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

MINERAL COMMODITY SUMMARIES 2000

Abrasives
Aluminum
Antimony
Arsenic
Asbestos
Barite
Bauxite
Beryllium
Bismuth
Boron
Bromine
Cadmium
Cement
Cesium
Chromium
Clays
Cobalt
Columbium
Copper
Diamond
Diatomite
Feldspar
Fluorspar
Gallium
Garnet
Gemstones
Germanium
Gold
Graphite
Gypsum
Hafnium
Helium
Indium
Iodine
Iron Ore
Iron and Steel
Kyanite
Lead
Lime
Lithium
Magnesium
Manganese
Mercury
Mica
Molybdenum
Nickel
Nitrogen
Peat
Perlite
Phosphate Rock
Platinum
Potash
Pumice
Quartz Crystal
Rare Earths
Rhenium
Rubidium
Salt
Sand and Gravel
Scandium
Selenium
Silicon
Silver
Soda Ash
Sodium Sulfate
Stone
Strontium
Sulfur
Talc
Tantalum
Tellurium
Thallium
Thorium
Tin
Titanium
Tungsten
Vanadium
Vermiculite
Yttrium
Zinc
Zirconium

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CONTENTS

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This publication has been prepared by the Minerals Information Team. Information about the team and its publications may be accessed via the Internet at http://minerals.usgs.gov/minerals or by writing: Chief Scientist, Minerals Information Team, 988 National Center, Reston, VA 20192. Information about the team and its publications may also be received from MINES FaxBack. MINES FaxBack is a simple-to-operate automated fax response system that operates 24 hours a day, 7 days a week. A user needs access to a fax machine with a touch-tone telephone. After calling MINES FaxBack, the requester is guided by a series of voice messages to assist in ordering the desired documents. Information on approximately 90 commodities, 50 States, and 190 countries is now available on MINES FaxBack. MINES FaxBack can be accessed by calling (703) 648-4999, using the touch-tone telephone attached to the user's fax machine.

KEY PUBLICATIONS

Minerals Yearbook—Annual publications that review the mineral industry of the United States and foreign countries. They contain statistical data on materials and minerals 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—Periodic statistical and economic reports 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, depending on the need for current data.

Metal Industry Indicators—A monthly publication that provides economic indicators of selected metal industries.

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

Materials Flow Studies—These occasional publications provide an understanding of the flow of materials from source to ultimate disposition to help better understand the economy, manage the use of natural resources, and protect the environment.

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

WHERE TO OBTAIN PUBLICATIONS

- *Metal Prices in the United States Through 1998, Mineral Commodity Summaries,* and the *Minerals Yearbook* are sold by the U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954. To order by telephone, call (202) 512-1800.

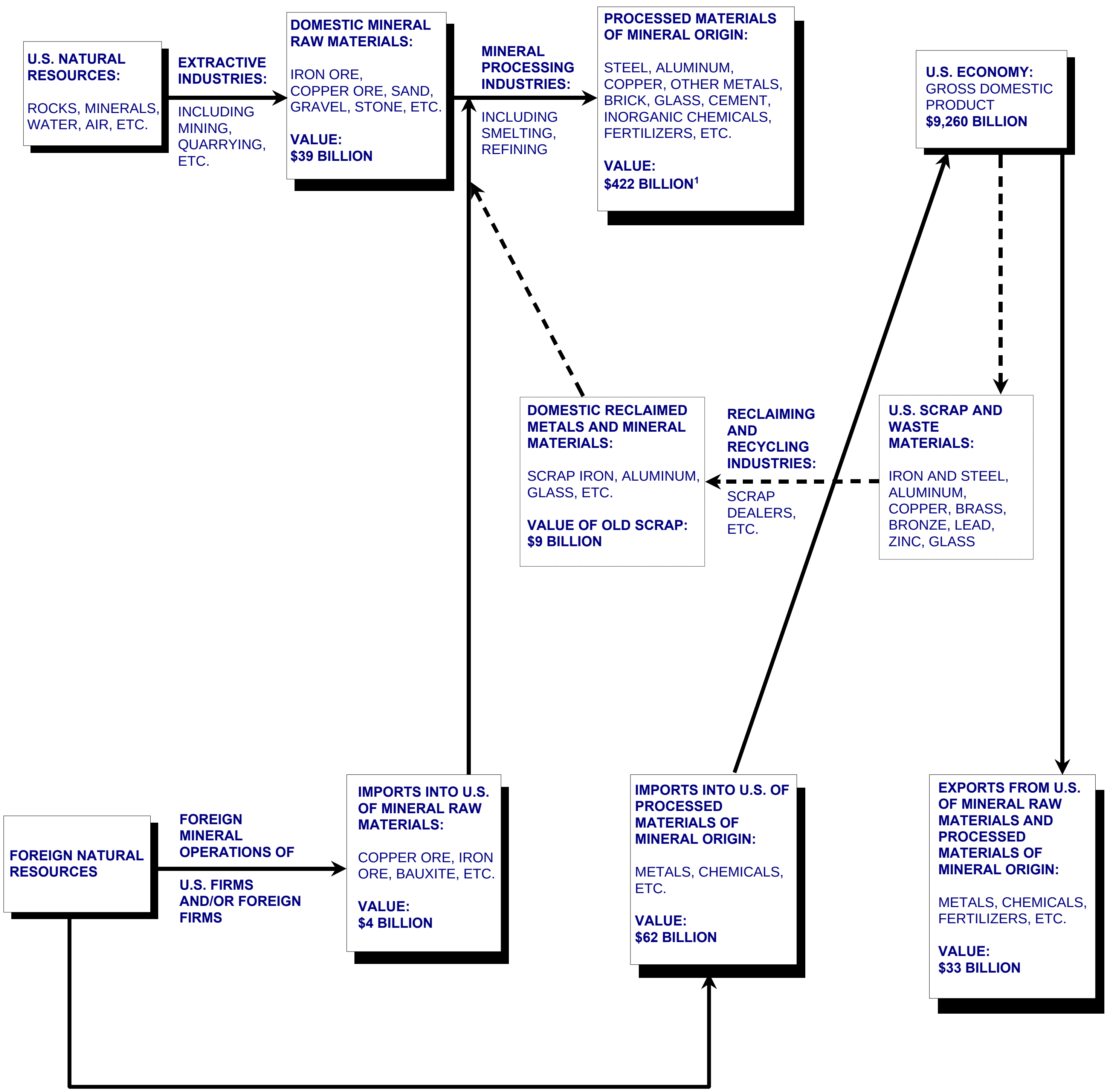
- *Mineral Industry Surveys* and *Metal Industry Indicators* can be obtained free of charge by calling (412) 386-6156 or writing NIOSH Printing Office, Pittsburgh Research Laboratory, P.O. Box 18070, Pittsburgh, PA 15236.

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

- All current publications are available in PDF format via the Internet at http://minerals.usgs.gov/minerals.

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

(ESTIMATED VALUES IN 1999)



[1]This value cannot be directly related to gross domestic product because it implicitly includes the cost of intermediate goods and services used in producing mineral products. Gross domestic product excludes such costs and its value is determined either in terms of sales for final consumption or in the income generated by producing goods and services.

