth/selenium additions are dominating this market. Selenium also 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, and the use of selenium supplements in the plant-animal-human food chain increased. However, even if proven safe and effective, the dosage requirement for direct human consumption would be small, 200 to 400 micrograms per day per person; consequently, selenium demand would not change dramatically. Increased supplementation of fertilizer could 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: Reserves and reserve base estimates for Chile, Peru, and Zambia have been increased base on new information from those countries.

	Refinery production		Reserves[4]	Reserve base[4]
	2001	2002[e]		
United States	W	W	10,000	19,000
Belgium	200	200	—	—
Canada	350	360	6,400	15,000
Chile	45	45	16,000	37,000
Finland	25	25	—	—
Germany	100	100	—	—
Japan	739	650	—	—
Peru	23	25	5,400	9,300
Philippines	40	40	2,000	3,000
Sweden	20	20	—	—
Yugoslavia	20	20	1,000	2,000
Zambia	9	10	3,500	6,500
Other countries[5]	9	10	42,000	90,000
World total (rounded)	[6]1,580	[6]1,460	84,000	180,000

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. — Zero.
[1]Prepared by Henry E. Hilliard.
[2]Defined as reported shipments + imports of selenium metal - estimated exports of selenium metal, excluding scrap.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions.
[5]In addition to the countries listed, Australia, China, India, Kazakhstan, Russia, the United Kingdom, and Zimbabwe are known to produce refined selenium.
[6]Excludes U.S. production.

SILICON

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

Domestic Production and Use: Estimated value of silicon metal and alloys (excluding semiconductor-grade silicon) produced in the United States in 2002 was about $265 million. Ferrosilicon was produced by four companies in five plants, and silicon metal was produced by three companies in four plants. Two of the six companies in the industry produced both products. All of the active ferrosilicon and silicon metal plants were east of the Mississippi River. Most ferrosilicon was consumed in the ferrous foundry and steel industries, predominantly in the eastern one-half of the United States. The main consumers of silicon metal were producers of aluminum and aluminum alloys and the chemical industry. The semiconductor industry, which manufactures chips for computers from high-purity silicon, accounted for only a few percent of silicon demand.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production	429	423	367	282	270
Imports for consumption	241	286	361	231	280
Exports	47	61	41	23	21
Consumption, apparent	616	643	689	502	509
Price,[1] average, cents per pound Si:					
Ferrosilicon, 50% Si	52.1	49.1	45.0	42.8	41
Ferrosilicon, 75% Si	43.1	40.2	35.4	31.9	32
Silicon metal	70.5	58.1	54.8	50.5	52
Stocks, producer, yearend	50	54	52	40	61
Net import reliance[2] as a percentage of apparent consumption	30	34	47	44	47

Recycling: Insignificant.

Import Sources (1998-2001): Norway, 23%; South Africa, 17%; Russia, 11%; Canada, 10%; and other, 39%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
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 2002 is projected to be just slightly more than that for 2001, or approximately 17% less than the average for 1998-2001. Of the 2002 total, the share accounted for by ferrosilicon is estimated to have decreased to 52% from 53% in 2001, while that for silicon metal increased to 48% from 47%. The annual growth rate for ferrosilicon demand usually falls in the range of 1% to 2%, in line with long-term trends in steel production. Through the first one-half of 2002, however, domestic steel production was 4% less than for 2001. In recent years, the annual growth rate for overall silicon metal demand has been in the vicinity of 5%. In 2002, this rate probably was not sustained, at least in part, because of lagging global demand by the chemical industry, principally for silicones. In 2000, the demand growth rate in the chemicals sector was nearly 7% per year. Prior to that, it had averaged about 8%.

Domestic production in 2002, expressed in terms of contained silicon, is projected to have declined. For all silicon materials combined, the overall decline was 4% to the lowest level since 1982. Production was curtailed or stopped at some plants because of high power costs and/or slackening demand.

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SILICON

Through the first 9 months of 2002, price trended upward in the U.S. market for silicon materials. Compared with those at the beginning of the year, prices as of the end of September were 16% to 22% higher for ferrosilicon and about 12% for silicon metal. Year-average prices were projected to be slightly lower for 50% ferrosilicon, about the same for 75% ferrosilicon, and slightly higher for silicon metal than those for 2001. At the end of September, the range in dealer import price, in cents per pound of contained silicon, was 44 to 46 for 50% ferrosilicon, 34.5 to 36.5 for 75% ferrosilicon, and 54 to 57 for silicon metal.

U.S. imports and exports of silicon materials in 2002, projected on the basis of data for the first 6 months of the year, were 4% less than those in 2001. The smallest overall percentage decline was for imports of silicon metal. Net import reliance declined significantly in comparison with that for recent years owing to a large increase in domestic ferrosilicon stocks.

World Production, Reserves, and Reserve Base:

	Production[e]		Reserves and reserve base[3]
	2001	**2002**	
United States	282	270	The reserves and reserve base in most major producing countries are ample in relation to demand. Quantitative estimates are not available.
Brazil	213	250	
Canada	66	69	
China	1,073	1,500	
France	139	140	
Iceland	46	47	
India	33	34	
Kazakhstan	95	99	
Norway	391	400	
Poland	47	46	
Russia	499	490	
Slovakia	33	34	
South Africa	110	110	
Spain	55	57	
Ukraine	211	200	
Venezuela	39	58	
Other countries	208	230	
World total (rounded)	3,500	4,100	

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 both ferrosilicon and silicon metal. An estimated 340,000 metric tons of silicon metal is included in China's total silicon production for 2002.

World Resources: World and domestic resources for making silicon metal and alloys are abundant, and, in most producing countries, adequate to supply world requirements for many decades. The source of the silicon is silica in various natural forms, such as quartzite.

Substitutes: Aluminum, silicon carbide, and silicomanganese can be substituted for ferrosilicon in some applications. Gallium arsenide and germanium are the principal substitutes for silicon in semiconductor and infrared applications.

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

SILVER

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

Domestic Production and Use: In 2002, U.S. mine production of silver was about 1,470 tons with an estimated value of $214 million. Nevada was the largest producer, with more than 600 tons. Precious metal ores accounted for approximately one-half of domestic silver production; the remainder was recovered as a byproduct from the processing of copper, lead, and zinc ores. There were 21 principal refiners of commercial-grade silver, with an estimated total output of approximately 2,900 tons. About 30 fabricators accounted for more than 90% of the silver consumed in arts and industry. The remainder was consumed mostly by small companies and artisans. Aesthetic uses of silver for decorative articles, jewelry, tableware, and coinage were overshadowed by industrial and technical uses. Industrial and technical uses include photographic materials, electrical and electronic products, catalysts, brazing alloys, dental amalgam, and bearings.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production:					
Mine	2,060	1,950	1,860	1,740	1,470
Refinery:					
Primary	2,300	2,000	2,780	2,640	2,900
Secondary	1,700	1,500	1,680	1,060	1,600
Imports for consumption[2]	3,330	2,660	3,810	3,310	3,630
Exports[2]	2,250	481	279	963	885
Consumption, apparent[e]	5,300	5,500	6,300	5,800	5,340
Price, dollars per troy ounce[3]	5.54	5.25	5.00	4.39	4.52
Stocks, yearend:					
Treasury Department[4]	582	617	220	220	220
COMEX, CBT[5]	2,360	2,360	2,920	3,342	3,272
National Defense Stockpile	1,030	778	458	200	—
Employment, mine and mill,[6] number	1,550	1,500	1,500	1,100	1,100
Net import reliance[7] as a percentage of apparent consumption[e]	43	39	43	44	61

Recycling: About 1,100 tons of silver was recovered from old and new scrap in 2001.

Import Sources[2] (1998-2001): Canada, 40%; Mexico, 37%; Peru, 7%; United Kingdom, 3%; and other, 13%.

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

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

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

Stockpile Status—9-30-02[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Silver	21	21	21	249	300

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SILVER

Events, Trends, and Issues: Digital imaging has become a serious threat to silver-based photographic applications. 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.

A considerable amount of silver is a byproduct of zinc mining. The closure of several uneconomic zinc mines owing to low zinc prices indicates a trend that may become significant to world silver output. Although some of the mines have been closed permanently, others have been placed on standby until zinc prices improve. Together, the closed zinc mines represent a loss of approximately 80 tons per year of silver. In addition, mine production cuts in copper will eliminate another 60 tons per year of silver output. These zinc and copper cuts are small when compared with global silver production of more than 18,000 tons in 2001. However, more cuts in the United States could significantly reduce domestic mined silver output in 2002 and beyond.

World Mine Production, Reserves, and Reserve Base: A decrease in estimated silver reserves for Canada, an increase in estimated silver reserves for Peru, and the inclusion of reserves and reserve base estimates for China were based on new information from those countries.

	Mine production		Reserves[9]	Reserve base[9]
	2001	2002[e]		
United States	1,740	1,470	25,000	80,000
Australia	2,100	2,200	31,000	37,000
Canada	1,270	1,300	16,000	35,000
China	1,800	1,800	26,000	115,000
Mexico	2,760	2,800	37,000	40,000
Peru	2,350	2,300	36,000	37,000
Other countries	6,680	8,500	104,000	180,000
World total (may be rounded)	18,700	18,800	270,000	520,000

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 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 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. — Zero.
[1]One metric ton (1,000 kilograms) = 32,150.7 troy ounces.
[2]Refined bullion, plus silver content of ores, concentrates, precipitates, and doré; excludes coinage, waste, and scrap material.
[3]Handy & Harman quotations.
[4]Balance in U.S. Mint only.
[5]COMEX: Commodity Exchange Inc., New York. CBT: Chicago Board of Trade.
[6]Source: Mine Safety and Health Administration.
[7]Defined as imports - exports + adjustments for Government and industry stock changes.
[8]See Appendix B for definitions.
[9]Includes silver recoverable from base metal ores. See Appendix C for definitions.

SODA ASH

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: The U.S. soda ash (sodium carbonate) industry, which is the largest in the world, comprised four companies in Wyoming operating five plants, one company in California with one plant, and one company with one plant in Colorado. The six producers have a combined annual nameplate capacity of 14.5 million tons. Sodium bicarbonate, sodium sulfate, potassium chloride, potassium sulfate, borax, and other minerals were produced as coproducts from sodium carbonate production in California. Sodium bicarbonate, sodium sulfite, sodium tripolyphosphate, and chemical caustic soda were manufactured as coproducts at several of the Wyoming soda ash plants. Sodium bicarbonate was produced as a coproduct at the Colorado operation. The total estimated value of domestic soda ash produced in 2002 was $770 million.[1]

Based on final 2001 data, the estimated 2002 reported distribution of soda ash by end use was glass, 48%; chemicals, 26%; soap and detergents, 11%; distributors, 5%; flue gas desulfurization, pulp and paper, and water treatment, 2% each; and other, 4%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production[2]	10,100	10,200	10,200	10,300	10,300
Imports for consumption	83	92	75	33	10
Exports	3,660	3,620	3,900	4,090	4,100
Consumption:					
Reported	6,550	6,430	6,390	6,380	6,240
Apparent	6,560	6,740	6,430	6,310	6,240
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	75.30	69.11	66.23	67.79	68.00
Stocks, producer, yearend	273	248	245	226	200
Employment, mine and plant, number	2,700	2,600	2,600	2,700	2,600
Net import reliance[3] as a percentage of apparent consumption	E	E	E	E	E

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

Import Sources (1998-2001): Canada, 99%; and other, 1%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/02**
Disodium carbonate	2836.20.0000	1.2% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: The domestic market for soda ash for the first half of the year was virtually identical to that of the corresponding period in 2001. Despite major price increase attempts that were initiated in late 2001, the estimated average annual value for 2002 was relatively unchanged. The U.S. soda ash industry was optimistic that the projected increase in exports in the last two quarters could bolster soda ash sales and revenue. To stimulate profitability, the industry in September announced a $7-per-ton increase in the off-list price of soda ash.

Because of mounting financial pressures, the parent company of the newest soda ash plant built in the United States decided to sell its 60% share of the Colorado facility early in the year. The only company that was interested in purchasing the plant was the remaining partner, which was attempting to secure financing by yearend.

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SODA ASH

A major Wyoming soda ash producer signed a letter of intent with a Utah-based power company to supply a sodium compound used for manufacturing spheres that store hydrogen for release on demand. The spheres, which contain sodium hydride that releases hydrogen when exposed to water, are encased in a waterproof plastic coating that can be cut open to expose the compound. The technology is particularly useful to developing countries that have limited energy resources. The hydrogen can power fuel cells to operate automobiles, houses, or nearly anything that currently is powered by electricity.

The United States continues to be the largest supplier of soda ash in the world; however, China continues expanding its soda ash manufacturing capability. Soda ash demand in China is very strong, with domestic supplies being augmented by imports from the United States. It is anticipated that competition with China for markets in Asia will be strong in the future. Notwithstanding economic and energy problems in certain areas of the world, overall global demand for soda ash is expected to grow from 1.5% to 2% annually. Domestic demand should be slightly higher in 2003.

World Production, Reserves, and Reserve Base:

	Production		Reserves[4 5]	Reserve base[5]
Natural:	2001	2002[e]		
United States	10,300	10,300	[6]23,000,000	[6]39,000,000
Botswana	270	270	400,000	NA
Kenya	260	300	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)	10,800	10,900	24,000,000	40,000,000
World total, synthetic (rounded)	24,300	22,100	XX	XX
World total (rounded)	35,100	33,000	XX	XX

World Resources: Soda ash is obtained from trona and sodium carbonate-rich brines. The world's largest deposit of trona is in the Green River Basin of Wyoming. About 47 billion metric tons of identified soda ash resources could be recovered from the 56 billion tons of bedded trona and the 47 billion tons of interbedded or intermixed trona and halite that are in beds more than 1.2 meters thick. About 34 billion tons of reserve base soda ash could be obtained from the 36 billion tons of halite-free trona and the 25 billion tons of interbedded or intermixed trona and halite that are in beds more than 1.8 meters thick. Underground room-and-pillar mining, using a combination of conventional, continuous, and shortwall mining equipment is the primary method of mining Wyoming trona ore. The method has an average 45% mining recovery, which is higher than the 30% average mining recovery from solution mining. Improved solution mining techniques, such as horizontal drilling to establish communication between well pairs, could increase this extraction rate and 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 of soda ash). Searles Lake and Owens Lake in California contain an estimated 815 million tons of soda ash reserves. There are at least 62 identified natural sodium carbonate deposits in the world, some of which have been quantified. Although soda ash can be manufactured from salt and limestone, both of which are practically inexhaustible, synthetic soda ash is more costly to produce and generates environmentally deleterious wastes.

Substitutes: Caustic soda can be substituted for soda ash in certain uses, particularly in the pulp and paper, water treatment, and certain chemical sectors. Soda ash, soda liquors, or trona can be used as feedstock to manufacture chemical caustic soda, which is an alternative to electrolytic caustic soda.

[e]Estimated. E Net exporter. NA Not available. XX Not applicable. — Zero.
[1]Does not include values for soda liquors and mine waters.
[2]Natural only.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]The reported quantities are sodium carbonate only. About 1.8 tons of trona yields 1 ton of sodium carbonate.
[5]See Appendix C for definitions.
[6]From trona, nahcolite, and dawsonite sources.