1999 U.S. NET IMPORT RELIANCE FOR SELECTED NONFUEL MINERAL MATERIALS

Commodity	Percent	Major Sources (1995-98)[1]
ARSENIC TRIOXIDE	100	China, Chile, Mexico
BAUXITE and ALUMINA	100	Australia, Guinea, Jamaica, Brazil
BISMUTH	100	Belgium, Mexico, United Kingdom, China
COLUMBIUM (niobium)	100	Brazil, Canada, Germany, Russia
FLUORSPAR	100	China, South Africa, Mexico
GRAPHITE (natural)	100	Mexico, Canada, China, Madagascar
MANGANESE	100	South Africa, Gabon, Australia, France
MICA, sheet (natural)	100	India, Belgium, Germany, China
STRONTIUM	100	Mexico, Germany
THALLIUM	100	Belgium, Mexico, Germany, United Kingdom
THORIUM	100	France
YTTRIUM	100	China, France, United Kingdom, Japan
GEMSTONES	99	Israel, Belgium, India
ANTIMONY	85	China, Bolivia, Mexico, South Africa
TIN	85	Brazil, Indonesia, Bolivia, China
TUNGSTEN	81	China, Russia, Bolivia, Germany
CHROMIUM	80	South Africa, Russia, Turkey, Zimbabwe
POTASH	80	Canada, Russia, Belarus
TANTALUM	80	Australia, Thailand, China, Germany
STONE (dimension)	77	Italy, India, Canada, Spain
TITANIUM CONCENTRATES	77	South Africa, Australia, Canada, India
COBALT	73	Norway, Finland, Canada, Zambia
RARE EARTHS	72	China, France, Japan, United Kingdom
IODINE	68	Chile, Japan, Russia
BARITE	67	China, India, Mexico, Morocco
NICKEL	63	Canada, Russia, Norway, Australia
PEAT	57	Canada
TITANIUM (sponge)	44	Russia, Japan, Kazakhstan, China
DIAMOND (dust, grit and powder)	41	Ireland, China, Russia
MAGNESIUM COMPOUNDS	40	China, Canada, Austria, Greece
PUMICE	35	Greece, Turkey, Ecuador, Italy
ALUMINUM	30	Canada, Russia, Venezuela, Mexico
SILICON	30	Norway, Russia, Brazil, Canada
ZINC	30	Canada, Mexico, Peru
GYPSUM	29	Canada, Mexico, Spain
MAGNESIUM METAL	29	Canada, Russia, China, Israel
COPPER	27	Canada, Chile, Mexico
NITROGEN (fixed), AMMONIA	26	Trinidad and Tobago, Canada, Mexico, Venezuela
CEMENT	23	Canada, Spain, Venezuela, Greece
MICA, scrap and flake (natural)	23	Canada, India, Finland, Japan
IRON and STEEL	22	European Union, Canada, Japan, Russia
LEAD	20	Canada, Mexico, Peru, Australia
CADMIUM	19	Canada, Belgium, Germany, Australia
IRON ORE	17	Canada, Brazil, Venezuela, Australia
SULFUR	17	Canada, Mexico, Venezuela
SALT	16	Canada, Chile, Mexico, The Bahamas
SILVER	14	Mexico, Canada, Peru, Chile
PERLITE	13	Greece
ASBESTOS	7	Canada
PHOSPHATE ROCK	7	Morocco
TALC	6	China, Canada, Japan
IRON and STEEL SCRAP	3	Canada, United Kingdom, Venezuela, Mexico
BERYLLIUM	2	Kazakhstan, Russia, Canada, Germany

[1] In descending order of import share.

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

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

SIGNIFICANT EVENTS, TRENDS, AND ISSUES

The Mineral Sector of the U.S. Economy

The U.S. economy expanded at a strong rate in 1999 and, consequently, the consumption of minerals and mineral–based products increased. The increasing growth in the economy pushed production and shipments of most U.S. metals manufacturers higher, as they began recovering from the declines in activity that occurred in 1998. Aluminum and steel activity picked up, but U.S. copper activity continued to decline. Moreover, the total value of shipments for metal producers continued to be held down by low metal prices. Notwithstanding increasing interest rates and fuel costs in 1999, a low inflation and increases in employment bolstered consumer confidence throughout the year. The rise in employment resulted in increased taxes paid at the State and Federal levels, helping the United States maintain its budget surplus. While the Federal budget surplus, low inflation, and low unemployment are positive indicators for the overall economy in 2000, many economists in Government and industry believe that economic growth will occur at a slower pace than in 1999, partly because of higher interest rates. Consumption of many industrial minerals, especially crushed stone and cement, remained firm in 1999, even though the pace of new construction slowed during the later half of the year. More detailed information on events, trends, and issues in the mineral and mineral products sectors is presented below and in the commodity sections that follow.

Overall Performance

The value of processed materials of mineral origin produced in the United States during 1999 was estimated to be $422 billion, which was essentially the same as in 1998. The estimated value of U.S. raw nonfuel minerals production in 1999 was over $39.1 billion, a slight decrease compared with that of 1998, mostly because of reduced metal prices, and the second decline in as many years. However, the estimated production value of all industrial minerals increased over $0.8 billion and almost offset the $1.3 billion drop in the estimated value of metals production. The total value of U.S. minerals production has increased in 31 of the last 39 years.

Total U.S. trade in raw minerals and processed materials of mineral origin was valued at $98 billion in 1999. Imports of processed mineral materials were valued at an estimated $62 billion, which was an increase of about $2 billion over that of 1998 and reflected an increase in the quantity of aluminum and copper imports. Exports of mineral raw materials and processed materials of mineral origin were valued at an estimated $33 billion, which was a decline of nearly $2 billion from that of 1998, and partly reflected a stronger performance of the U.S. dollar against other currencies. Imports of metal ores and concentrates and of raw industrial minerals increased slightly to almost $4 billion. Raw minerals exports were essentially unchanged with an estimated value of about $3 billion. Consumption of metals and other mineral-based materials used extensively in motor vehicle manufacturing increased in 1999 because of a large increase in production of automotive products including light trucks. The motor vehicle manufacturing sector is a major consumer of steel and other mineral-based materials, chiefly aluminum, copper, lead, platinum-group metals, zinc, glass, and plastics.

The domestic construction industry also contributed to the modest growth in minerals consumption. Construction is the largest consumer of brick clay, cement, sand and gravel, and stone. Road construction expenditures in 1999 maintained the high levels of the last few years as a result of the Transportation Equity Act for the 21st Century. Large quantities of asphalt, cement, crushed stone, and sand and gravel are used in road building. Apartment building construction and new home construction also increased in 1999, which had a positive effect on the consumption of brick clay, cement, sand and gravel, steel, and stone.

Because of a decline in domestic and world demand for fertilizer nutrients, the domestic mineral fertilizer manufacturing sector reduced its operating rate, which resulted in lower demand for fixed nitrogen, phosphate rock, and sulfur. Global fertilizer nutrient consumption decreased and U.S. consumption at the farm level was also lower, owing to a drop in world demand for coarse grains.

In fiscal year 1999, the Defense Logistics Agency sold excess mineral materials valued at $446 million (see “Government Stockpile” in the commodity sections that follow). The Defense Production Act provides authority for priorities, allocations, and defense-related supply expansions.

Significant International Events

In the year or more since the worst part of the international economic collapse that began with the financial turmoil in East Asia and Southeast Asia in 1997, the overall picture has changed for the better, but problems remain that may prove difficult to ameliorate. Metals prices have recovered from their lows of early 1999, but the world economic picture on the threshold of 2000 leaves much to be desired. The United States generated a major part—certainly more than one-half—of the demand growth of the world economy for several years, providing a significant degree of economic health and stability such that various other countries were afforded time to restructure internally, to reduce interest rates, to stimulate fiscal systems, and to revise external financial arrangements under circumstances of global economic expansion instead of a continuation of the contraction that marked the initial collapse. No small matter, this, but can it continue?

Prosperity in the United States has induced extremely high equity values. The ratios of private-sector debt to gross domestic product are higher than during the last

TABLE 1.—U.S. MINERAL INDUSTRY TRENDS

	1995	1996	1997	1998	1999[e]
Total mine production:[1]					
Metals	14,000	13,000	13,100	11,100	9,790
Industrial minerals	24,600	25,800	27,400	28,500	29,300
Coal	19,500	19,700	19,800	19,700 [e]	18,800
Employment:[2]					
Coal mining	84	80	79	75	70
Metal mining	41	42	41	38	37
Industrial minerals, except fuels	80	81	82	83	83
Chemicals and allied products	580	575	573	586	583
Stone, clay, and glass products	418	423	431	440	446
Primary metal industries	553	553	555	557	538
Average weekly earnings of production workers:[3]					
Coal mining	828	858	863	856	862
Metal mining	735	763	791	812	811
Industrial minerals, except fuels	624	648	671	682	701
Chemicals and allied products	675	699	716	740	751
Stone, clay, and glass products	534	555	569	592	605
Primary metal industries	643	662	683	685	701

[e]Estimated.

[1]Million dollars.

[2]Thousands of production workers.

[3]Dollars.

Sources: U.S. Geological Survey; U.S. Department of Energy, Energy Information Administration; U.S. Department of Labor, Bureau of Labor Statistics.

U.S. recession. Either of these two factors would ordinarily be cause for concern, but perhaps these are not ordinary times. The technological revolution that produced the personal computer and the Internet, thought by many to equal or exceed the Industrial Revolution in importance, has brought about a huge expansion of communication and commerce worldwide. This accounts for much of the truly heavy investment in the future of the equities relating to these technological enterprises. Share prices, however, are based on confidence, not on certainty. When and if confidence founders causing share prices to fall, billions of dollars' worth of value can simply disappear, as did real estate and share values in Japan several years ago and in other Asian countries in 1997. The U.S. situation would be exacerbated if much collateralized private-sector debt, backed by equities, turned bad. The result could be economic collapse in the United States with serious consequences for the world economy.

So how have conditions changed for the better? Recall that the trouble began with credit overextension into uncollectable loans, runs on currencies, bank failures, and a critical contraction of value in equity markets in 1997, resulting in a general loss of confidence. Overcapacity and oversupply in metals production and petroleum, still common 1 year ago in a number of countries, caused metals prices to hit bottom in early 1999, resulting in many mine closures as well as the withdrawal of investment capital for new mines and mine expansions. Gradually, with the cutting of production, prices began to climb in February and March. Price increases for aluminum, copper, lead, nickel, and zinc, among the base metals, and petroleum crude have reestablished a basis for production. This alleviated much of the dislocation in production, labor, and capital flow that had threatened to combine with the great Asian financial collapse to bring about a 1929-30 style equities "crash" and depression, possibly throughout the world. Meanwhile, in Asia, draconian measures, involving the reorganization of banking practices and the elimination of problem loans from balance sheets, were taken to improve the financial health of various Asian economies. The Republic of Korea and Thailand were in the forefront of the restoration of viability to their financial systems, and their financial architecture will probably be changed permanently to a condition of greater transparency and stricter rules governing collateral and quality of lending.[1]

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

	1995	1996	1997	1998	1999[e]
Gross domestic product (billion dollars)	7,401	7,813	8,301	8,760	9,260
Industrial production (1992=100):					
Total index	114	119	127	132	137
Manufacturing	116	121	130	136	142
Stone, clay, and glass products	111	118	122	127	130
Primary metals	116	120	127	126	127
Iron and steel	117	119	126	123	124
Nonferrous metals	116	121	128	129	131
Chemicals and chemical products	107	110	115	115	117
Mining	102	104	106	104	98
Metals	102	104	110	109	97
Coal	103	105	108	110	108
Oil and gas extraction	101	102	103	99	92
Stone and earth minerals	113	115	120	123	122
Capacity utilization (percent):[1]					
Total industry	83	82	83	82	81
Mining	87	89	89	86	81
Metals	88	89	92	89	80
Stone and earth minerals	87	86	86	85	83
Housing starts (thousands)	1,354	1,477	1,474	1,617	1,673
Automobile sales (thousands)	14,760	15,130	15,160	15,590	17,000
Highway construction, all public, expenditures (billion dollars)	35	37	39[p]	39[e]	41

[e]Estimated. [p]Preliminary.

[1]1999 estimates based on seasonally adjusted figures.

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

Three countries important to the world economy—Russia, Japan, and China—continued to present imponderable situations more or less refractive to nominal analysis. In the case of Russia, a potentially prolific producer of mineral commodities, manufactured goods, and technological innovations, what constituted normal banking procedures, in the midst of major defaults was not clear, and certain mystifying multinational transactions were under intense scrutiny. Russia's nuclear arsenal has been of special interest to the western world and persuasive in attracting economic assistance.

Japan, the world's second largest economy, has a huge public debt at 130% of gross domestic product (GDP), massive unfunded pension liabilities exceeding 107% of GDP, and a sluggish economy with negative growth in which consumer spending cannot seem to be stimulated in favor of consumer savings.[2] But a sea-change in the appearance of Japan's problems was underway as the result of major tax cuts, a recovering stock market, and efforts to address the aforementioned deficits. Further improvement will probably result from a merger of three banks to form the world's largest bank, with assets of more than $1 trillion, followed by more mergers of pairs of banks, primarily a strong one with a weak one. These consolidations will afford an orderly approach to writing off problem loans without destroying the structure of Japanese banking. Probably Japan's economic health, for better or worse, will affect a major part of the world economy in 2000.

The third country, China, continues to work its way from total central planning toward what might be called central guidance, involving the gradual conversion of state-owned (and largely military-operated) production facilities by privatization to a capitalized status involving share ownership by investors, workers, and, one way or another, the state. The trend toward decentralization included the disbanding of the China National Nonferrous Metals Industry Corp. (CNNC) in favor of the State Nonferrous Metals Administration, under the State Economic and Trade Commission, to manage some temporarily State-owned nonferrous enterprises. The China Aluminum Corp., the China Copper Lead Zinc Corp., and the China Rare Metals and Rare Earth Corp.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1999[p 1]