SODIUM SULFATE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: The domestic natural sodium sulfate industry consisted of two producers operating two plants in California and Texas. Fifteen companies operating 16 plants in 13 States recovered byproduct sodium sulfate from various manufacturing processes or products, including ascorbic acid, battery reclamation, cellulose, rayon, and silica pigments. More than one-half of total output was a byproduct of these plants. The total value of natural and synthetic sodium sulfate sold was an estimated $55 million. Estimates of U.S. sodium sulfate consumption by end use were soap and detergents, 46%; pulp and paper, 13%; textiles, 12%; glass, 11%; carpet fresheners, 7%; and miscellaneous, 11%.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production, total (natural and synthetic)[1]	571	599	462	512	500
Imports for consumption	110	87	73	34	40
Exports	90	137	165	191	100
Consumption, apparent (natural and synthetic)	591	549	370	355	440
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	3	E	E	E	E

Recycling: There was some recycling of sodium sulfate by consumers, particularly in the pulp and paper industry, but no recycling by sodium sulfate producers.

Import Sources (1998-2001): Canada, 95%; Mexico, 4%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Disodium sulfate:		
Saltcake (crude)	2833.11.1000	Free.
Other:	2833.11.5000	0.4% ad val.
Anhydrous	2833.11.5010	0.4% ad val.
Other	2833.11.5050	0.4% ad val.

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

Government Stockpile: None.

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SODIUM SULFATE

Events, Trends, and Issues: The first pair of evaporation ponds to produce sodium sulfate with coproduct iodine at Aguas Blancas, Chile, went into operation at midyear. The initial phase of the project was scheduled to produce 50,000 tons annually with full production targeted for 300,000 tons per year. When in full operation, the facility will be the largest sodium sulfate producer in South America.

Domestic sodium sulfate demand continued to decline in 2002. Although powdered home laundry detergents may contain as much as 50% sodium sulfate in their formulation, the market for liquid detergents, which do not contain any sodium sulfate, continued to grow. Sodium sulfate consumption in the textile industry also has been declining because imports of less expensive textile products have won a greater share of the domestic market. Declining domestic demand in the past several years resulted in a decrease of sodium sulfate imports, especially from Canada. However, growth in powdered home laundry detergents abroad (approximately 80% of world sodium sulfate consumption is for detergents) and the expanding textile sectors in Central America and South America caused U.S. sodium sulfate exports to increase. Exports are expected to continue increasing in the next few years.

The outlook for sodium sulfate in 2003 is expected to be comparable with that of 2002, with detergents remaining the largest sodium sulfate-consuming sector. If the winter of 2002–03 is relatively mild, byproduct recovery of sodium sulfate from automobile batteries may decline because fewer battery failures during mild winter weather reduces recycling. World production and consumption of sodium sulfate have been stagnant but are expected to grow in the next few years, especially in Asia and South America.

World Production, Reserves, and Reserve Base: Although data on mine production for natural sodium sulfate are not available, total world production of natural sodium sulfate is estimated to be about 4 million tons. Total world production of byproduct sodium sulfate is estimated to be between 1.5 million and 2.0 million tons.

	Reserves[3]	Reserve base[3]
United States	860,000	1,400,000
Canada	84,000	270,000
Mexico	170,000	230,000
Spain	180,000	270,000
Turkey	100,000	NA
Other countries	1,900,000	2,400,000
World total	3,300,000	4,600,000

World Resources: Sodium sulfate resources are sufficient to last hundreds of years at the present rate of world consumption. In addition to the countries listed above with reserves, the following countries also contain identified resources of sodium sulfate: Botswana, China, Egypt, Italy, Mongolia, Romania, and South Africa. Commercial production from domestic resources is from deposits in California and Texas. The brine in Searles Lake, CA, contains about 450 million tons of sodium sulfate resource, representing about 35% of the lake's brine. In Utah, about 12% of the dissolved salts in the Great Salt Lake is sodium sulfate, representing about 400 million tons of resource. An irregular, 21-meter-thick mirabilite deposit is associated with clay beds 4.5 to 9.1 meters below the lake bottom near Promontory Point, UT. Several playa lakes in west Texas contain underground sodium-sulfate-bearing brines and crystalline material. Other economic and subeconomic deposits of sodium sulfate are near Rhodes Marsh, NV, Grenora, ND, Okanogan County, WA, and Bull Lake, WY. Sodium sulfate 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 $9.1 billion was produced by 1,300 companies operating 3,400 active quarries in 49 States. Leading States, in order of production, were Texas, Florida, Pennsylvania, Missouri, Illinois, Ohio, Georgia, North Carolina, California, and Virginia, together accounting for 52.5% of the total output. It is estimated that about 50% of the 1.59 billion tons of crushed stone produced in 2002 was for unspecified uses, of which 16% was estimated for nonrespondents to the U.S. Geological Survey (USGS) canvasses. Of the remaining 795 million tons reported by uses, 83% 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 2% 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 USGS Minerals Yearbook, are not included in the above percentages. Of the total crushed stone produced in 2002, about 71% was limestone and dolomite; 15%, granite; 8%, traprock; and the remaining 6%, was shared, in descending order of quantity, by sandstone and quartzite, miscellaneous stone, marble, calcareous marl, slate, volcanic cinder and scoria, and shell.

The estimated output of crushed stone in the 48 conterminous States shipped for consumption in the first 9 months of 2002 was 1.18 billion tons, which represents an increase of 0.6% compared with the same period of 2001. Additional production information, by quarter for each State, geographic division, and the United States, is published in the USGS Mineral Industry Surveys for Crushed Stone and Sand and Gravel (quarterly).

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production	1,510	1,530	1,550	1,600	1,590
Imports for consumption	14	12	13	13	14
Exports	4	4	4	4	4
Consumption, apparent[3]	1,520	1,550	1,560	1,610	1,600
Price, average value, dollars per metric ton	5.39	5.35	5.39	5.57	5.72
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e 4]	78,500	79,000	78,800	79,200	79,000
Net import reliance[5] as a percentage of apparent consumption	1	1	1	([6])	([6])

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

Import Sources (1998-2001): Canada, 52%; Mexico, 34%; The Bahamas, 8%; and other, 6%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
Crushed stone	2517.10.00	Free.

Depletion Allowance: (Domestic) 14% for some special uses; 5% if used as riprap, ballast, road material, concrete aggregate, and similar purposes.

Government Stockpile: None.

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STONE (CRUSHED)

Events, Trends, and Issues: Crushed stone output decreased 1.2% in 2002 to 1.59 billion tons. It is estimated that in 2003, domestic production and apparent consumption will be about 1.62 billion tons each, a 2.5% 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 Aviation Investment and Reform Act for the 21st Century (Public Law 106-181), signed into law on April 5, 2000, is a 3-year reauthorization of Federal Aviation Administration programs. The law released an estimated $3.3 billion in fiscal year 2002, and will release $3.4 billion in fiscal year 2003, the second and third years of the program.

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[7]
	2001	2002[e]	
United States	1,600	1,590	Adequate except where special
Other countries[8]	NA	NA	types are needed or where
World total	NA	NA	local shortages exist.

World Resources: Stone resources of the world are very large. High-purity limestone and dolomite suitable for specialty uses are limited in many geographic areas. The largest resources of high-purity limestone and dolomite in the United States are in the central and eastern parts of the country.

Substitutes: Crushed stone substitutes for roadbuilding include sand and gravel and slag. Substitutes for crushed stone used as construction aggregates include sand and gravel, slag, sintered or expanded clay or shale, and perlite or vermiculite.

[e]Estimated. NA Not available.
[1]See also Stone (Dimension).
[2]See Appendix A for conversion to short tons.
[3]Data rounded to no more than three significant digits.
[4]Including office staff.
[5]Defined as imports - exports + adjustments for Government and industry stock changes. Changes in stocks were assumed to be zero in the net import reliance and apparent consumption calculations because data on stocks were not available.
[6]Less than ½ unit.
[7]See Appendix C for definitions.
[8]No reliable production information for other countries is available, owing to a wide variation of ways in which countries report their crushed stone production. Some countries do not report production for this mineral commodity. Production information for some countries is available in the country chapters of the USGS Minerals Yearbook.

STONE (DIMENSION)[1]

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Approximately 1.3 million tons of dimension stone, valued at $240 million, was sold or used in 2002. Dimension stone was produced by 132 companies, operating 172 quarries, in 34 States. Leading producer States, in descending order by tonnage, were Indiana, Georgia, Wisconsin, Vermont, and Texas. These five States accounted for 49% of the tonnage output. Leading producer States, in descending order by value, were Indiana, Vermont, Georgia, South Dakota, and North Carolina. These States contributed 48% of the value of domestic production. Approximately 33%, by tonnage, of dimension stone sold or used was granite, followed by limestone (26%), sandstone (15%), marble (5%), slate (2%), and miscellaneous stone (19%). By value, the largest sales or uses were for granite (41%), followed by limestone (26%), sandstone (9%), marble (8%), slate (6%), and miscellaneous stone (10%). Rough block represented 50% of the tonnage and 41% of the value of all the dimension stone sold or used by domestic producers, including exports. The largest uses of rough block, by tonnage, were in construction (38%) and monumental stone (26%). Dressed stone was sold for flagging (26%), curbing (21%), and ashlars and partially squared pieces (14%), by tonnage.

Salient Statistics—United States:[2]	**1998**	**1999**	**2000**	**2001**	**2002**[e]
Production:					
Tonnage	1,140	1,250	1,320	1,220	1,300
Value, million dollars	225	254	235	263	240
Imports for consumption, value, million dollars	698	808	986	1,070	1,700
Exports, value, million dollars	60	55	60	74	89
Consumption, apparent, value, million dollars	863	1,010	1,160	1,260	1,800
Price	Variable, depending on type of product				
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[3]	3,000	3,000	3,000	3,000	3,000
Net import reliance[4] as a percentage of apparent consumption (based on value)	74	75	78	79	88
Granite only:					
Production	420	437	415	408	408
Imports for consumption	NA	NA	NA	NA	NA
Exports (rough and finished)	145	166	116	128	128
Consumption, apparent	NA	NA	NA	NA	NA
Price	Variable, depending on type of product				
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[3]	1,500	1,500	1,500	1,500	1,500
Net import reliance[4] as a percentage of apparent consumption (based on tonnage)	NA	NA	NA	NA	NA

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

Import Sources (1998-2001 by value): Dimension stone: Italy, 39%; Canada, 12%; India, 10%; Spain, 9%; and other, 30%. Granite only: Italy, 43%; Brazil, 15%; Canada, 13%; India, 12%; and other, 17%.

Tariff: Dimension stone tariffs ranged from free to 6.5% ad valorem for countries with normal trade relations in 2002, 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 tonnage increased to about 1.3 million tons, with value decreasing to $240 million in 2002. Imports of dimension stone continued their meteoric increase. Imports increased by 50% in value to $1.7 billion. Dimension stone exports increased by 20% to $89 million. Apparent consumption, by value, was $1.8 billion in 2002—a $540 million increase over the revised figure for 2001. Dimension stone is being used more commonly in residential markets. Additionally, improved quarrying, finishing, and handling technology, as well as a greater variety of stone and the rising costs of alternative construction materials, are among the factors that suggest a continuing increase in demand for dimension stone during the next 5 to 10 years.

A noteworthy event during the year that involved the U.S. dimension stone industry was the restoration and renovation of the damage to the Pentagon that resulted from the September 11, 2001, terrorist attacks. Specifications called for the use of Indiana limestone, because this material was used when the Pentagon was originally constructed in 1943. The final piece of limestone was laid during a dedication ceremony on June 11, 2002.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	2001	2002[e]	
United States	1,220	1,300	Adequate except for certain
Other countries[6]	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.
[6]No reliable production information for other countries is available, owing to a wide variation of ways in which countries report their dimension stone production. Some countries do not report production for this mineral commodity. Production information for some countries is available in the country chapters of the U.S. Geological Survey Minerals Yearbook.

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, 77%; ferrite ceramic magnets, 8%; pyrotechnics and signals, 9%; and other applications, 6%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Imports for consumption:					
Strontium minerals	10,600	13,700	7,460	5,640	6,000
Strontium compounds	25,000	26,800	29,900	26,500	23,000
Exports, compounds	875	2,890	4,520	941	1,000
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent, celestite and compounds	34,700	37,600	32,800	31,200	28,000
Price, average value of mineral imports at port of exportation, dollars per ton	60	73	62	62	62
Net import reliance[2] as a percentage of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1998-2001): Strontium minerals: Mexico, 100%. Strontium compounds: Mexico, 91%; Germany, 6%; and other, 3%. Total imports: Mexico, 94%; Germany, 4%; and other, 2%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/02**
Celestite	2530.90.8010	Free.
Strontium metal	2805.19.1000	3.7% ad val.
Compounds:		
Strontium carbonate	2836.92.0000	4.2% ad val.
Strontium nitrate	2834.29.2000	4.2% ad val.
Strontium oxide, hydroxide, peroxide	2816.40.1000	4.2% ad val.

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

Government Stockpile: Although 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 2003 Annual Materials Plan, announced in October 2002 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 the plant capacity to produce 95,000 and 103,000 tons per year, respectively, Germany and Mexico have been the largest producers of strontium carbonate for many years. The German producer uses imported celestite, and Mexican producers use domestic ore to supply their plants. Operations in both countries were believed to be operating near capacity. In recent years, Chinese strontium carbonate capacity has expanded tremendously to about 140,000 tons per year, although actual plant production is believed to be much less than that. The Chinese strontium carbonate is marketed in Asia and Europe, causing decreases in celestite and strontium carbonate prices in those regions. Chinese celestite reserves are smaller and of lower quality than the ores in major producing countries including Mexico, Spain, and Turkey, raising the question of whether Chinese producers will be able to maintain high production levels to meet the demand at strontium carbonate plants for an extended period of time.

The demand for strontium carbonate for television faceplate glass continues and increases as the popularity of larger screen sizes increases. Domestic consumption of strontium carbonate has decreased in the past 2 years, probably as a result of a shift in production facilities for color televisions to other countries and a slow economy. China, Europe, and North America are the most important markets for televisions. Southeast Asia and Latin America have higher growth rates, representing potentially huge markets for television manufacturers and thus the strontium carbonate industry. Flat screen technology, which does not require strontium carbonate, likely will diminish the demand for strontium carbonate for television displays as the technology becomes more affordable and commonplace. Industry experts, however, do not expect flat screens to present significant competition for the next 10 years.

World Mine Production, Reserves, and Reserve Base:[3]

	Mine production		Reserves[4]	Reserve base[4]
	2001	2002[e]		
United States	—	—	—	1,400,000
Argentina	2,200	2,200	All other:	All other:
China	[e]50,000	50,000	6,800,000	11,000,000
Iran	2,000	2,000		
Mexico	160,000	140,000		
Pakistan	2,000	2,000		
Spain	130,000	143,000		
Tajikistan	NA	NA		
Turkey	25,000	25,000		
World total (may be rounded)	370,000	360,000	6,800,000	12,000,000

World Resources: Resources in the United States are several times the reserve base. Although not thoroughly evaluated, world resources are thought to exceed 1 billion tons.

Substitutes: Although it is possible to substitute other materials for strontium in some of its applications, such a change would adversely affect product performance and/or cost. For example, barium could replace strontium in color television picture tube glass only after extensive circuit redesign to reduce operating voltages that produce harmful secondary X-rays. Barium replacement of strontium in ferrite ceramic magnets would decrease the maximum energy and temperature characteristics of the magnets. Substituting for strontium in pyrotechnics would be impractical because the desired brilliance and visibility are imparted only by strontium and its compounds.

[e]Estimated. NA Not available. — Zero.
[1]The strontium content of celestite is 43.88%; this amount was used to convert units of celestite.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]Metric tons of strontium minerals.
[4]See Appendix C for definitions.

SULFUR

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

Domestic Production and Use: In 2002, elemental sulfur and byproduct sulfuric acid were produced at 124 operations in 30 States and the U.S. Virgin Islands. Total shipments were valued at about $230 million. Elemental sulfur production was 8.3 million tons; Louisiana and Texas accounted for about 50% of domestic production. Elemental sulfur was recovered at petroleum refineries, natural-gas-processing plants, and coking plants by 44 companies at 114 plants in 26 States and the U.S. Virgin Islands. Mining of elemental sulfur using the Frasch method, ended in 2000. Byproduct sulfuric acid, representing almost 11% of sulfur in all forms, was recovered at 10 nonferrous smelters in 7 States by 8 companies. Domestic elemental sulfur provided 71% of domestic consumption, and byproduct acid accounted for 9%. The remaining 20% of sulfur consumed was provided by imported sulfur and sulfuric acid. About 90% of sulfur was consumed in the form of sulfuric acid. Agricultural chemicals (primarily fertilizers) composed 60% of reported sulfur demand; petroleum refining, 18%; metal mining, 5%; and organic and inorganic chemicals, 3%. Other uses, accounting for 14% 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:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production:					
Frasch[e]	1,800	1,780	900	—	—
Recovered elemental	8,220	8,220	8,380	8,270	8,300
Other forms	1,610	1,320	1,030	982	980
Total[e] (may be rounded)	11,600	11,300	10,300	9,250	9,280
Shipments, all forms	12,100	11,100	10,500	9,240	9,280
Imports for consumption:					
Recovered, elemental	2,270	2,580	2,330	1,730	1,800
Sulfuric acid, sulfur content	668	447	463	462	350
Exports:					
Frasch and recovered elemental	889	685	762	675	500
Sulfuric acid, sulfur content	51	51	62	69	50
Consumption, apparent, all forms	14,100	13,400	12,500	10,700	10,900
Price, reported average value, dollars per ton of elemental sulfur, f.o.b., mine and/or plant	29.14	37.81	24.73	10.11	25.00
Stocks, producer, yearend	283	451	208	232	220
Employment, mine and/or plant, number	3,100	3,000	3,000	2,700	2,700
Net import reliance[1] as a percentage of apparent consumption	18	16	18	13	15

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

Import Sources (1998-2001): Elemental: Canada, 67%; Mexico, 22%; Venezuela, 9%; and other, 2%. Sulfuric acid: Canada, 60%; Mexico, 15%; Japan, 8%; Germany, 3%, and other, 14%. Total sulfur imports: Canada, 66%; Mexico, 21%; Venezuela, 7%; and other, 6%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
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: Total sulfur production was virtually the same in 2002 as it was in 2001 because sulfur recovered at oil refineries increased and production at natural gas facilities decreased. Production of elemental sulfur from petroleum refineries will continue to grow steadily, supported by new facilities being installed to increase refining capacity and the capability of current operations to handle higher sulfur crude oil. Additional equipment will be installed at many refineries to reduce the sulfur in gasoline and diesel fuel to comply with the environmental regulations that were enacted in 2000 and 2001 and that will go into effect in 2006. Recovered sulfur from natural gas processing may continue to decline as a result of projects to reinject acid gas rather than produce recovered elemental sulfur. Byproduct sulfuric acid production continued at low rates because three copper smelters remained closed with little likelihood of reopening. Despite continued decreases in native sulfur and pyrites production because of environmental and cost considerations, total world sulfur production remained about the same as a result of expanded recovered production worldwide.

Domestic phosphate fertilizer production improved slightly in 2002, increasing demand for sulfur in that end use. Continued increases in phosphate fertilizer production could raise sulfur consumption to about 11.2 million tons in 2003. Increased demand drove prices higher, and improved prices made increased imports, especially from Canada, more likely. Additional facilities for importing formed sulfur were under consideration to increase the alternative sources available.

World Production, Reserves, and Reserve Base:

	Production—All forms	
	2001	2002[e]
United States	9,250	9,280
Australia	720	750
Canada	9,360	9,400
Chile	1,160	1,300
China	5,380	5,500
Finland	543	540
France	1,100	1,100
Germany	1,240	1,300
India	941	940
Iran	983	1,000
Italy	743	800
Japan	3,370	3,400
Kazakhstan	1,700	1,800
Korea, Republic of	1,270	1,300
Kuwait	524	530
Mexico	1,450	1,500
Netherlands	510	500
Poland	1,420	1,200
Russia	6,250	6,250
Saudi Arabia	2,350	2,400
Spain	622	600
United Arab Emirates	1,490	1,500
Other countries	5,070	5,100
World total (may be rounded)	57,300	58,000

Reserves and reserve base[2]

Previously published reserve and reserve base data are outdated and inadequate for this tabulation because of changes in the world sulfur industry. For this reason, specific country data has been omitted from this report.

Reserves of sulfur in crude oil, natural gas, and sulfide ores are large. Because most sulfur production is a result of the processing of fossil fuels, supplies should be adequate for the foreseeable future. Because petroleum and sulfide ores can be processed long distances from where they are produced, actual sulfur production may not be in the country for which the reserves were attributed. For instance, sulfur reserves from Saudi Arabia actually may be recovered at oil refineries in the United States.

World Resources: Resources of elemental sulfur in evaporite and volcanic deposits and sulfur associated with natural gas, petroleum, tar sands, and metal sulfides amount to about 5 billion tons. The sulfur in gypsum and anhydrite is almost limitless, and some 600 billion tons is contained in coal, oil shale, and shale rich in organic matter, but low-cost methods have not been developed to recover sulfur from these sources. The domestic resource is about one-fifth of the world total. Elemental sulfur deposits have become marginal reserves even at deposits that are already developed. Sulfur from petroleum and metal sulfides may be recovered where it is refined, which may be in the country of origin or in an importing nation. The rate of sulfur recovery from refineries is dependent on the environmental regulations where refining is accomplished, most of which are becoming more stringent.

Substitutes: Substitutes for sulfur at present or anticipated price levels are not satisfactory; some acids, in certain applications, may be substituted for sulfuric acid.

[e]Estimated. — Zero.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix C for definitions.

TALC AND PYROPHYLLITE

(Data in thousand metric tons, unless noted)

Domestic Production and Use: The total estimated crude ore value of 2002 domestic talc production was $21 million. There were 10 talc-producing mines in 5 States in 2002. Companies in Montana, New York, Texas, and Vermont accounted for most of the domestic production. Ground talc was consumed in ceramics, 25%; paint, 22%; paper, 22%; roofing, 8%; plastics, 6%; rubber, 4%; cosmetics, 3%; and other, 10%. Two firms in North Carolina mined pyrophyllite. Production was essentially unchanged from that of 2001. Consumption was, in decreasing order, in refractories, ceramics, and paint.

Salient Statistics—United States:[1]	**1998**	**1999**	**2000**	**2001**	**2002**[e]
Production, mine	971	925	851	853	830
Sold by producers	870	881	821	786	820
Imports for consumption	165	208	270	180	230
Exports	146	147	154	137	160
Shipments from Government stockpile excesses	—	([2])	—	—	—
Consumption, apparent	990	986	967	896	900
Price, average, processed dollars per ton	126	116	116	119	112
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill	730	690	640	520	530
Net import reliance[3] as a percentage of apparent consumption	2	6	12	5	8

Recycling: Insignificant.

Import Sources (1998-2001): China, 48%; Canada, 24%; France, 9%; Japan, 5%; and other, 14%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
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—9-30-02[4]
(Metric tons)

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 2002**	**Disposals FY 2002**
Talc, block and lump	910	—	910	[5]1,810	—
Talc, ground	988	—	988	—	—

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TALC AND PYROPHYLLITE

Events, Trends, and Issues: Production decreased 3% and sales increased 4% from those of 2001. Apparent consumption increased slightly. Exports increased by 17% compared with those of 2001. Canada was the major destination for U.S. talc exports, accounting for about 37% of the tonnage. U.S. imports of talc increased by 28% compared with those of 2001. Canada, China, and France supplied approximately 91% of the imported talc.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for Brazil, India, and Japan have changed significantly based on new information from those countries.

	Mine production		Reserves[6]	Reserve base[6]
	2001	2002[e]		
United States[1]	853	830	140,000	540,000
Brazil	450	450	180,000	250,000
China	3,500	3,500	Large	Large
India	546	550	4,000	9,000
Japan	668	650	100,000	160,000
Korea, Republic of	1,100	1,100	14,000	18,000
Other countries	2,040	2,040	Large	Large
World total (rounded)	8,920	9,120	Large	Large

World Resources: The United States is self-sufficient in most grades of talc and related minerals. Domestic and world resources are estimated to be approximately five times the quantity of reserves. Revised data from the Brazilian government resulted in a large increase in the estimated reserves and reserve base for pyrophyllite and talc in that country.

Substitutes: The major substitutes for talc are clays and pyrophyllite in ceramics, kaolin and mica in paint, kaolin in paper, clays and mica in plastics, and kaolin and mica in rubber.

[e]Estimated. NA Not available. — Zero.
[1]Excludes pyrophyllite.
[2]Less than ½ unit.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]Includes Talc, ground.
[6]See Appendix C for definitions.

TANTALUM

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

Domestic Production and Use: There has been no significant domestic tantalum mining since 1959. Domestic tantalum resources are of low grade, some mineralogically complex, and most are not commercially recoverable. Most metal, alloys, and compounds were produced by three companies; tantalum units were obtained from imported concentrates and metal and from foreign and domestic scrap. Tantalum was consumed mostly in the form of metal powder, ingot, fabricated forms, compounds, and alloys. The major end use for tantalum was in the production of electronic components, more than 60% of use, mainly in tantalum capacitors. Major end uses for tantalum capacitors include automotive electronics, pagers, personal computers, and portable telephones. The value of tantalum consumed in 2002 was estimated at about $180 million.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, mine	—	—	—	—	—
Imports for consumption:					
Mineral concentrates[e]	380	320	650	690	700
Tantalum metal and tantalum-bearing alloys[e]	208	244	251	316	300
Exports, concentrate, metal, alloys, waste, scrap[e]	440	480	530	700	600
Government stockpile releases[e 1]	213	5	242	(53)	13
Consumption, apparent	738	555	650	550	525
Price, tantalite, dollars per pound[2]	34.00	34.00	220.00	37.00	30.00
Net import reliance[3] as a percentage of apparent consumption	80	80	80	80	80

Recycling: Tantalum was mostly recycled from new scrap that was generated during the manufacture of tantalum-related electronic components and new and old scrap products of tantalum-containing cemented carbides and superalloys. Combined prompt industrial and obsolete scrap consumed represented about 20% of apparent consumption.

Import Sources (1998-2001): Australia, 49%; China, 10%; Japan, 8%; Thailand, 8%; and other, 25%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
Synthetic tantalum-columbium concentrates	2615.90.3000	Free.
Tantalum ores and concentrates	2615.90.6060	Free.
Tantalum oxide	2825.90.9000	3.7% ad val.
Potassium fluotantalate	2826.90.0000	3.1% ad val.
Tantalum, unwrought:		
Powders	8103.20.0030	2.5% ad val.
Alloys and metal	8103.20.0090	2.5% ad val.
Tantalum, waste and scrap	8103.30.0000	Free.
Tantalum, other	8103.90.0000	4.4% ad val.

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

Government Stockpile: For fiscal year 2002, the Defense National Stockpile Center (DNSC) sold about 18 tons of tantalum contained in tantalum metal ingots valued at about $3.53 million from the National Defense Stockpile (NDS). There were no sales of tantalum carbide powder, tantalum metal powder, tantalum minerals, and tantalum oxide in fiscal year 2002. The DNSC proposed maximum disposal limits in fiscal year 2003 of about 2 tons of tantalum contained in tantalum carbide powder, about 18 tons of tantalum contained in tantalum metal ingots, about 23 tons[4] of tantalum contained in tantalum metal powder, about 227 tons of tantalum contained in tantalum minerals, and about 9 tons of tantalum contained in tantalum oxide. The NDS uncommitted inventories shown below include a small quantity in nonstockpile-grade tantalum capacitor-grade metal powder and about 325 tons of tantalum contained in nonstockpile-grade tantalum minerals.

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TANTALUM

Stockpile Status—9-30-02[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Tantalum:					
Carbide powder	6	—	6	2	—
Metal:					
Powder	18	16	18	[4]23	—
Ingots	46	6	46	18	18
Minerals	866	—	866	227	—
Oxide	31	3	31	9	—

Events, Trends, and Issues: Total consumption of tantalum decreased compared with that in 2001. Overall tantalum imports were basically unchanged. Imports for consumption of tantalum mineral concentrates increased slightly, with Australia supplying almost 80% of quantity and about 90% of value. Exports decreased; Germany, Israel, Japan, Mexico and the United Kingdom were the major recipients of the tantalum materials. In October, quoted spot price ranges for tantalum ore (per pound tantalum pentoxide content), in three published sources, were $20 to $25, $20 to $30, and $40 to $50, compared with the $32 to $39, $25 to $35, and $40 to $50, respectively, quoted in early January. The most recent published industry source (August 1999) on tantalum product prices indicated that the average selling prices per pound tantalum content for some tantalum products were as follows: capacitor-grade powder, $135 to $260; capacitor wire, $180 to $270; and vacuum-grade metal for superalloys, $75 to $100. Public information on current prices for these tantalum products was not available; pricing is normally established by negotiation between buyer and seller. No domestic mine production is expected in 2003, and it is estimated that U.S. apparent consumption will be about 550 tons.

World Mine Production, Reserves, and Reserve Base:

	Mine production[6] 2001	Mine production[6] 2002[e]	Reserves[7]	Reserve base[7]
United States	—	—	—	Negligible
Australia	660	900	36,000	58,000
Brazil	340	340	NA	53,000
Burundi	7	7	NA	NA
Canada	77	80	3,000	NA
Congo (Kinshasa)	60	60	NA	NA
Ethiopia	47	40	NA	NA
Nigeria	3	3	NA	NA
Rwanda	95	90	NA	NA
Zimbabwe	9	7	NA	NA
Other countries[8]	—	—	NA	NA
World total (may be rounded)	1,300	1,530	39,000	110,000

World Resources: Most of the world's resources of tantalum occur outside the United States. On a worldwide basis, identified resources of tantalum are considered adequate to meet projected needs. These resources are largely in Australia, Brazil, and Canada. The United States has about 1,500 tons of tantalum resources in identified deposits, all of which were considered uneconomic at 2002 prices.