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$1,080,000	13	2.76	Stone (crushed), cement (portland), lime, sand and gravel (construction), cement (masonry).
Alaska	1,090,000	12	2.78	Zinc, gold, lead, silver, sand and gravel (construction).
Arizona	2,510,000	3	6.41	Copper, sand and gravel (construction), cement (portland), molybdenum, stone (crushed).
Arkansas	518,000	28	1.33	Bromine, stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial).
California	3,200,000	1	8.17	Sand and gravel (construction), cement (portland), boron (B_2O_3), stone (crushed), soda ash.
Colorado	555,000	26	1.42	Sand and gravel (construction), cement (portland), stone (crushed), gold, molybdenum.
Connecticut[2]	103,000	43	0.26	Stone (crushed), sand and gravel (construction), stone (dimension), clays (common), gemstones.
Delaware[2]	9,620	50	0.03	Sand and gravel (construction), magnesium compounds, gemstones.
Florida	1,930,000	4	4.93	Phosphate rock, stone (crushed), cement (portland), sand and gravel (construction), titanium (ilmenite) concentrates.
Georgia	1,840,000	5	4.71	Clays (kaolin), stone (crushed), cement (portland), clays (fuller's earth), sand and gravel (construction).
Hawaii	88,800	45	0.23	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry), gemstones.
Idaho	420,000	32	1.07	Phosphate rock, silver, sand and gravel (construction), molybdenum, gold.
Illinois	913,000	17	2.33	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), lime.
Indiana	717,000	19	1.83	Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry).
Iowa	537,000	27	1.37	Stone (crushed), cement (portland), sand and gravel (construction), gypsum (crude), lime.
Kansas	566,000	25	1.45	Cement (portland), salt, stone (crushed), helium (Grade-A), helium (crude).
Kentucky	483,000	30	1.23	Stone (crushed), lime, cement (portland), sand and gravel (construction), clays (ball).
Louisiana	374,000	33	0.96	Salt, sulfur (Frasch), sand and gravel (construction), stone (crushed), sand and gravel (industrial).
Maine	101,000	44	0.26	Sand and gravel (construction), cement (portland), stone (crushed), peat, cement (masonry).
Maryland	336,000	34	0.86	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry), stone (dimension).
Massachusetts	204,000	39	0.52	Stone (crushed), sand and gravel (construction), lime, stone (dimension), clays (common).
Michigan	1,660,000	7	4.24	Iron ore (usable), cement (portland), sand and gravel (construction), stone (crushed), magnesium compounds.
Minnesota	1,580,000	8	4.04	Iron ore (usable), sand and gravel (construction), stone (crushed), stone (dimension), sand and gravel (industrial).
Mississippi	190,000	40	0.49	Sand and gravel (construction), cement (portland), clays (fuller's earth), stone (crushed), sand and gravel (industrial).
Missouri	1,380,000	9	3.52	Stone (crushed), cement (portland), lead, lime, zinc.

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1999[p 1]—Continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Montana	$491,000	29	1.26	Palladium, copper, gold, cement (portland), platinum.
Nebraska	163,000	42	0.42	Cement (portland), sand and gravel (construction), stone (crushed), lime, cement (masonry).
Nevada	2,780,000	2	7.11	Gold, sand and gravel (construction), silver, lime, diatomite.
New Hampshire[2]	63,600	47	0.16	Sand and gravel (construction), stone (crushed), stone (dimension), gemstones.
New Jersey	300,000	37	0.77	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), greensand marl, peat.
New Mexico	671,000	21	1.72	Copper, potash (K_2O), sand and gravel (construction), cement (portland), perlite (crude).
New York	935,000	16	2.39	Stone (crushed), cement (portland), salt, sand and gravel (construction), zinc.
North Carolina	761,000	18	1.95	Stone (crushed), phosphate rock, sand and gravel (construction), sand gravel (industrial), feldspar.
North Dakota	37,700	48	0.10	Sand and gravel (construction), lime, stone (crushed), sand and gravel (industrial), clays (common).
Ohio	1,040,000	14	2.67	Stone (crushed), sand and gravel (construction), salt, lime, cement (portland).
Oklahoma	475,000	31	1.21	Stone (crushed), cement (portland), sand and gravel (construction), helium (Grade-A), sand and gravel (industrial).
Oregon	303,000	36	0.77	Stone (crushed), sand and gravel (construction), cement (portland), diatomite, lime.
Pennsylvania[2]	1,270,000	10	3.25	Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry).
Rhode Island[2]	25,400	49	0.07	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), gemstones.
South Carolina	574,000	24	1.47	Cement (portland), stone (crushed), cement (masonry), sand and gravel (construction), gold.
South Dakota	226,000	38	0.58	Gold, cement (portland), sand and gravel (construction), stone (crushed), stone (dimension).
Tennessee	710,000	20	1.81	Stone (crushed), zinc, cement (portland), sand and gravel (construction), clays (ball).
Texas	1,780,000	6	4.54	Cement (portland), stone (crushed), sand and gravel (construction), lime, salt.
Utah	1,260,000	11	3.21	Copper, magnesium metal, gold, sand and gravel (construction), cement (portland).
Vermont[2]	83,300	46	0.21	Stone (dimension), stone (crushed), sand and gravel (construction), talc and pyrophyllite, gemstones.
Virginia	667,000	22	1.71	Stone (crushed), cement (portland), sand and gravel (construction), lime, clays (fuller's earth).
Washington	631,000	23	1.61	Sand and gravel (construction), stone (crushed), magnesium metal, cement (portland), gold.
West Virginia	180,000	41	0.46	Stone (crushed), cement (portland), sand and gravel (industrial), lime, salt.
Wisconsin[2]	334,000	35	0.85	Stone (crushed), sand and gravel (construction), lime, sand and gravel (industrial), stone (dimension).

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1999[p 1]—Continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Wyoming	$956,000	15	2.44	Soda ash, clays (bentonite), helium (Grade-A), cement (portland), stone (crushed).
Undistributed	31,100	XX	0.08	
Total	39,100,000	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.”

will represent the Government as a shareholder of their related subsidiaries which had been under CNNC. China has been widely praised for not devaluing its currency, but its tax rebates on exports, which equal export subsidies, are tantamount to a de facto “stealth” devaluation of as much as 15%.[3] Any further devaluation would likely cause a new rush of Chinese exports into the U.S. market and push U.S. exports to even lower levels. Finally, however, the effect of China’s presumed acceptance into the World Trade Organization in 2000 may overshadow the significance of these possibilities.

Two commodities of worldwide importance deserve notice here. The first is petroleum, whose overproduction dragged world market prices downward to a point, at less than $10 per barrel, that was nearly ruinous for the economies of certain countries—Mexico, Russia, Saudi Arabia, and Venezuela in particular—until the Organization of Petroleum Exporting Countries (OPEC) finally adopted production restraints that cured oversupply and allowed normal demand to lift prices back to a level of $20 per barrel and above that helped sustain these dependent economies. The restoration of market prices for petroleum in concert with the turnaround in metals prices at about the same time greatly improved the outlook for world commodity markets at the approach of the new year.

The second commodity of great significance is gold, whose price performance in world markets had been sinking gradually to levels at which production from many mines was no longer profitable and shutdowns became the alternative to loss. Although world demand for gold has been steady, it seemed to have lost some of its luster as a store of value or basis of monetization for the central banks of many countries in an age where great quantities of money flowed around the world instantaneously by electronic means. Gold continued to be prized by individuals, jewelers, and industry, but the widely advertised spectre of central bank selling at unannounced times and in unpredictable quantities hung over the market. Mine closures were putting thousands of miners out of work in a number of countries, with the threat of even more and bigger closures as the United Kingdom continued auctioning off 300 metric tons (t) of gold in 25-t lots, Switzerland discussed the selling of its central bank hoard of 1,300 t of gold, and the International Monetary Fund (IMF) prepared to sell 10 million ounces (311 t) to raise money for relief of heavily indebted poor countries in need of assistance. A number of countries and mining entities responded by pointing out that selling this much of its gold would further depress market prices and, in many cases, hurt the very economies it wanted to help. The IMF then decided to raise money by revaluing its gold upward from the 1971 prices it carried in its books to current market prices, using a selling-and-buying gambit that evidently satisfied certain legalities involved. Hard on this decision came the news that 15 European central banks, led by the European Central Bank, pledged that they would limit their gold sales for the next 5 years to 2000 t, essentially representing commitments already in force and discounted by the market, and freeze gold lending to make market hedging and speculation more costly, if not prohibitive. The market response to these farsighted moves was electric—gold prices shot upward from $260 per ounce to as high as $329 in intraday trading. Although the price settled back to the $280- to $300-per-ounce range as initial enthusiasm subsided, the long-term effects of the curbs on gold lending and hedging were seen as positive for prices and the industry.[4]

World mining may be entering some better years, so far as new capital is concerned, because the depressed prices for base and precious metals seem to have turned around. The technological revolution has seen the introduction of chip devices for design and control of equipment, knowledge about materials being mined, and control of mineral processing. Moreover, rapid electronic communication has facilitated market hedging operations and other rapid financial transactions. Investment capital sources that had tended to switch into super-safe U.S. Government debt instruments were seeing bond values decline as yields worked higher, and yet were seeing the riskier side of high-technology investments as 1999 waned. A risk factor in mining, however, has always been the difference between mining and most (or all) other industries—mineral resources are fixed in place, geographically, and cannot be moved to a better climate, a more-industrialized country, or a better labor pool. The physical location of mineral resources is an invariant in the world economy of capital investment, production, and trade. It is still true, however, that serious risk and great opportunity characterize mining the world over.