Substitutes: The following materials can be substituted for tantalum, but usually with less effectiveness: columbium in carbides; aluminum and ceramics in electronic capacitors; columbium, glass, platinum, titanium, and zirconium in corrosion-resistant equipment; and columbium, hafnium, iridium, molybdenum, rhenium, and tungsten in high-temperature applications.

[e]Estimated. NA Not available. — Zero.
[1]Net quantity (uncommitted inventory). Parentheses indicate negative number (increase in inventory).
[2]Yearend average value, contained pentoxides.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]Actual quantity limited to remaining sales authority or inventory.
[5]See Appendix B for definitions.
[6]Excludes production of tantalum contained in tin slags.
[7]See Appendix C for definitions.
[8]Bolivia, China, Russia, and Zambia also produce (or are thought to produce) tantalum, but available information is inadequate to make reliable estimates of output levels.

TELLURIUM[1]

(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 2002, 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:	1998	1999	2000	2001	2002[e]
Production, refinery	W	W	W	W	W
Imports for consumption, unwrought, waste and scrap[2]	89	38	52	30	23
Exports	NA	NA	NA	NA	NA
Consumption, apparent	NA	NA	NA	NA	NA
Price, dollars per pound, 99.7% minimum[3]	18	15	14	15	17
Stocks, producer, refined, yearend	W	W	W	W	W
Employment, number	NA	NA	NA	NA	NA
Net import reliance[4] as a percentage 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 (1998-2001): United Kingdom, 28%; Philippines, 28%; Belgium, 18%; Canada, 11%; and other, 15%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Metal	2804.50.0020	Free.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: None.

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TELLURIUM

Events, Trends, and Issues: Domestic and world tellurium demand decreased slightly in 2002. World production of tellurium, a byproduct of copper refining, was down slightly owing to a drop in the level of copper production. 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.

Tellurium is used in a germanium-antimony-tellurium alloy for optical storage in digital video discs. This is a rapidly growing market, but the amount of tellurium used for each disc is very small.

World Refinery Production, Reserves, and Reserve Base: Reserves and reserve base estimates for Peru have been increased based on new information from that country.

	Refinery production		Reserves[5]	Reserve base[5]
	2001	2002[e]		
United States	W	W	3,000	6,000
Canada	80	75	650	1,500
Japan	39	39	—	—
Peru	22	20	1,600	2,800
Other countries[6]	NA	NA	16,000	37,000
World total (may be rounded)	[7]141	[7]130	21,000	47,000

World Resources: The figures shown for reserves and reserve base include only tellurium contained in economic copper deposits. In addition to copper deposits, significant quantities of tellurium are contained in 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. — Zero.

[1]Prepared by Henry E. Hilliard.

[2]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.

[3]Yearend prices quoted by the sole producer.

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

[5]See Appendix C for definitions. Estimates include tellurium contained in copper resources only.

[6]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.

[7]Excludes refinery production from the United States.

THALLIUM

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

Domestic Production and Use: Thallium is a byproduct metal recovered in some countries from flue dusts and residues collected in the smelting of copper, zinc, and lead ores. Although thallium was contained in ores mined or processed in the United States, it has not been recovered domestically since 1981. Consumption of thallium metal and its compounds continued for most of their established end uses. These uses included a semiconductor material for selenium rectifiers, an activator in gamma radiation detection equipment, an electrical resistance component in infrared radiation detection and transmission equipment, and a crystalline filter for light diffraction in acousto-optical measuring devices. Other uses included an alloying component with mercury for low-temperature measurements, an additive in glass to increase its refractive index and density, a catalyst or intermediate in the synthesis of organic compounds, and a high-density liquid for sink-float separation of minerals. Also, the use of radioactive thallium compounds for medical purposes in cardiovascular imaging continued in 2002.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, mine	—	—	—	—	—
Imports for consumption[1]	104	838	100	2,110	100
Exports	NA	NA	NA	NA	NA
Consumption[e]	300	380	300	800	500
Price, metal, dollars per kilogram[2]	1,280	1,295	1,295	1,295	1,250
Net import reliance[3] as a percentage of estimated consumption	100	100	100	100	100

Recycling: None.

Import Sources (1998-2001): Belgium, 79%; Canada, 14%; France, 3%; Russia, 2%; and United Kingdom, 2%.

Tariff: Item	Number	Normal Trade Relations[4] 12/31/02
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 2002 to improve and expand the use of thallium. These activities included the development of high-temperature superconducting materials for such applications as magnetic resonance imaging, storage of magnetic energy, magnetic propulsion, and electric power generation and transmission. Consideration continued to be given to the use of a thallium-oxide superconductor as a material for such applications. The development of improved methods for synthesizing high-temperature superconductors, such as thallium cuprates, also received attention during the year. Further use of radioactive thallium in clinical diagnostic applications, including cardiovascular and oncological imaging, also was studied during 2002. One such study involved the use of a thallium radiation technique to assess the therapeutic response to a particular type of oncological treatment.

Thallium metal and its compounds are highly toxic materials and are strictly controlled to prevent a threat to humans and the environment. Thallium and its compounds can be absorbed into the human body by skin contact, ingestion, or inhalation of dust or fumes. In 2002, the U.S. Environmental Protection Agency initiated health assessments on thallium and several other metals and chemicals for inclusion in the agency's Integrated Risk Information System data base. Information from the public was requested in making the assessments. The U.S. Department of Transportation issued a proposed rule that would amend its requirements for the safe transport of radioactive materials, including thallium, to make them compatible with international requirements.

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

	Mine production		Reserves[6]	Reserve base[6]
	2001	2002		
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. — Zero.
[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]By the North American Free Trade Agreement, there is no tariff for Canada or Mexico.
[5]Estimates are 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. In the United States, thorium has been a byproduct of refining monazite for its rare-earth content. Monazite itself is recovered as a byproduct of processing heavy-mineral sands for titanium and zirconium minerals. In 2002, monazite was not recovered domestically as a salable product. Essentially all thorium compounds and alloys consumed by the domestic industry were derived from imports, stocks of previously imported materials, or materials shipped from U.S. Government stockpiles. About eight companies processed or fabricated various forms of thorium for nonenergy uses, such as high-temperature ceramics, catalysts, and welding electrodes. Thorium's use in most products has decreased because of its naturally-occurring radioactivity. The value of thorium alloys, compounds, and metal used by the domestic industry was estimated to have decreased to about $10,000.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production, refinery[1]	—	—	—	—	—
Imports for consumption:					
Thorium ore and concentrates (monazite), gross weight	—	—	—	—	—
Thorium ore and concentrates (monazite), ThO_2 content	—	—	—	—	—
Thorium compounds (oxide, nitrate, etc.), gross weight	7.45	5.29	11.10	1.85	0.17
Thorium compounds (oxide, nitrate, etc.), ThO_2 content	5.51	3.91	8.20	1.37	0.13
Exports:					
Thorium ore and concentrates (monazite), gross weight	—	—	—	—	—
Thorium ore and concentrates (monazite), ThO_2 content	—	—	—	—	—
Thorium compounds (oxide, nitrate, etc.), gross weight	1.13	2.52	4.64	7.30	1.08
Thorium compounds (oxide, nitrate, etc.), ThO_2 content	0.84	1.86	3.43	5.40	0.80
Shipments from Government stockpile excesses ($ThNO_3$)	—	—	—	—	0.15
Consumption:					
Reported, (ThO_2 content[e])	7.0	7.0	6.0	—	NA
Apparent	4.7	3.1	7.7	—	—
Price, yearend, dollars per kilogram:					
Nitrate, welding-grade[2]	5.46	5.46	5.46	5.46	5.46
Nitrate, mantle-grade[3]	27.00	27.00	27.00	27.00	27.00
Oxide, yearend:					
99.9% purity[4]	82.50	82.50	82.50	82.50	82.50
99.99% purity[4]	107.25	107.25	107.25	107.25	107.25
Stocks, industrial, yearend	NA	NA	NA	NA	NA
Net import reliance[5] as a percentage of apparent consumption	100	100	100	XX	XX

Recycling: None.

Import Sources (1998-2001): Monazite: None. Thorium compounds: France, 47%; Canada, 22%; United Kingdom, 16%; Japan, 7%; and other, 8%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Thorium compounds	2844.30.1000	5.5% ad val.

Depletion Allowance: Monazite, 23% on thorium content, 15% on rare-earth and yttrium content (Domestic); 14% (Foreign).

Government Stockpile:

Stockpile Status—9-30-02[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Thorium nitrate (gross weight)	3,219	—	3,219	3,221	0.154

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THORIUM

Events, Trends, and Issues: Domestic mine production of thorium-bearing monazite ceased at the end of 1994 as world demand for ores containing naturally occurring radioactive thorium declined. Imports and existing stocks supplied essentially all thorium consumed in the United States in 2001. Domestic demand for thorium ores, compounds, metals, and alloys has exhibited a long-term declining trend. No thorium consumption was reported in the United States in 2001. In 2002, apparent consumption, primarily for use in catalyst applications, is estimated to have decreased. On the basis of data through July 2002, the average value of imported thorium compounds increased to $58.26 per kilogram from the 2001 average of $36.58 per kilogram (gross weight). Price increases were the result of real and potential costs associated with handling and shipping radioactive materials and not based on supply-demand factors. The use of thorium in the United States has decreased significantly since the 1980s, when consumption averaged 45 tons per year. Increased costs to monitor and dispose of thorium have caused domestic processors to switch to thorium-free materials. Real and potential costs related to compliance with State and Federal regulations, proper disposal, and monitoring of thorium's radioactivity have limited its commercial value. It is forecast that thorium's domestic nonenergy use in the near-term will be variable and intermittent unless a low-cost disposal process is developed.

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

	Refinery production		Reserves[8]	Reserve base[8]
	2001	2002		
United States	—	—	160,000	300,000
Australia	—	—	300,000	340,000
Brazil	NA	NA	16,000	18,000
Canada	NA	NA	100,000	100,000
India	NA	NA	290,000	300,000
Malaysia	—	—	4,500	4,500
Norway	—	—	170,000	180,000
South Africa	—	—	35,000	39,000
Other countries	NA	NA	90,000	100,000
World total	NA	NA	1,200,000	1,400,000

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

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

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

[e]Estimated. E Net exporter. NA Not available. XX Not applicable. — Zero.
[1]All domestically consumed thorium was derived from imported materials.
[2]Source: U.S. Department of Defense, Defense Logistics Agency. Based on sales from the National Defense Stockpile.
[3]Source: Rhodia Canada, Inc., f.o.b. port of entry, duty paid, ThO_2 basis.
[4]Source: Rhodia Electronics and Catalysis, Inc., 1-950 kilogram quantities, f.o.b. port of entry, duty paid.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]See Appendix B for definitions.
[7]Estimates, based on thorium contents of rare-earth ores.
[8]See Appendix C for definitions.

TIN

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

Domestic Production and Use: Tin has not been mined domestically since 1993. Production of tin at the only U.S. tin smelter, at Texas City, TX, stopped in 1989. Twenty-five firms used about 92% of the primary tin consumed domestically in 2002. The major uses were as follows: cans and containers, 27%; electrical, 23%; construction, 10%; transportation, 10%; and other, 30%. On the basis of the New York composite price, the estimated values of some critical items were as follows: primary metal consumed, $243 million; imports for consumption, refined tin, $243 million; and secondary production (old scrap), $43 million.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production:					
Secondary (old scrap)	8,500	7,750	6,560	6,700	6,500
Secondary (new scrap)	7,800	8,650	9,140	7,190	7,000
Imports for consumption, refined tin	44,000	47,500	44,900	37,500	37,000
Exports, refined tin	5,020	6,770	6,640	4,350	3,500
Shipments from Government stockpile excesses	12,200	765	12,000	12,000	12,000
Consumption, reported:					
Primary	37,100	38,000	38,100	34,200	37,000
Secondary	8,620	8,890	8,940	6,990	9,000
Consumption, apparent	60,600	59,700	57,200	48,250	54,000
Price, average, cents per pound:					
New York market	261	255	255	211	188
New York composite	373	366	370	315	298
London	251	245	246	203	177
Kuala Lumpur	246	241	244	201	178
Stocks, consumer and dealer, yearend	10,500	10,700	11,200	14,800	13,000
Net import reliance[1] as a percentage of apparent consumption	85	85	88	86	79

Recycling: About 14,000 tons of tin from old and new scrap was recycled in 2002. Of this, about 7,000 tons was recovered from old scrap at 3 detinning plants and 65 secondary nonferrous metal processing plants.

Import Sources (1998-2001): Peru, 27%; China, 23%; Indonesia, 14%; Brazil, 12%; Bolivia, 12%; and other, 12%.

Tariff: Most major imports of tin, including unwrought metal, waste and scrap, and unwrought tin alloys, enter duty free.

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

Government Stockpile: The Defense National Stockpile Center (DNSC) continued its active longtime tin sales program. The Annual Materials Plan for tin for fiscal year 2003 remained at 12,000 tons. DNSC will continue to have two long-term negotiated "contract" sales totaling 10,000 tons for the year. The remaining 2,000 tons will be sold using the Basic Ordering Agreement (BOA). Under the BOA approach, DNSC posts the amount of tin that it wants to sell on its Web site every Tuesday. Interested parties submit a quote, and DNSC makes a sales determination by the end of the business day. BOA sales began in June 2002. In fiscal year 2002, DNSC had only one long-term sale, and that was in July. Tin is warehoused at four depots, with the largest inventories at Hammond, IN, and Point Pleasant, WV. The other sites are New Haven, IN, and Baton Rouge, LA.

Stockpile Status—9-30-02[2]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Pig tin	45,416	8,392	45,416	12,000	8,878

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TIN

Events, Trends, and Issues: The Steel Recycling Institute announced that the steel can (tin-plated) recycling rate in the United States was 58% in 2001, the same as in 2000. Tin, as well as steel, is recovered in can recycling.

Tin prices continued to decline in 2002. Industry observers attributed lower prices to an oversupply of tin in the market. World tin consumption also was believed to have declined somewhat during the year because many countries experienced an economic slowdown.

The world tinplate industry continued to be characterized by more mergers and consolidations. In most cases, this trend resulted in the loss of tin mill capacity. During the past 2 years, several domestic steel producers that make tinplate have declared bankruptcy, thus raising concerns about the status of future domestic tinplate sources.

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

	Mine production		Reserves[3]	Reserve base[3]
	2001	2002[e]		
United States	—	—	20,000	40,000
Australia	9,600	9,000	110,000	300,000
Bolivia	12,500	12,200	450,000	900,000
Brazil	14,000	13,000	540,000	2,500,000
China	79,000	90,500	1,700,000	3,500,000
Indonesia	51,000	50,000	800,000	900,000
Malaysia	4,970	6,000	1,000,000	1,200,000
Peru	38,200	71,000	710,000	1,000,000
Portugal	1,200	1,000	70,000	80,000
Russia	4,500	5,000	300,000	350,000
Thailand	2,500	1,700	170,000	200,000
Other countries	4,680	5,000	180,000	200,000
World total (may be rounded)	222,000	231,000	6,100,000	11,000,000

World Resources: U.S. resources of tin, primarily in Alaska, were insignificant compared with those of the rest of the world. Sufficient world resources, principally in western Africa, southeastern Asia, Australia, Bolivia, Brazil, China, and Russia are available to sustain recent annual production rates well into the 21st century.

Substitutes: Aluminum, glass, paper, plastic, or tin-free steel substitute for tin in cans and containers. Other materials that substitute for tin are epoxy resins for solder; aluminum alloys, copper-base alloys, and plastics for bronze; plastics for bearing metals that contain tin; and compounds of lead and sodium for some tin chemicals.

[e]Estimated. — Zero.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix B for definitions.
[3]See Appendix C for definitions.

TITANIUM MINERAL CONCENTRATES[1]

(Data in thousand metric tons of contained TiO_2, unless otherwise noted)

Domestic Production and Use: Two firms produced ilmenite and rutile concentrates from surface mining operations in Florida and Virginia. The value of titanium mineral concentrates consumed in the United States in 2002 was about $450 million. The major coproduct of mining from ilmenite and rutile deposits was zircon. About 97% of titanium mineral concentrates was consumed by domestic TiO_2 pigment producers. The remainder was used in welding rod coatings and for manufacturing carbides, chemicals, and metal.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production[2] (ilmenite and rutile, rounded)	400	300	300	300	300
Imports for consumption:					
Ilmenite and slag	732	776	647	737	750
Rutile, natural and synthetic	365	324	413	303	361
Exports,[e] all forms	38	6	12	5	6
Consumption, reported:					
Ilmenite and slag[3]	980	963	919	856	890
Rutile, natural and synthetic	392	413	497	448	466
Price, dollars per metric ton:					
Ilmenite, bulk, 54% TiO_2, f.o.b. Australian ports	77	98	94	100	93
Rutile, yearend, bulk, f.o.b. Australian ports	500	473	485	475	450
Slag:[e]					
80% TiO_2, f.o.b. Sorel, Quebec	338	390	362	335	344
85% TiO_2, f.o.b. Richards Bay, South Africa	385	406	425	419	432
Stocks, mine, consumer, yearend:					
Ilmenite	270	343	262	221	220
Rutile	111	96	101	118	120
Employment, mine and mill, number[e]	490	450	470	360	360
Net import reliance[4] as a percentage of reported consumption	76	75	79	78	82

Recycling: None.

Import Sources (1998-2001): South Africa, 46%; Australia, 32%; Canada, 14%; Ukraine, 4%; and other, 4%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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.

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TITANIUM MINERAL CONCENTRATES

Events, Trends, and Issues: Owing to a slowing world economy, global consumption of titanium concentrates was estimated to have decreased moderately in 2002 compared with that of 2001. Increased production of titanium dioxide pigment resulted in an estimated 4% increase in domestic consumption of titanium mineral concentrates compared with that of 2000. The United States continued its reliance on imported mineral concentrates primarily from Australia, Canada, and South Africa. In 2002, imports of titanium concentrates increased an estimated 7% compared with those of 2001.

In 2002, numerous projects were underway to develop new sources of titanium mineral concentrates. In the United States, feasibility studies were being conducted at the Camden, TN, and Limon, CO, deposits. In Canada, a bulk sampling program was in progress at Truro, Nova Scotia. The first phase of a bankable feasibility study was completed at the Corridor Sands project in Mozambique. If completed, Corridor Sands would produce 1 million tons per year of titanium slag. In Australia, a host of projects primarily located in the Murray Basin were in various stages of development. Mine construction was expected to begin on the Moma project in Mozambique. If completed, the Moma project would produce 625,000 tons per year of ilmenite and 12,500 tons per year of rutile.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	2001	2002[e]		
Ilmenite:				
United States[2]	[6]300	[6]300	7,000	59,000
Australia	1,150	1,100	[7]200,000	[7]250,000
Canada[8]	950	950	31,000	36,000
India	232	250	30,000	38,000
Norway[8]	338	350	40,000	40,000
South Africa[8]	960	950	63,000	220,000
Ukraine	252	250	5,900	13,000
Other countries	391	390	49,000	84,000
World total (ilmenite, may be rounded)	4,600	4,500	420,000	730,000
Rutile:				
United States	([9])	([9])	400	1,800
Australia	225	220	[7]22,000	[7]34,000
India	16	15	6,600	7,700
South Africa	110	105	8,300	24,000
Ukraine	56	56	2,500	2,500
Other countries	4	4	8,000	17,000
World total (rutile, rounded)	[10]410	[10]400	48,000	87,000
World total (ilmenite and rutile, rounded)	5,000	4,900	470,000	820,000

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]Production rounded to one significant digit to avoid disclosing company proprietary data.
[3]Excludes ilmenite used to produce synthetic rutile.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.
[6]Includes rutile to avoid disclosing company proprietary data.
[7]Derived from data published by the Australian Geological Survey Organisation.
[8]Mine production is primarily used to produce titaniferous slag. Reserves and reserve base are ilmenite.
[9]Included with ilmenite to avoid disclosing company proprietary data.
[10]Excludes U.S. production.

TITANIUM AND TITANIUM DIOXIDE[1]

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: Titanium sponge metal was produced by two operations in Nevada and Utah. Ingot was made by the two sponge producers and by nine other firms in seven States. About 30 firms consumed ingot to produce forged components, mill products, and castings. In 2002, an estimated 65% of the titanium metal used was in aerospace applications. The remaining 35% was used in armor, chemical processing, power generation, marine, medical, sporting goods, and other nonaerospace applications. The value of sponge metal consumed was about $148 million, assuming an average selling price of $7.77 per kilogram. The value of ingot produced from sponge and scrap was estimated to be $420 million.

In 2002, titanium dioxide (TiO_2) pigment, valued at about $2.7 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, 49%; paper, 16%; plastics, 25%; and other, 10%. Other uses of TiO_2 included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Titanium sponge metal:					
Production	W	W	W	W	W
Imports for consumption	10,900	6,000	7,240	13,300	12,600
Exports	348	807	1,930	2,170	2,000
Shipments from Government stockpile excesses	1,384	515	4,870	7,640	3,340
Consumption, reported	28,200	18,100	18,200	26,200	19,000
Price, dollars per kilogram, yearend	9.70	9.37	9.37	7.89	7.77
Stocks, industry yearend[e]	10,600	7,970	5,010	6,340	10,000
Employment, number[e]	300	300	300	300	300
Net import reliance[2] as a percentage of reported consumption	39	44	72	67	54
Titanium dioxide:					
Production	1,330,000	1,350,000	1,400,000	1,330,000	1,380,000
Imports for consumption	200,000	225,000	218,000	209,000	220,000
Exports	398,000	384,000	464,000	415,000	470,000
Consumption, apparent	1,140,000	1,160,000	1,150,000	1,100,000	1,160,000
Price, rutile, list, dollars per pound, yearend	0.98	1.01	1.01	1.05	1.05
Stocks, producer, yearend	103,000	137,000	141,000	159,000	130,000
Employment, number[e]	4,600	4,600	4,600	4,600	4,500
Net import reliance[2] as a percentage of apparent consumption	E	E	E	E	E

Recycling: New scrap metal recycled by the titanium industry totaled about 13,300 tons in 2002. Estimated use of titanium as scrap and ferrotitanium by the steel industry was about 6,900 tons; by the superalloy industry, 830 tons; and, in other industries, 300 tons. Old scrap reclaimed totaled about 500 tons.

Import Sources (1998-2001): Sponge metal: Japan, 36%; Russia, 36%; Kazakhstan, 25%; and other, 3%. Titanium dioxide pigment: Canada, 33%; Germany, 12%; France, 8%; Spain, 6%; China, 5%; and other, 36%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
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	8108.30.0000	Free.
Unwrought titanium metal	8108.20.0000	15.0% ad val.
Wrought titanium metal	8108.90.6000	15.0% ad val.
Other titanium metal articles	8108.90.3000	5.5% ad val.

Depletion Allowance: Not applicable.

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TITANIUM AND TITANIUM DIOXIDE

Government Stockpile: The Defense National Stockpile Center (DNSC) continued to solicit offers for the sale of titanium sponge held in the Government stockpile. For fiscal year 2003, 6,350 tons of sponge is planned for disposal. In support of an armor upgrade program, DNSC provided the U.S. Army with 227 tons of titanium sponge metal. The quantities shown below include stockpile and nonstockpile-grade sponge.

Stockpile Status—9-30-02[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Titanium sponge	15,300	1,160	15,300	6,350	6,570

Events, Trends, and Issues: In 2002, estimated domestic production of TiO_2 pigment was 1.38 million tons, a 4% increase compared with that of 2001. Imports of TiO_2 pigment increased by 10% compared with 2001, while exports increased 13%. Apparent consumption of pigment increased 5% and published prices of rutile-grade pigment were unchanged. Imports of titanium sponge metal decreased by an estimated 5% compared with those of 2001. Consumption of titanium sponge metal in 2002 decreased an estimated 27% compared with that of 2001.

World Sponge Metal Production and Sponge and Pigment Capacity:

	Sponge production		Capacity 2002[4]	
	2001	2002[e]	Sponge	Pigment
United States	W	W	8,940	1,570,000
Australia	—	—	—	213,000
Belgium	—	—	—	100,000
Canada	—	—	—	81,000
China[e]	2,500	4,000	6,900	100,000
Finland	—	—	—	120,000
France	—	—	—	225,000
Germany	—	—	—	411,000
Italy	—	—	—	80,000
Japan	24,900	25,000	30,000	346,000
Kazakhstan[e]	14,000	14,000	22,000	1,000
Mexico	—	—	—	120,000
Russia[e]	23,000	23,000	26,000	20,000
Spain	—	—	—	65,000
Ukraine[e]	6,100	6,200	6,500	120,000
United Kingdom	—	—	—	335,000
Other countries	—	—	—	618,000
World total (rounded)	[5]71,000	[5]72,000	100,000	4,500,000

World Resources:[6] Resources and reserves of titanium minerals (ilmenite and rutile) are discussed in Titanium Mineral Concentrates. Titanium for domestic sponge production was obtained from rutile or rutile substitutes. The feedstock sources for pigment production were ilmenite, slag, and synthetic rutile.

Substitutes: Although there are few substitutes for titanium in aircraft and space use, graphite-based materials may displace some titanium used in future military aircraft. For industrial uses, high-nickel steel, zirconium, and, to a limited extent, the superalloy metals may be substituted for titanium alloys. Ground calcium carbonate, precipitated calcium carbonate, kaolin, and talc compete with titanium dioxide as a white pigment.

[e]Estimated. E Net exporter. W Withheld to avoid disclosing company proprietary data. — Zero.
[1]See also Titanium Mineral Concentrates.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.
[4]Operating capacity.
[5]Excludes U.S. production.
[6]See Appendix C for definitions.

TUNGSTEN

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

Domestic Production and Use: The last reported U.S. production of tungsten concentrates was in 1994. In 2002, approximately eight companies in the United States processed tungsten concentrates, ammonium paratungstate, tungsten oxide, and/or scrap to make tungsten powder, tungsten carbide powder, and/or tungsten chemicals. More than 70 industrial consumers were surveyed on a monthly or annual basis. Data reported by these consumers indicates that 62% of the tungsten consumed in the United States was used in cemented carbide parts for cutting and wear-resistant materials primarily in the metalworking, oil and gas drilling, mining, and construction industries. The remaining tungsten was consumed in making lamp filaments, electrodes, and other components for the electrical and electronics industries; steels, superalloys, and wear-resistant alloys; and chemicals for catalysts and pigments. The total estimated value of tungsten consumed in 2002 was $250 million.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production:					
Mine	—	—	—	—	—
Secondary	3,350	4,980	5,210	5,390	4,500
Imports for consumption:					
Concentrate	4,750	2,870	2,370	2,680	3,900
Other forms	8,490	8,230	7,810	8,150	7,000
Exports:					
Concentrate	10	26	70	220	90
Other forms	3,640	2,860	2,800	4,860	3,500
Government stockpile shipments:					
Concentrate	—	([1])	1,240	2,200	1,600
Other forms	—	([1])	591	986	200
Consumption:					
Reported, concentrate	[2]3,210	[2]2,100	W	W	W
Apparent, all forms	12,300	12,900	14,400	14,500	12,900
Price, concentrate, dollars per mtu WO_3,[3] average:					
U.S. spot market, Platts Metals Week	52	47	47	64	55
European market, Metal Bulletin	44	40	45	65	38
Stocks, industry, yearend:					
Concentrate	514	W	W	W	W
Other forms	2,780	2,490	2,280	2,110	1,800
Net import reliance[4] as a percentage of apparent consumption	77	65	66	64	70

Recycling: During 2002, the tungsten content of scrap consumed by processors and end users was estimated at 4,500 tons. This represented approximately 35% of apparent consumption of tungsten in all forms.

Import Sources (1998-2001): Tungsten content of ores and concentrates, intermediate and primary products, wrought and unwrought tungsten, and waste and scrap: China, 48%; Russia, 16%; and other, 36%. In 2001, imports of tungsten materials from Russia decreased to 4% of total tungsten imports.

Tariff: Item	Number	Normal Trade Relations[5] 12/31/02
Ore	2611.00.3000	Free.
Concentrate	9902.26.1100	Free.
Ferrotungsten	7202.80.0000	5.6% ad val.
Tungsten powders	8101.10.0000	7.0% ad val.
Ammonium tungstate	2841.80.0010	5.5% ad val.
Tungsten carbide	2849.90.3000	6.5% ad val.
Tungsten oxide	2825.90.3000	5.5% ad val.

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

Government Stockpile: Sales of National Defense Stockpile tungsten began in 1999. Included in the data listed in the table below, as of September 30, 2002, are the following quantities of uncommitted nonstockpile-grade materials authorized for disposal (tons of tungsten content): ores and concentrates, 6,410, and metal powder, 151.

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TUNGSTEN

Stockpile Status—9-30-02[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Carbide powder	—	4	—	—	—
Ferrotungsten	404	83	404	136	137
Metal powder	479	11	479	136	144
Ores and concentrates	30,100	17	30,100	1,810	([7])

Events, Trends, and Issues: World tungsten supply continued to be dominated by Chinese production and exports. Beginning in 1999 and continuing into 2002, the Chinese Government took several steps to control the release of Chinese tungsten into the world market. A new source of tungsten concentrates became available in early 2002, when production resumed from the CanTung Mine in Canada. All production from the mine was sold under contract to two major consumers, one in the United States and one in Sweden.

The downward trend in tungsten prices that began during the second half of 2001 continued through October 2002. The price decrease was attributed to a severe reduction in demand for tungsten end products resulting from a slowing of the world economy; an increase in smuggling of nonlicensed primary tungsten materials, including tungsten concentrates, out of China; and a buildup of inventories by consumers and traders. The decrease in tungsten demand is evident from decreases in the following estimates for 2002: U.S. apparent consumption, U.S. consumption of tungsten scrap, U.S. imports of tungsten materials other than concentrates, shipments of materials from the National Defense Stockpile, and U.S. exports of tungsten materials.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for China have been revised based on new information from that country.