Asia and the Pacific

Major investment by industry in virtually every sector across Asia and the Pacific, made on the assumption that record-breaking growth would continue without interruption, came to an abrupt halt in the financial crisis that began in the region in 1997. Basic commodities, particularly metals but also other minerals and fossil fuels, were overabundant, capacity greatly outstripped demand, and prices dropped. Asian economies, viewed as models of development and growth, went into recession, and a deflationary trend began to spread across the globe. This created a challenge for various countries in the region that were reluctant to cut excess production capacity through tight monetary policies, thinking that such an action would cause massive bankruptcies and layoffs. Instead, many of those countries chose to address the economic downturn by lowering interest rates and raising government spending to encourage demand instead of eliminating excess capacity by cutting production and the workforce. The Republic of Korea and Thailand have been cited most frequently in the media as leading the Asian economic recovery, although these economies are not large compared with China and Japan, where troubles have not yet dissolved.

Although the largest exporter of coking and thermal coals in the world, Australia endured collapsing coal prices once again in 1999, making it the most difficult year in nearly two decades. Coal is Australia’s most important mineral commodity export, but contract thermal and coking coal prices with Japanese steel mills fell by 13% and 18% respectively; spot market prices also declined during the year.

In a major move toward privatization, the Government of India decided to sell 51% of its Bharat Aluminum Co. Ltd. through a global tender to a strategic investor who could bring in fresh capital and new technology. At a later date, a public offer would be made in the domestic market that would reduce the Government’s ownership to 26% of this company and its 100,000-metric-ton-per-year (t/yr) primary aluminum smelter.

The Government of Pakistan moved toward privatization by planning the sale of its Karachi-based Pakistan Steel Mills Corp. Bin Qasim plant, which had been operating at 62% of capacity, to investors. Capacity was slated to be increased eventually to 3 million metric tons per year (Mt/yr). A second natural gas field was discovered in Sind Province, where the discovery well’s initial production was 20 million cubic feet per day.

In Papua New Guinea, Rio Tinto PLC’s 200,000 t/yr Panguna copper-gold mine and supporting infrastructure were looted and vandalized to destruction by militants after the ceasefire in 1998 but before the political situation could be stabilized in mid-1999.

After suffering slowed economic growth during the Asian financial crisis, Vietnam approved a plan for the State-owned Vietnam Minerals Corp. to combine with France’s Pechiney Co. to explore the feasibility of a bauxite mine in Lam Dong Province near Ho Chi Minh City.

Burma’s first production of refined copper, using solvent extraction-electrowinning technology, was underway at the rate of 2,100 metric tons per month from mines near Monywa in the west-central part of the country. The project is owned by the Myanmar Ivanhoe Copper Co. Ltd., a 50-50 joint venture of the State-owned No. 1 Mining Enterprise and Ivanhoe Mines Ltd. of Canada.

In Taiwan, the earthquake of September 21, 1999, destroyed several power grids and forced Taipower to impose restrictions on power consumption in the northern region of the island. Industrial sectors, such as petrochemicals and steel, and companies in industrial parks were not affected.

Japan’s Nippon Mining and Metals Co. Ltd.’s (Nippon) copper refining capacity was to be expanded to 450,000 t/yr by 2000. To reinforce its overseas copper operations, Nippon agreed with LG Metals of the Republic of Korea to form a 50-50 joint venture, LG Nikko Copper, to acquire and operate refineries at Onsan and Changhang in the Republic of Korea whose capacities total 450,000 t/yr. Japan’s other major copper refiner, Sumitomo was prepared to raise its capacity—to 300,000 t/yr from 240,000 t/yr—as demand restored itself in Asian markets.[5]

Middle East

The Middle East was heavily affected by the Asian economic downturn; not only was the demand for petroleum greatly reduced and, consequently, the price, but lack of revenue jeopardized several natural gas export and other mineral related projects. Many upstream and downstream natural gas projects were canceled, especially Qatar’s liquified natural gas program. Against this background, the oil companies of the world consolidated and formed alliances to share costs and to spread risk, the better to compete amidst low prices.

Although the nations of the Middle East entered 1999 producing and exporting less oil and earning far lower revenues than the year before, the economic crisis eased somewhat, and crude oil prices made an impressive recovery as OPEC announced production curtailment of 1.7 million barrels per day (Mbbl/d). This brought the total reduction since March 1998 to 4.2 Mbbl/d and set an output ceiling of 22.9 Mbbl/d for the coming year. The price rise was aided by the decline in world oil stocks, as well as an increase in gasoline and jet-fuel consumption attributed to military action in Kosovo. The landed price of Middle East crude oil in the United States started 1999 at about $9.95 per barrel, reached $17.27 in July, and climbed to about $25.15 in November. For the 6 months ending in July, U.S. imports of Middle East crude oil were up by 32% compared with the same period in 1998. The Middle East share of world oil export trade was about 47%. The

Arabian states with the greatest reserves will need to invest heavily in new oil production, processing, and transport facilities. Most of the growth in world oil demand will be satisfied from the countries where a surplus production capacity exists, especially Saudi Arabia, but also Iraq, Kuwait, and the United Arab Emirates.

Africa

Renewed outbreaks of civil war seriously interrupted mineral exploration and development in Angola, the Republic of the Congo [Congo (Brazzaville)] and the Democratic Republic of the Congo [Congo (Kinshasa)]. Further, the war in Congo (Kinshasa) drew other participants such as Burundi, The Central African Republic, Kenya, Namibia, Rwanda, Tanzania, Uganda, Zambia, and Zimbabwe, all of which sustained consequent negative impacts on their own economies. Other conflicts or struggles plague Eritrea/Ethopia, Guinea-Bissau, Liberia, Sierra Leone, Somalia, and Sudan, discouraging investment in those countries. Opposition forces in each of the widely separated countries of Angola and Sierra Leone used revenues from illegal diamond mining to support their efforts, earning the rubric of “diamond wars” for their efforts from the international community. In Angola, the National Union for the Total Independence of Angola (UNITA) was thought to have sold more than $3 billion worth of diamonds to support its cause. On the other side of the resource war in Angola, 17 world-class deep-water oilfields were discovered offshore in the past 3 years. Crude oil production was expected to increase to more than 1 million bbl/d in the next 2 years.

Energy shortages in Ghana are being resolved by the addition of more than 755 megawatts of gas-fueled thermal power to the national grid, with about one-third of this new capacity being added by the mining industry. Plans to import natural gas from Nigeria through the $500 million West African Natural Gas Pipeline should help reduce Ghana’s dependency on hydroelectric power based on erratic rainfall patterns in the future. Ghana’s largest gold producer, Ashanti Goldfields Co. Ltd.(Ashanti), suffered liquidity problems owing to its aggressive gold-hedging strategy and the sharp increase in gold prices in the third quarter and was the target of an unsolicited takeover bid by Lonmin, plc, of the United Kingdom. With support from the Ghanaian Government and a subsequent settling back in gold prices, Ashanti was able to restructure its hedging liabilities and its credit lines through 2003 and to maintain its independence.[6]

Along with more than 700 billion cubic meters of natural gas reserves, Mozambique’s hydroelectric resources are a catalyst for a number of postwar recovery and value-added industrial projects. A consortium of ARCO (United States), Sasol (South Africa), and Zarara Petroleum Resources Ltd. initiated plans to develop the Temane gas fields and to construct a pipeline to Maputo and then on to a Sasol synfuels plant near Johannesburg. Also, Enron Development Corp. (United States) agreed with the Government to develop the Pande gasfield and construct a pipeline to Maputo and South Africa, and to develop a steel slab plant near Maputo. Construction of a new aluminum smelter at Maputo by Billiton plc (United Kingdom) progressed. After completion in 2001, the smelter will have an initial capacity of 245,000 t/yr of aluminum, which will double to 500,000 t/yr at a later date.[7]

Offshore diamond exploration and development in Namibia are boosting a mining sector that declined with the 1998 closing of the Tsumeb Corp. Ltd.’s copper and lead mines. After a failed merger between Trans Hex International (Canada) and Ocean Diamond Mining Holdings (ODM) of South Africa, Namibian Minerals Co. (Namco) increased its ownership of ODM to 100%, thus becoming the world’s second largest marine diamond miner after De Beers Consolidated Mines Ltd. By starting up a second 120-t underwater crawler, Namco doubled production in 1999 to 260,000 carats, including some of the highest-value diamonds in the world selling at over $300 per carat.[8]

In South Africa, the steady decline of gold prices through midyear threatened the loss of another 80,000 jobs in the gold industry, but the price rebound at the end of the third quarter reduced the threat somewhat. The country produced gold at a rate of 444 t/yr in 1999, down by about 10% from output the previous year. Corporate restructuring continued with a major transaction between AngloGold Ltd. and Gold Fields Ltd. In three transactions, Gold Fields bought AngloGold’s 21.5% interest in Driefontein Consolidated Ltd. (Driefontein) for $226 million; Gold Fields canceled almost $11 million of its own shares owned by Anglo American and Amgold plc. (United Kingdom) who, in exchange, received almost 2 million AngloGold shares owned by Gold Fields. Finally, Gold Fields initiated full acquisition of Driefontein and its gold assets. The merger with Driefontein makes Gold Fields the world’s third largest gold company with annual production of about 125 t and gold reserves of 2,986 t.[9] Significantly, the gold industry continued to reduce costs and to optimize mine holdings through sales and asset swaps with adjacent companies.

De Beers Consolidated Diamond Mines bought a 21.3% interest in Anglovaal Mining Ltd. for $128 million, thus achieving a 59% interest in the Saturn Partnership that operates the Venetia diamond mine, which provides about 45% of DeBeers’ South African diamond production.

In other events, the increasing world demand, and uncertainty of Russian supply, has pushed the South African platinum group metals industry to increase its world market share beyond the 81% for platinum and 48% for palladium that were held in 1998. Increased production is expected in 2000 from Anglo American Platinum Corp. Ltd.’s new Bakofeng Rasimone mine and from Aquarius Platinum Ltd.’s new Kroondal mine near Rustenburg. In Zimbabwe, however, mining of the Hartley platinum deposit was closed down and Broken Hill Proprietary Ltd. sold its interest in the company to its joint-venture partner, Zimbabwe Platinum Mines Ltd.

In 1999, Tanzania saw a consolidation of ownership and assets and further progress on bringing Tanzania into position as Africa's third largest gold producer. Barrick Gold Corp. (Canada) acquired Sutton Resources (Canada), including its Bulyanhulu gold deposit for $281 million, and purchased the Golden Ridge deposit from Randgold Resources (United Kingdon). After purchasing Samax Ltd. (Canada) in 1998, including its Kukuluma deposit and its 50% interest in the Golden Pride mine, Ashanti began consolidation of Kukuluma with its Geita-Lone Cone property; production is scheduled for late 2000. Resolute Ltd. (Australia) then bought out the 50% Ashanti-Samax interest in the Golden Pride property for $20 million and additional contingent payments depending upon gold prices over the next 3 years.

The highlight of the year in Zambia was the agreement between the Government and Anglo American for the latter, after several rejected bids, to buy an 80% interest, for $90 million, in three Zambian Consolidated Copper Mines Ltd. (ZCCM) properties, the Konkola and the Nchanga Divisions' copper-cobalt operations and the Nampundwe pyrite mine. Anglo American made a further commitment to invest $200 million in the new Konkola Deeps copper project subject to a favorable feasibility study. For its part, the Government will buy out the 27.3% interest in ZCCM held by Zambia Consolidated Investments, an Anglo American subsidiary, for a deferred payment of $30 million. This agreement amounts to a major step in revitalizing the country's copper-cobalt industry.[10]

Europe and Central Eurasia

Western Europe remained a major world minerals processing and consuming region and, consequently, a major determinant of world demand for all mineral commodities. The region continues to be a major player as a producer of copper, iron, lead, and zinc, although its role as a mineral producer has been diminishing over the years as mineral reserves have become exhausted. Mineral-resource exploration and development have been encouraged by up-to-date mining legislation, deregulation, and tax relief. The trend in mineral exploration in Western Europe continued to be for copper, gold, lead, and zinc, as well as diamond in Scandinavia. Major gold operations in Sardinia and Spain continued as additional reserves were discovered. Possibly the most significant event in European mining, and Spanish mining in particular, was the environmental accident at the Aznacollar-Los Frailes Mine of the Boliden-Apirsa in which the slimes dam failed and several million cubic meters of tailings ran into the Guadiamar River. Proximity of the Donana National Park to the accident caused major concern. After clean-up of the tailings, permission of the Andalucian Government to resume mining activity required almost a year.

When the Central European countries (the Czech Republic, Hungary, Poland, and Slovakia) and the Balkans (Albania, Bulgaria, Romania, and successor states of the former Yugoslavia), were under central planning as members of the Soviet-based Council for Mutual Economic Assistance (CMEA), they developed mineral industries that were insulated from the world market. Also, they were greatly dependent on the U.S.S.R. for many base metals and substantial amounts of coal, crude oil, and natural gas. Following the dissolution of central planning in the region, many mineral industries clearly could not be sustained economically. Only Poland appeared to have economically viable resources of coal, copper, lead, salt, silver, sulfur, and zinc. After an economic winnowing process, industries that have survived in the region have been increasingly able to attract foreign investment. Major minerals-oriented foreign investment in Central Europe centered on industrial minerals, such as cement plants, construction materials, and quarry products. Foreign investment was visible also in the base-metals sector in Hungary and Poland. Bulgaria's copper and gold potential continued to attract interest of foreign investors. Overshadowing everything in the Balkans, however, was the political instability that remained a major obstacle to foreign investment.

The successor states of the former Soviet Union (FSU) and the countries of Eastern Europe continued to develop their market economy structures. Starting from a common base of centrally planned economies, but with differences in culture, industrial and social infrastructures, and natural-resource endowment, these countries have shown wide variations within the transition process to a market-based economic system. The continuing Russian financial crisis dominated economic developments in the FSU throughout 1999. Russia's reliance on short-term debt to finance fiscal deficits, coupled with a strong impact from the economic crisis in East Asia, led to an unsustainable debt repayment situation. The Russian crisis greatly worsened the environment for many FSU countries whose economies and trade were closely linked with Russia. Exports from these countries to Russia dropped conspicuously because Russia was unable to pay for imports.[11] Investors seemed to be waiting for FSU countries to establish more-reliable financial structures and institutions, and for the economic situation in these countries to stabilize, before committing new monies to this regions's mineral industries. In Eastern Europe and Central Eurasia, Russia, Kazakhstan, and Ukraine remained the FSU's dominant producers of most mineral commodities.