	Mine production		Reserves[8]	Reserve base[8]
	2001	2002[e]		
United States	—	—	140,000	200,000
Austria	1,600	1,600	10,000	15,000
Bolivia	360	500	53,000	100,000
Brazil	14	15	8,500	20,000
Burma	71	70	15,000	34,000
Canada	—	2,500	260,000	490,000
China	37,000	37,000	1,800,000	4,200,000
Korea, North	700	700	NA	35,000
Portugal	750	800	25,000	25,000
Russia	3,500	3,200	250,000	420,000
Thailand	30	50	30,000	30,000
Other countries	180	180	310,000	630,000
World total (rounded)	44,200	46,600	2,900,000	6,200,000

World Resources: Although world tungsten resources are geographically widespread, China has many deposits, including some of the largest in the world. As a result, China ranks number one in terms of tungsten resources and reserves. Canada, Russia, and the United States also have significant tungsten resources.

Substitutes: Cemented tungsten carbide remained a primary cutting-tool insert material because of its versatility in meeting technical requirements in many turning and milling operations. However, ceramics, ceramic-metallic composites, and other materials continued to be developed and utilized as substitutes to meet the changing needs of the world market. Increased quantities of carbide cutting-tool inserts were coated with alumina, diamond, titanium carbide, and/or titanium nitride to extend the life of the inserts. Tungsten remained the preferred and essentially unsubstitutable material for 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. — Zero.
[1]Less than ½ unit.
[2]Excludes 6 months of withheld data.
[3]A metric ton unit (mtu) of tungsten trioxide (WO_3) contains 7.93 kilograms of tungsten.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]Special tariff rates apply for Canada and Mexico.
[6]See Appendix B for definitions.
[7]Quantity not reported.
[8]See Appendix C for definitions.

VANADIUM[1]

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

Domestic Production and Use: Eight firms make up the U.S. vanadium industry. These firms produce ferrovanadium, vanadium pentoxide, vanadium metal, and vanadium-bearing chemicals or specialty alloys by processing materials such as petroleum residues, spent catalysts, utility ash, and vanadium-bearing iron slag. Metallurgical use, primarily as an alloying agent for iron and steel, accounts for about 90% of the vanadium consumed domestically. Of the other uses for vanadium, the major nonmetallurgical use was in catalysts for the production of maleic anhydride and sulfuric acid.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production, mine, mill	W	W	—	—	—
Imports for consumption:					
Ash, ore, residues, slag	2,400	1,650	1,890	1,670	2,000
Vanadium pentoxide, anhydride	847	208	902	600	400
Oxides and hydroxides, other	33	—	14	1,080	100
Aluminum-vanadium master alloys (gross weight)	298	1,210	16	10	100
Ferrovanadium	1,620	1,930	2,510	2,550	2,600
Exports:					
Vanadium pentoxide, anhydride	681	747	653	71	60
Oxides and hydroxides, other	232	70	100	63	200
Aluminum-vanadium master alloys (gross weight)	856	514	677	363	600
Ferrovanadium	579	213	172	70	100
Consumption, reported	4,380	3,620	3,520	3,210	3,300
Price, average, dollars per pound V_2O_5	5.47	1.99	1.82	1.37	1.40
Stocks, consumer, yearend	336	348	303	246	300
Employment, mine and mill, number	400	400	400	400	400
Net import reliance[2] as a percentage of reported consumption	78	76	100	100	100

Recycling: Some tool steel scrap was recycled primarily for its vanadium content, and vanadium was recycled from spent chemical process catalysts, but these two sources together accounted for only a very small percentage of total vanadium used.

Import Sources (1998-2001): Ferrovanadium: South Africa, 29%; Canada, 24%; China, 20%; Czech Republic, 11%; and other, 16%. Vanadium pentoxide: South Africa, 98%; and other, 2%.

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

Item	Number	Normal Trade Relations 12/31/02
Vanadium pentoxide anhydride	2825.30.0010	7.6% ad val.
Vanadium oxides and hydroxides, other	2825.30.0050	7.6% ad val.
Vanadates	2841.90.1000	6.6% ad val.
Ferrovanadium	7202.92.0000	4.2% ad val.
Aluminum-vanadium master alloys	7601.20.9030	Free.

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

Government Stockpile: None.

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VANADIUM

Events, Trends, and Issues: Preliminary data indicate that U.S. vanadium consumption in 2002 was essentially unchanged from the previous year. Among the major uses for vanadium, production of carbon and full alloy steels accounted for 27% and 23% of domestic consumption, respectively.

Both ferrovanadium and vanadium pentoxide prices remained low during 2002. Articles in various industry-related publications attributed the low prices primarily to an increased supply of material.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for China have been significantly increased based on new information from that country.

	Mine production		Reserves[3]	Reserve base[3]
	2001	2002[e]		
United States	—	—	45,000	4,000,000
China	30,000	39,000	5,000,000	14,000,000
Russia	9,000	9,000	5,000,000	7,000,000
South Africa	18,000	18,000	3,000,000	12,000,000
Other countries	1,000	1,000	NA	1,000,000
World total (may be rounded)	58,000	67,000	13,000,000	38,000,000

World Resources: World resources of vanadium exceed 63 million tons. Vanadium occurs in deposits of titaniferous magnetite, phosphate rock, and uraniferous sandstone and siltstone, in which it constitutes less than 2% of the host rock. Significant amounts are also present in bauxite and carboniferous materials, such as crude oil, coal, oil shale, and tar sands. Because vanadium is usually recovered as a byproduct or coproduct, demonstrated world resources of the element are not fully indicative of available supplies. While domestic resources 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 (niobium), manganese, molybdenum, titanium, and tungsten, are to some degree interchangeable with vanadium as alloying elements in steel. Platinum and nickel can replace vanadium compounds as catalysts in some chemical processes. There is currently no acceptable substitute for vanadium in aerospace titanium alloys.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.

[1]Prepared by Robert G. Reese, Jr.

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

[3]See Appendix C for definitions.

VERMICULITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Two companies with mining and processing facilities produced vermiculite concentrate. One company had its operation in South Carolina, and the other company had an operation in Virginia and an operation in South Carolina (which was operated by its subsidiary company). Most of the vermiculite concentrate was shipped to 19 exfoliating plants in 10 States. The end uses for exfoliated vermiculite were estimated to be agricultural, insulation, and other, 78%; and lightweight concrete aggregates (including cement premixes, concrete, and plaster), 22%.

Salient Statistics—United States:	1998	1999	2000	2001	2002[e]
Production[1]	W	[e, 2]150	[e, 3]150	W	W
Imports for consumption[e]	68	71	59	65	48
Exports[e]	11	13	5	7	5
Consumption, apparent, concentrate	W	[e]208	[e]204	W	W
Consumption, exfoliated[e]	170	175	165	140	125
Price, base value, concentrate, dollars per ton, ex-plant[4]	143	143	143	143	143
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number[e]	130	130	120	100	100
Net import reliance[5] as a percentage of apparent consumption	W	[e]28	[e]26	W	W

Recycling: Insignificant.

Import Sources (1998-2001): South Africa, 72%; China, 26%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12/31/02
Vermiculite, perlite and chlorites, unexpanded	2530.10.0000	Free.
Exfoliated vermiculite, expanded clays, foamed slag, and similar expanded materials	6806.20.0000	Free.

Depletion Allowance: 14% (Domestic and foreign).

Government Stockpile: None.

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VERMICULITE

Events, Trends, and Issues: The U.S. Geological Survey has been studying the composition of 101 vermiculite-rich, archived samples from 62 domestic vermiculite mines and deposits in 10 States. The purpose of the study is to determine how common the amphibole asbestos minerals, like those found at Libby, MT, are in other vermiculite deposits, and if they occur in similar morphologies and compositions. (The Libby mine was shut down in 1990.) Studies of vermiculite deposits may help guide priorities for sampling, reclamation, permitting, and monitoring of active and inactive vermiculite mines.[6]

Imerys Minerals Australia Pty. Ltd. acquired Australian Vermiculite Industries Pty. Ltd. for about $2.5 million. The operation, near Alice Springs in the Northern Territory, has a vermiculite production capacity of 12,000 tons per year.[7] In Canada, Hedman Resources Ltd. began production at a plant near North Bay, Ontario. The joint-venture operation, with Enviro Industrial Technologies Inc. (NY), has a capacity of 15,000 tons yearly.[8] Canada's IBI Corp. received a letter of intent for the sale of $1.7 million of its Ugandan vermiculite. IBI's subsidiary, Canmin Resources Ltd., operates the Namekara vermiculite mine near the Kenyan border.[9]

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[10]	Reserve base[10]
	2001	2002[e]		
United States	W	W	25,000	100,000
Brazil	23	23	NA	NA
China	40	55	NA	NA
Russia	25	25	NA	NA
South Africa	157	220	20,000	80,000
Zimbabwe	12	9	NA	NA
Other countries	48	40	5,000	20,000
World total (may be rounded)	305	370	50,000	200,000

World Resources: Marginal reserves of vermiculite, occurring in Colorado, Nevada, North Carolina, Texas, and Wyoming, are estimated to be 2 million 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]Moeller, E.M., 2000, Vermiculite: Mining Engineering, v. 52, no. 6, June, p. 66-67.
[3]Moeller, E.M., 2001, Vermiculite: Mining Engineering, v. 53, no. 6, June, p. 65.
[4]Industrial Minerals magazine, yearend prices.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]Van Gosen, B.S., Lowers, H.A., Bush, A.L., Meeker, G.P., Plumlee, G.S., Brownfield, I.K., and Sutley, S.J., 2002, Reconnaissance study of the geology of U.S. vermiculite deposits—Are asbestos minerals common constituents?: U.S. Geological Survey Bulletin 2192, 8 p.
[7]Industrial Minerals, 2002, Imerys buys Australian Vermiculite Industries: Industrial Minerals, no. 415, April, p. 27.
[8]Industrial Minerals, 2002, Hedman Canadian vermiculite plant on-stream: Industrial Minerals, no. 419, August, p. 21.
[9]Industrial Minerals, 2002, IBI vermiculite order: Industrial Minerals, no. 420, September, p. 70.
[10]See Appendix C for definitions.

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 bastnäsite at Mountain Pass, CA, but was not recovered as a separate element during processing. Bastnäsite, a rare-earth fluocarbonate mineral, was mined as the primary product. Bastnäsite'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 for color televisions and computer monitors, trichromatic fluorescent lights, temperature sensors, and x-ray-intensifying screens. Yttrium was also used as a stabilizer in zirconia, in alumina-zirconia abrasives, wear-resistant and corrosion-resistant cutting tools, seals and bearings, high-temperature refractories for continuous-casting nozzles, jet engine coatings, oxygen sensors in automobile engines, and simulant gemstones. In electronics, yttrium-iron-garnets were components in microwave radar to control high frequency signals. Yttrium was an important component in yttrium-aluminum garnet laser crystals used in industrial cutting and welding, medical and dental surgical procedures, temperature and distance sensing, photoluminescence, photochemistry, digital communications, and nonlinear optics. Yttrium was also used in heating-element alloys, superalloys, and high-temperature superconductors. The approximate distribution in 2001 by end use was as follows: lamp and cathode-ray-tube phosphors, 82%; oxygen sensors, laser crystals, miscellaneous, 13%; and ceramics and abrasives, 5%.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production, mine	—	—	—	—	—
Imports for consumption:					
In monazite (yttrium oxide content[e])	—	—	—	—	—
Yttrium compounds, greater than 19% to less than 85% oxide equivalent (gross weight)	107	268	97	92	NA
Exports, in ore and concentrate	NA	NA	NA	NA	NA
Consumption, estimated[2]	516	428	454	473	450
Price, dollars:					
Monazite concentrate, per metric ton[3]	400	400	400	400	400
Yttrium oxide, per kilogram, 99.0% to 99.99% purity[4]	22-85	22-85	25-200	22-88	22-88
Yttrium metal, per kilogram, 99.0% to 99.9% purity[4]	80-100	80-100	95-115	95-115	95-115
Stocks, processor, yearend	NA	NA	NA	NA	NA
Net import reliance[e 5] as a percentage of apparent consumption	100	100	100	100	100

Recycling: Small quantities, primarily from laser crystals and synthetic garnets.

Import Sources (1998-2001):[e] Yttrium compounds, >19% to < 85% weight percent yttrium oxide equivalent: China, 58%; Japan, 36%; France, 4%; United Kingdom, 1%; and other, 1%. Import sources based on Journal of Commerce data (year 2001 only): China, 79%; United Kingdom, 10%; Japan, 6%; and Germany, 5%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed	2805.30.0000	5.0% ad val.
Yttrium bearing materials and compounds containing by weight >19% to <85% Y_2O_3	2846.90.4000	Free.
Other rare-earth compounds, including yttrium oxide $\geq$ 85%, yttrium nitrate, and other individual compounds	2846.90.8000	3.7% ad val.

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

Government Stockpile: None.

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YTTRIUM

Events, Trends, and Issues: Yttrium demand in the United States increased in 2001, but declined slightly in 2002 as the U.S. economy experienced slower growth, and a strong dollar reduced U.S. competitiveness. International yttrium markets continued to be competitive, although China was the source of most of the world's supply. Yttrium was consumed primarily in the form of high-purity compounds, especially the oxide and nitrate.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for Brazil have been significantly increased based on new information from that country. Reserves and reserve base estimates for Malaysia have been significantly lowered based on a decrease in the economic base of tin ores (primarily cassiterite) from which the byproduct yttrium-bearing minerals xenotime and monazite are derived during processing. Reserves and reserve base estimates for India have been increased based on new information about heavy mineral sands deposits.

	Mine production[e 6]		Reserves[7]	Reserve base[7]
	2001	2002		
United States	—	—	120,000	130,000
Australia	—	—	100,000	110,000
Brazil	4	4	2,200	6,200
Canada	—	—	3,300	4,000
China	2,300	2,300	220,000	240,000
India	55	55	72,000	80,000
Malaysia	7	7	13,000	21,000
South Africa	—	—	4,400	5,000
Sri Lanka	2	2	240	260
Thailand	36	20	600	600
Other	26	26	9,000	10,000
World total (rounded)	2,400	2,400	540,000	610,000

World Resources: Large resources of yttrium in monazite and xenotime are available worldwide in ancient and recent placer deposits, weathered clay deposits (ion-adsorption ore), carbonatites, and uranium ores. Additional large subeconomic resources of yttrium occur in other monazite-bearing deposits, apatite-magnetite rocks, sedimentary phosphate deposits, deposits of columbium-tantalum minerals, and certain uranium ores, especially those of the Blind River District in Canada. It is probable that the world's resources are very large.

Substitutes: Substitutes for yttrium are available for some applications, but generally are much less effective. In most uses, especially in 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 they generally are not as resilient.

[e]Estimated. NA Not available. — Zero.
[1]See also Rare Earths.
[2]Essentially all yttrium consumed domestically was imported or refined from imported ores and concentrates.
[3]Monazite concentrate prices derived from U.S. Census Bureau data (1998-2001).
[4]Yttrium oxide and metal prices from Elements—Rare Earths, Specialty Metals and Applied Technology (a High Tech Materials on-line publication at www.rareearthsmarketplace.com), Rhodia Rare Earths, Inc., Shelton, CT, and the China Rare Earth Information Center, Baotou, China.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]Includes yttrium contained in rare-earth ores.
[7]See Appendix C for definitions.