Regional issues also arose as the poor performance of the global economy exacerbated natural tensions between the European Union (EU)-member nations and the transition-economy countries of the FSU and the non-EU Central European and Balkan countries. The two regions remained asymmetrical to each other, as the transition-economy countries required further transformation and economic development to be on a par with Western Europe. Interaction in the minerals sector between these two regions was based on this asymmetry—the EU imported mineral commodities from, smelted raw materials on a toll basis in, and sold equipment and technology to the FSU and the non-EU Central European and Balkan countries largely without reciprocation.

Latin America and Canada

Initially, basic interest in exploration and mine development activity did not seem to be seriously impaired in Latin America, where they had been highest, as a result of the Asian economic crisis. In retrospect, however, exploration expenditures were down more sharply than in the rest of the world according to Canada's Metals Economics Group. A year ago, monetary concern focused on Brazil, where capital flight put the *real* in jeopardy, and the economic troubles and the effects of the international financial crisis are not over yet. A downturn in Government accounts renders Brazil's IMF targets at risk, with the possibility of urgent cost-cutting measures to meet IMF's requirements. Complicating this, Brazil's fiscal austerity drive was ruled unconstitutional by the nation's supreme court in an action involving civil service salaries and retirement pensions. The devaluation of the *real*, however, improved export prospects, as did firming prices for metals and petroleum. The big issue for Latin American countries was whether or to what extent mining would suffer from the withdrawal of capital owing to lack of confidence in emerging markets. In Brazil, the direct foreign investment could total about $28 billion. The new Petrobras now allows joint ventures with the private sector, but foreign participation is presently limited to a 34% minority stake.

Despite low metals prices, Mexico's mining sector continued to attract a significant portion of Latin America's foreign investment. As 1999 began, 444 foreign companies were exploring in Mexico, up from 372 the previous year. Investment in the mining sector during 1999 was about $1.4 billion, not greatly different from the year before. Turmoil in global financial markets delayed some privatizations in Mexico, but did not change the commitment to privatization overall. After a contest with Phelps Dodge Corp., Grupo Mexico completed a takeover agreement with copper producer Asarco Incorporated (United States) in an arrangement worth about $2.5 billion. Phelps Dodge will now rank second after Chile's Corporacion Nacional del Cobre de Chile (CODELCO) in world copper production, with Grupo Mexico in third place after assimilating Asarco.

With a growing economy, Argentina expected a total investment in its mining sector of $3.3 billion between 1997 and 2000, all from private sources. The Bajo de la Alumbrera (copper-gold) project, projected to require $900 million, finally cost $1.2 billion and looked less attractive after being in production for a year of low gold prices and weakened demand for copper until that market turned around during 1999. Capacity of the operation is 180,000 t/yr of copper and 19.9 t/yr of gold.

Bolivia continued to seek the guarantee of private investment to sponsor growth of its economy by removing most barriers to overseas investment and any discrimination against foreign enterprises. Despite steady modernization and diversification of the mining sector, many companies are considered to be in dire straits as cost cutting and work-force reductions at most operations have reached ultimate limits. Mining investment fell to $45 million in 1998 and an estimated $40 million in 1999, compared with $95 million in 1997.

Chile's CODELCO did not approve any new investment projects in 1999 following the Finance Ministry's decision to cut its yearly budget more than 35% from the roughly $700 million the company had requested. Two copper projects hit by this budget cut were the Rodomiro Tomic expansion, the capacity of which would have increased by 70,000 t/yr, and the El Teniente project, the output of which would have increased to 500,000 t/yr.[12] Because of the depressed copper market, Chile's Minera Escondida Ltda. delayed its decision on a major expansion.

The new Pierina gold mine in the northern Peruvian Andes, owned by Barrick, is Peru's second largest gold producer after Minera Yanacocha, owned by Newmont Mining Corp.(United States). In 1999, Pierina's cash cost of gold production, $45 per ounce, was the lowest of any mine in the world, but in the future this cost is expected to climb significantly.[13] After the acquisition of Cyprus Amax Minerals by Phelps Dodge Corp., Peru's Cerro Verde copper mine in Arequipa became a part of the merger.

Although recovering from the financial consequences of low petroleum prices, Colombia struggled to come to terms with terrorist groups that were destroying petroleum pipelines and rail infrastructure and abducting key personnel at mineral extraction operations. Existing production of metals and industrial minerals, however, was reasonably steady and emerald output was up sharply. Although petroleum operations were frequently interrupted, coal activity continued, including privatization of mines, consolidation of properties, and an increase in output and exports.

In Canada, mineral production began to be influenced by falling prices. At least nine mines, producing gold or base metals, were placed on suspension in 1998, followed by three more in 1999. The Ekati diamond mine complex near Lac de Gras, Canada's first diamond production, was projected to increase to about 5% of world diamond output. The huge Voisey's Bay nickel-copper project is still languishing because of a plethora of political, technical, and environmental directives, claims, and counterclaims. The Newfoundland Government insisted that Inco smelt its ore within the Province, rather than shipping concentrates to Sudbury, Ontario, for treatment.