ZINC

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

Domestic Production and Use: The value of zinc mined in 2002, based on contained zinc recoverable from concentrate, was about $660 million. It was produced in 5 States by 12 mines operated by 7 companies. Alaska, Missouri, New York, and Tennessee accounted for 98% of domestic mine output; Alaska alone accounted for about 85% of production. Two primary and 13 large- and medium-sized secondary smelters refined zinc metal of commercial grade in 2002. Of zinc metal consumed, about 75% was used in Illinois, Indiana, Michigan, New York, Ohio, and Pennsylvania, mostly by steel companies. Of the total zinc consumed, about 55% was used in galvanizing, 17% in zinc-base alloys, 13% in brass and bronze, and 15% in other uses. Zinc compounds and dust were used principally by the agriculture, chemical, paint, and rubber industries. Major coproducts of zinc mining and smelting, in order of decreasing tonnage, were lead, sulfur, cadmium, silver, gold, and germanium.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[e]**
Production:					
Mine, zinc in ore[1]	755	852	852	842	740
Primary slab zinc	234	241	228	203	210
Secondary slab zinc	134	131	143	108	130
Imports for consumption:					
Ore and concentrate	46	75	53	84	80
Refined zinc	879	1,060	915	813	900
Exports:					
Ore and concentrate	552	531	523	696	710
Refined zinc	2	2	3	1	1
Shipments from Government stockpile	26	22	39	18	20
Consumption:					
Apparent, refined zinc	1,290	1,430	1,330	1,140	1,244
Apparent, all forms	1,590	1,700	1,630	1,400	1,500
Price, average, cents per pound:					
Domestic producers[2]	51.4	53.5	55.6	44.0	40.0
London Metal Exchange, cash	46.4	48.8	51.2	40.2	36.0
Stocks, slab zinc, yearend	68	84	77	75	90
Employment:					
Mine and mill, number[e]	2,400	2,500	2,600	2,400	2,000
Smelter primary, number[e]	1,000	1,000	1,000	900	900
Net import reliance[3] as a percentage of apparent consumption:					
Refined zinc	71	74	72	73	73
All forms of zinc	58	62	60	59	60

Recycling: In 2002, an estimated 370,000 tons of zinc was recovered from waste and scrap; about 30% was recovered in the form of slab zinc and the remainder in alloys, oxide, and chemicals. Of the total amount of scrap recycled, 300,000 tons was derived from new scrap and 70,000 tons was derived from old scrap. About 25,000 tons of scrap was exported, mainly to China, Canada, and Taiwan, and 40,000 tons was imported, 90% of which came from Canada.

Import Sources (1998-2001): Ore and concentrate: Peru, 53%; Mexico, 19%; Australia, 17%; and other, 11%. Metal: Canada, 57%; Mexico, 12%; Kazakhstan, 9%; and other, 22%. Combined total: Canada, 54%; Mexico, 12%; Kazakhstan, 8%; and other, 26%.

Tariff: Item	Number	Normal Trade Relations[4] 12/31/02
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—9-30-02[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 2002	Disposals FY 2002
Zinc	110	3	110	45	4

Events, Trends, and Issues: In 2002, the price of zinc on the London Metal Exchange (LME) reached its lowest level in 15 years. At the same time, LME stocks were reaching greater heights, not seen since the beginning of 1996. Reaction of mining companies to declining prices and rising stocks reflected their individual size and financial strength. Smaller companies that operated small underground mines or low-capacity smelters could not absorb prolonged financial loses and were forced to either temporarily suspend production or close the entire operation. Larger companies with ample financial resources and diversified production were in better position to withstand the downturn of the zinc industry. Some even increased production in order to take advantage of economies of scale to ensure lower unit prices. During the past 2 years, four underground mines were closed in the United States and another three mines were put on care and maintenance. In addition, one company suspended mining operation while another postponed development of a new underground mine. These closures deprived the smelters of domestically produced zinc concentrates, forcing one smelter to convert solely to zinc recycling. These market-imposed closures in the United States and around the world may hasten consolidation of the zinc industry, as favored by many industry experts.

The United States remained one of the largest consumers of zinc and zinc products. However, domestic metal production capacity, both primary and secondary, accounts for less than one-third of the quantity consumed. 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: Reserves and reserve base estimates for Mexico and Peru have been significantly increased based on new information from those countries.

	Mine production[6]		Reserves[7]	Reserve base[7]
	2001	2002[e]		
United States	842	740	30,000	90,000
Australia	1,520	1,520	33,000	80,000
Canada	1,000	1,000	11,000	31,000
China	1,700	1,500	33,000	92,000
Mexico	429	475	8,000	25,000
Peru	1,060	1,150	16,000	20,000
Other countries	2,300	2,500	69,000	110,000
World total (may be rounded)	8,850	8,900	200,000	450,000

World Resources: Identified zinc resources of the world are about 1.9 billion tons.

Substitutes: Aluminum, steel, and plastics substitute for galvanized sheet. Aluminum, plastics, and magnesium are major competitors as diecasting materials. Plastic coatings, paint, and cadmium and aluminum alloy coatings replace zinc for corrosion protection; aluminum alloys are used in place of brass. Many elements are substitutes for zinc in chemical, electronic, and pigment uses.

[e]Estimated.
[1]Zinc recoverable after smelting and refining was reported for mine production prior to Mineral Commodity Summaries 2001.
[2]Platts Metals Week price for North American Special High Grade zinc.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]No tariff for Canada and Mexico for items shown.
[5]See Appendix B for definitions.
[6]Zinc content of concentrate and direct shipping ore.
[7]See Appendix C for definitions.

ZIRCONIUM AND HAFNIUM

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: Zircon sand was produced at two mines in Florida and at one mine in Virginia. Zirconium and hafnium metal were produced from zircon sand by two domestic producers, one in Oregon and the other in Utah. Typically, both metals are in the ore in a zirconium to hafnium ratio of about 50:1. Primary zirconium chemicals were produced by the Oregon metal producer and at a plant in New Jersey. Secondary zirconium chemicals were produced by 10 other companies. Zirconia (ZrO_2) was produced from zircon sand at plants in Alabama, New Hampshire, New York, Ohio, and by the metal producer in Oregon. Zircon ceramics, opacifiers, refractories, and foundry applications are the largest end uses for zirconium. Other end uses of zirconium include abrasives, chemicals, metal alloys, welding rod coatings, and sandblasting. The largest market for hafnium metal is as an addition in superalloys.

Salient Statistics—United States:	**1998**	**1999**	**2000**	**2001**	**2002[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)	58,200	37,500	42,400	39,400	20,900
Zirconium, alloys, waste and scrap, and other (ZrO_2 content)	1,210	1,160	1,400	197	720
Zirconium oxide (ZrO_2 content)[2]	3,900	3,140	3,950	2,950	2,910
Hafnium, unwrought, waste and scrap	12	9	11	5	1
Exports:					
Zirconium ores and concentrates (ZrO_2 content)	26,600	45,200	47,400	43,500	25,300
Zirconium, alloys, waste and scrap, and other (ZrO_2 content)	216	211	259	251	87
Zirconium oxide (ZrO_2 content)[2]	1,540	1,680	2,100	2,400	2,160
Consumption, zirconium ores and concentrates, apparent (ZrO_2 content)	W	W	W	W	W
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic[3]	320	300	340	340	350
Imported, f.o.b.[4]	355	311	396	356	410
Zirconium sponge, dollars per kilogram[5]	20-26	20-26	20-26	20-31	20-31
Hafnium sponge, dollars per kilogram[5]	165-209	165-209	165-209	119-141	119-141
Net import reliance[6] as a percentage of apparent consumption:					
Zirconium	W	W	W	W	W
Hafnium	NA	NA	NA	NA	NA

Recycling: Scrap zirconium metal and alloys was recycled by four companies, one each in California, Michigan, New York, and Texas. In-plant recycled zirconium came from scrap generated during metal production and fabrication and was recycled by companies in Oregon and Utah. Zircon foundry mold cores and spent or rejected zirconia refractories are often recycled. Recycling of hafnium metal was insignificant.

Import Sources (1998-2001): Zirconium ores and concentrates: South Africa, 53%; Australia, 43%; and other, 4%. Zirconium, wrought, unwrought, waste and scrap: France, 63%; Germany, 17%; Japan, 7%; Canada, 5%; and other, 8%. Hafnium, unwrought, waste and scrap: France, 80%; Germany, 8%; United Kingdom, 3%; and other, 9%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/02**
Zirconium ores and concentrates	2615.10.0000	Free.
Germanium oxide and zirconium oxide	2825.60.0000	3.7% ad val.
Ferrozirconium	7202.99.1000	4.2% ad val.
Zirconium, other unwrought, powders	8109.20.0000	4.2% ad val.
Zirconium, waste and scrap	8109.30.0000	Free.
Zirconium, other wrought, alloys	8109.90.0000	3.7% ad val.
Unwrought hafnium	8112.92.2000	Free.

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

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ZIRCONIUM AND HAFNIUM

Government Stockpile: The National Defense Stockpile (NDS) shipped 16,182 metric tons (17,838 short tons) of zirconium ore (baddeleyite) during fiscal year 2002. 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.

Events, Trends, and Issues: The global supply and demand of zirconium mineral concentrates was largely balanced in 2002. 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 decreased by 47%, while exports were estimated to have decreased by 58% compared with those of 2001. A mining operation at Green Cove Springs, FL, is nearing the end of its mine life, and dredging at the site will be phased out over the next few years. Smaller economic deposits surrounding the main mined-out ore body will continue to be mined with a mobile mining unit and concentrator. The mining and processing operations at Green Cove Springs will be moved to a new deposit in northern Florida and southern Georgia and are scheduled to commence in 2003. A new zircon finishing plant was installed at Stony Creek, VA, to improve and upgrade product quality. The plant was completed in the fourth quarter of 2002. The 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 its markets.

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. Reserves and reserve base estimates for Brazil and China have been increased based on new information from those countries.

	Zirconium				Hafnium	
	Mine production (thousand metric tons)		Reserves[7]	Reserve base[7]	Reserves[7]	Reserve base[7]
			(million metric tons, ZrO_2)		(thousand metric tons, HfO_2)	
	2001	2002[e]				
United States[1]	100	100	3.4	5.3	68	97
Australia	400	400	9.1	30	180	600
Brazil	30	30	2.2	4.6	44	91
China	[e]15	15	0.5	3.7	NA	NA
India	12	12	3.4	3.8	42	46
South Africa	250	260	14	14	280	290
Ukraine	[e]75	72	4.0	6.0	NA	NA
Other countries	23	30	0.9	4.1	NA	NA
World total (rounded)	900	910	37	72	610	1,100

World Resources: Resources of zircon in the United States included about 14 million tons associated with titanium resources in heavy-mineral sand deposits. Phosphate and sand and gravel deposits have the potential to yield substantial amounts of zircon as a future byproduct. Eudialyte and gittinsite are zirconium silicate minerals that have a potential for zirconia production. Identified world resources of zircon exceed 60 million tons.

Resources of hafnium in the United States are estimated to be about 130,000 tons, available in the 14-million-ton domestic resources of zircon. World resources of hafnium are associated with those of zircon and baddeleyite and exceed 1 million tons.

Substitutes: Chromite and olivine can be used instead of zircon for some foundry applications. Dolomite and spinel refractories can also substitute for zircon in certain high-temperature applications. Columbium (niobium), stainless steel, and tantalum provide limited substitution in nuclear applications, while titanium and synthetic materials may substitute in some chemical plant uses.

Silver-cadmium-indium control rods are used in lieu of hafnium at numerous nuclear powerplants. Zirconium can be used interchangeably with hafnium in certain superalloys; in others, only hafnium produces the desired or required grain boundary refinement.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Rounded to one significant digit to avoid disclosing company proprietary data. ZrO_2 content of zircon is typically 65%.
[2]Includes germanium oxides and zirconium oxides.
[3]E.I. du Pont de Nemours & Co. and Iluka Resources, Inc., average price.
[4]U.S. Census Bureau trade data.
[5]American Metal Market, daily, Miscellaneous prices. Converted from pounds.
[6]Defined as imports - exports.
[7]See Appendix C for definitions.

APPENDIX A

Abbreviations and Units of Measure

1 carat (metric) (diamond)	= 200 milligrams
1 flask (fl)	= 76 pounds, avoirdupois
1 karat (gold)	= one twenty-fourth part
1 kilogram (kg)	= 2.2046 pounds, avoirdupois
1 long ton (lt)	= 2,240 pounds, avoirdupois
1 long ton unit (ltu)	= 1% of 1 long ton or 22.4 pounds avoirdupois
long calcined ton (lct)	= excludes water of hydration
long dry ton (ldt)	= excludes excess free moisture
Mcf	= 1,000 cubic feet
1 metric ton (t)	= 2,204.6 pounds, avoirdupois or 1,000 kilograms
1 metric ton (t)	= 1.1023 short ton
1 metric ton unit (mtu)	= 1% of 1 metric ton or 10 kilograms
1 pound (lb)	= 453.6 grams
1 short ton (st)	= 2,000 pounds, avoirdupois
1 short ton unit (stu)	= 1% of 1 short ton or 20 pounds, avoirdupois
1 short dry ton (sdt)	= 2,000 pounds, avoirdupois, excluding moisture content
1 troy ounce (tr oz)	= 1.09714 avoirdupois ounces or 31.103 grams
1 troy pound	= 12 troy ounces

APPENDIX B

Definitions of Selected Terms Used in This Report

Terms Used for Materials in the National Defense Stockpile and Helium Stockpile

Uncommitted inventory refers to the quantity of mineral materials held in the National Defense Stockpile. Prior to this report, nonstockpile-grade quantities were not reported in the Stockpile Status table of the Mineral Commodity Summaries. Beginning with this report, however, nonstockpile-grade materials may be included in the table; where significant, the quantities of these stockpiled materials will be specified in the text accompanying the table.

Committed inventory refers to materials that have been sold or traded from the stockpile, either in the current fiscal year 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 2002 indicates the total amount of a material in the National Defense Stockpile that the U.S. Department of Defense is permitted to sell under the Annual Materials Plan approved by Congress for the fiscal year. Fiscal year 2002 is the period October 1, 2001, through September 30, 2002. Note that, unlike the National Defense Stockpile, helium stockpile sales by the Bureau of Land Management under the Helium Privatization Act of 1996 are permitted to exceed disposal plans.

Disposals FY 2002 refers to material sold or traded from the stockpile in fiscal year 2002; it may or may not have been removed by the buyers.

Depletion Allowance

The depletion allowance is a business tax deduction analogous to depreciation, but applies to an ore reserve rather than equipment or production facilities. Federal tax law allows this deduction from taxable corporate income, recognizing that an ore deposit is a depletable asset that must eventually be replaced.

APPENDIX C

A Resource/Reserve Classification for Minerals[1]

INTRODUCTION

Through the years, geologists, mining engineers, and others operating in the minerals field have used various terms to describe and classify mineral resources, which as defined herein include energy materials. Some of these terms have gained wide use and acceptance, although they are not always used with precisely the same meaning.

The U.S. Geological Survey 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

[1]Based on U.S. Geological Survey Circular 831, 1980.

(marginal reserves), and some of those that are currently subeconomic (subeconomic resources). The term “geologic reserve” has been applied by others generally to the reserve-base category, but it also may include the inferred-reserve-base category; it is not a part of this classification system.

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*

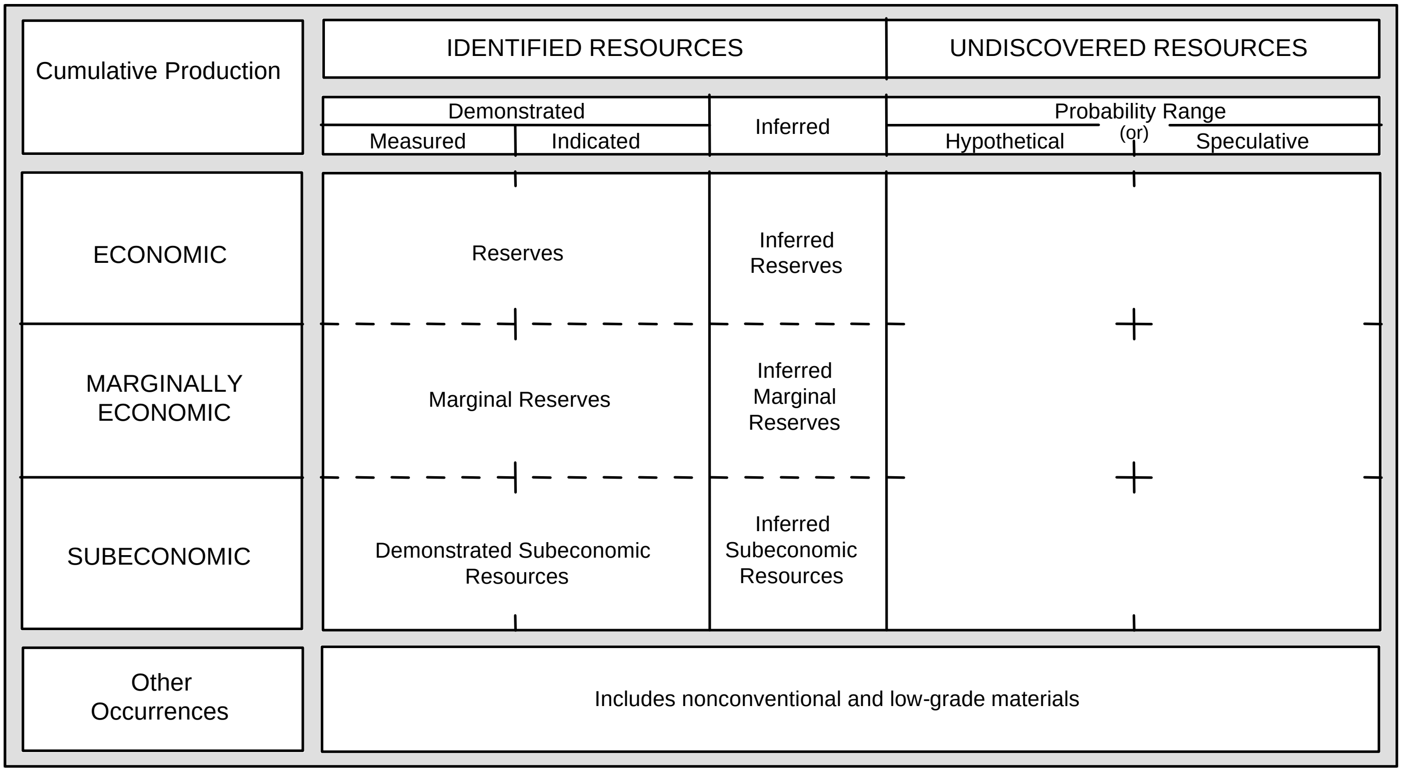
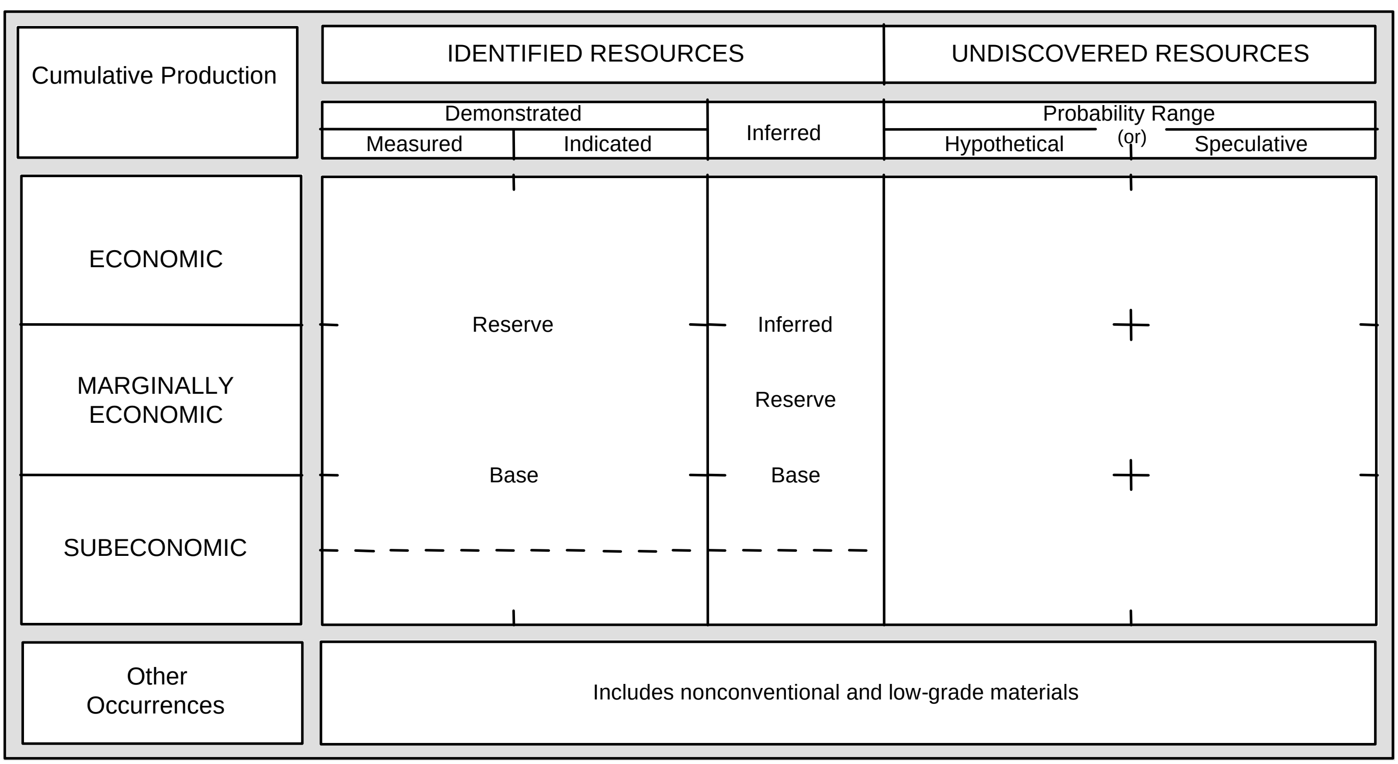


FIGURE 2.—*Reserve Base* and *Inferred Reserve Base* Classification Categories



APPENDIX D

Country Specialists Directory

Minerals information country specialists at the U.S. Geological Survey collect and analyze information on the mineral industries of more than 170 nations throughout the world. The specialists are available to answer minerals-related questions concerning individual countries.

Africa and the Middle East

Algeria	Philip M. Mobbs
Angola	George J. Coakley
Bahrain	Philip M. Mobbs
Benin	Thomas R. Yager[1]
Botswana	George J. Coakley
Burkina Faso	Thomas R. Yager[1]
Burundi	Thomas R. Yager
Cameroon	Philip M. Mobbs[1]
Cape Verde	Thomas R. Yager[1]
Central African Republic	Thomas R. Yager[1]
Chad	Philip M. Mobbs
Comoros	Thomas R. Yager
Congo (Brazzaville)	George J. Coakley
Congo (Kinshasa)	George J. Coakley
Côte d'Ivoire	George J. Coakley[1]
Cyprus	Philip M. Mobbs
Djibouti	Thomas R. Yager
Egypt	Philip M. Mobbs
Equatorial Guinea	Philip M. Mobbs
Eritrea	Thomas R. Yager
Ethiopia	Thomas R. Yager
Gabon	George J. Coakley[1]
The Gambia	Thomas R. Yager[1]
Ghana	George J. Coakley
Guinea	Thomas R. Yager[1]
Guinea-Bissau	Thomas R. Yager[1]
Iran	Philip M. Mobbs
Iraq	Philip M. Mobbs
Israel	Thomas R. Yager
Jordan	Thomas R. Yager
Kenya	Thomas R. Yager
Kuwait	Philip M. Mobbs
Lebanon	Thomas R. Yager
Lesotho	George J. Coakley
Liberia	Thomas R. Yager[1]
Libya	Philip M. Mobbs
Madagascar	Thomas R. Yager
Malawi	Thomas R. Yager
Mali	Philip M. Mobbs[1]
Mauritania	Philip M. Mobbs[1]
Mauritius	Thomas R. Yager
Morocco & Western Sahara	Philip M. Mobbs[1]
Mozambique	Thomas R. Yager
Namibia	George J. Coakley
Niger	Philip M. Mobbs[1]
Nigeria	Philip M. Mobbs
Oman	Philip M. Mobbs
Qatar	Philip M. Mobbs
Reunion	Thomas R. Yager
Rwanda	Thomas R. Yager
São Tomé & Principe	Philip M. Mobbs[1]
Saudi Arabia	Philip M. Mobbs
Senegal	Thomas R. Yager[1]
Seychelles	Thomas R. Yager
Sierra Leone	Thomas R. Yager[1]
Somalia	Thomas R. Yager
South Africa	George J. Coakley
Sudan	Thomas R. Yager
Swaziland	George J. Coakley
Syria	Thomas R. Yager
Tanzania	Thomas R. Yager
Togo	Thomas R. Yager[1]
Tunisia	Philip M. Mobbs
Turkey	Philip M. Mobbs
Uganda	Thomas R. Yager
United Arab Emirates	Philip M. Mobbs
Yemen	Philip M. Mobbs
Zambia	George J. Coakley
Zimbabwe	George J. Coakley

Asia and the Pacific

Afghanistan	Travis Q. Lyday
Australia	Travis Q. Lyday
Bangladesh	Chin S. Kuo
Bhutan	Chin S. Kuo
Brunei	John C. Wu
Burma	John C. Wu
Cambodia	John C. Wu
China	Pui-Kwan Tse
Christmas Island	Travis Q. Lyday
Fiji	Travis Q. Lyday
India	Chin S. Kuo
Indonesia	Pui-Kwan Tse
Japan	John C. Wu
Korea, North	Pui-Kwan Tse
Korea, Republic of	Pui-Kwan Tse
Laos	John C. Wu
Malaysia	John C. Wu
Mongolia	Pui-Kwan Tse
Nepal	Chin S. Kuo
New Caledonia	Travis Q. Lyday
New Zealand	Travis Q. Lyday
Pakistan	Travis Q. Lyday
Papua New Guinea	Travis Q. Lyday
Philippines	Travis Q. Lyday
Singapore	Pui-Kwan Tse
Solomon Islands	Travis Q. Lyday
Sri Lanka	Chin S. Kuo
Taiwan	Pui-Kwan Tse
Thailand	John C. Wu
Tonga	Travis Q. Lyday
Vanuatu	Travis Q. Lyday
Vietnam	John C. Wu

Europe and Central Eurasia

Albania	Walter G. Steblez
Armenia	Richard M. Levine
Austria	Harold R. Newman
Azerbaijan	Richard M. Levine
Belarus	Richard M. Levine

Belgium	Harold R. Newman
Bosnia and Herzegovina	Walter G. Steblez
Bulgaria	Walter G. Steblez
Croatia	Walter G. Steblez
Czech Republic	Walter G. Steblez
Denmark, Faroe Island, and Greenland	Chin S. Kuo
Estonia	Chin S. Kuo
Finland	Chin S. Kuo
France	Harold R. Newman
Georgia	Richard M. Levine
Germany	Harold R. Newman
Greece	Harold R. Newman
Hungary	Walter G. Steblez
Iceland	Chin S. Kuo
Ireland	Harold R. Newman
Italy	Harold R. Newman
Kazakhstan	Richard M. Levine
Kyrgyzstan	Richard M. Levine
Latvia	Chin S. Kuo
Lithuania	Chin S. Kuo
Luxembourg	Harold R. Newman
Macedonia	Walter G. Steblez
Malta	Harold R. Newman
Moldova	Richard M. Levine
Netherlands	Harold R. Newman
Norway	Chin S. Kuo
Poland	Walter G. Steblez
Portugal	Harold R. Newman
Romania	Walter G. Steblez
Russia	Richard M. Levine
Slovakia	Walter G. Steblez
Slovenia	Walter G. Steblez
Spain	Harold R. Newman
Sweden	Chin S. Kuo
Switzerland	Harold R. Newman
Tajikistan	Richard M. Levine
Turkmenistan	Richard M. Levine
Ukraine	Richard M. Levine
United Kingdom	Harold R. Newman
Uzbekistan	Richard M. Levine
Yugoslavia	Walter G. Steblez

North America, Central America, and the Caribbean

Antigua and Barbuda	Ivette E. Torres[1]
Aruba	Ivette E. Torres[1]
The Bahamas	Ivette E. Torres[1]
Barbados	Ivette E. Torres[1]
Belize	Pablo Velasco
Bermuda	Ivette E. Torres[1]
Canada	Alfredo C. Gurmendi
Costa Rica	Pablo Velasco
Cuba	Ivette E. Torres
Dominica	Ivette E. Torres[1]
Dominican Republic	Ivette E. Torres
El Salvador	Pablo Velasco
Grenada	Ivette E. Torres[1]
Guadeloupe	Ivette E. Torres[1]
Guatemala	Pablo Velasco
Haiti	Ivette E. Torres[1]
Honduras	Pablo Velasco
Jamaica	Ivette E. Torres[1]
Martinique	Ivette E. Torres[1]
Mexico	Ivette E. Torres
Montserrat	Ivette E. Torres[1]
Netherlands Antilles	Ivette E. Torres[1]
Nicaragua	Pablo Velasco
Panama	Pablo Velasco
St. Kitts and Nevis	Ivette E. Torres[1]
St. Lucia	Ivette E. Torres[1]
St. Vincent & the Grenadines	Ivette E. Torres[1]
Trinidad and Tobago	Ivette E. Torres[1]

South America

Argentina	Ivette E. Torres
Bolivia	Pablo Velasco
Brazil	Alfredo C. Gurmendi
Chile	Pablo Velasco
Colombia	Ivette E. Torres
Ecuador	Pablo Velasco
French Guiana	Alfredo C. Gurmendi[1]
Guyana	Alfredo C. Gurmendi[1]
Paraguay	Pablo Velasco
Peru	Alfredo C. Gurmendi
Suriname	Alfredo C. Gurmendi[1]
Uruguay	Pablo Velasco
Venezuela	Ivette E. Torres

[1]Interim

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Thomas R. Yager	(703) 648-7739	tyager@usgs.gov