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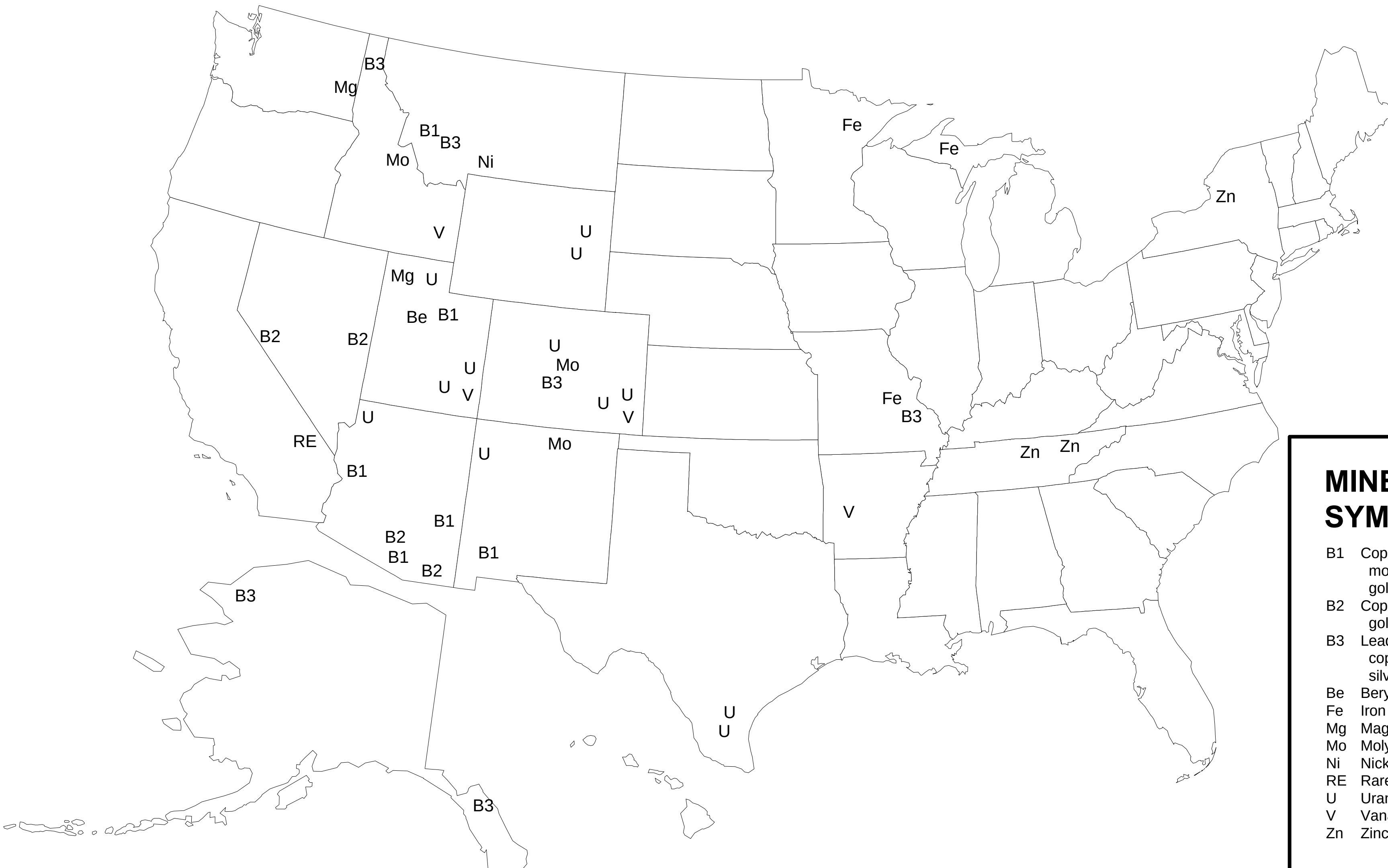
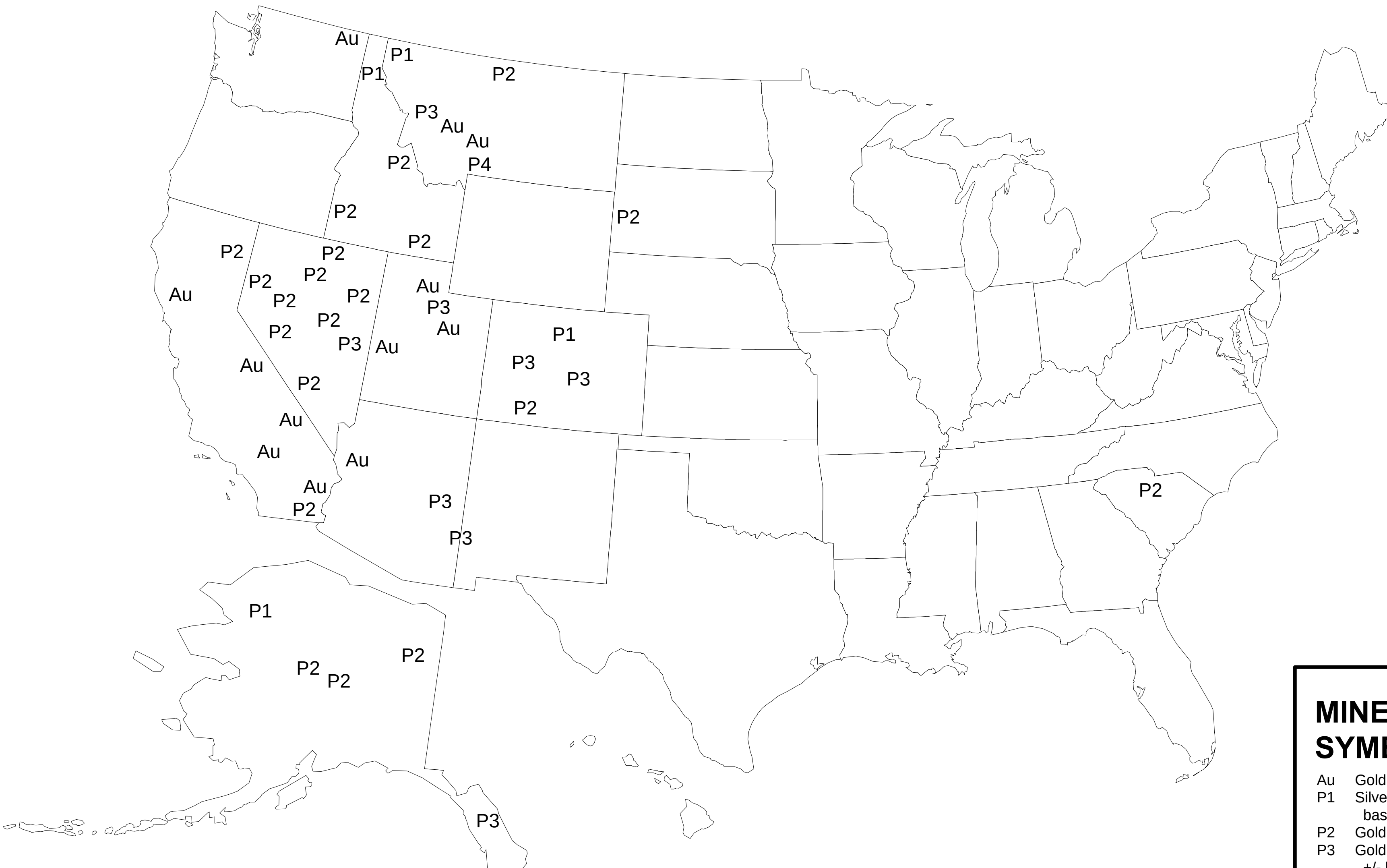
MAJOR BASE AND FERROUS METAL PRODUCING AREAS



MINERAL SYMBOLS

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

MAJOR PRECIOUS METAL PRODUCING AREAS



MINERAL SYMBOLS

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

MAJOR INDUSTRIAL ROCK AND MINERAL PRODUCING AREAS - PART 1

MINERAL SYMBOLS

Asb	Asbestos	Mica	Mica
Ba	Barite	Ol	Olivine
B	Borates	Peat	Peat
Br	Bromine	P	Phosphate
Dia	Diatomite	K	Potash
Gar	Garnet	Salt	Salt
Gyp	Gypsum/ anhydrite	NaS	Sodium sulfate
		S	Sulfur
He	Helium	Talc	Talc/ pyrophyllite
Irz	Ilmenite, rutile, and zircon	Tr	Trona
I	Iodine	Vm	Vermiculite
Ky	Kyanite	Wol	Wollastonite
Mg	Magnesium compounds	Zeo	Zeolites

MAJOR INDUSTRIAL ROCK AND MINERAL PRODUCING AREAS - PART II

MINERAL SYMBOLS

BC	Ball clay
Bent	Bentonite
Clay	Clay/shale
D-S	Dimension stone
Fel	Feldspar
FC	Fire clay/ refractory clay
Ful	Fuller's earth
Kao	Kaolin
Li	Lithium
Per	Perlite
Pum	Pumice
Si	Silica/ industrial sand
Trip	Tripoli/novaculite

ABRASIVES (MANUFACTURED)

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

Domestic Production and Use: Fused aluminum oxide was produced by three companies at six plants in the United States and Canada. Production of regular-grade fused aluminum oxide was valued at more than $38 million and production of high-purity fused aluminum oxide was valued at more than $9.4 million. Silicon carbide was produced by three companies at three plants in the United States and Canada. Domestic and Canadian production of crude silicon carbide had an estimated value of $42 million. Bonded and coated abrasive products account for most abrasive uses of fused aluminum oxide and silicon carbide.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production, United States and Canada (crude):					
Fused aluminum oxide, regular	126,000	124,000	93,500	99,600	97,500
Fused aluminum oxide, high-purity	20,100	22,700	14,200	W	W
Silicon carbide	75,400	73,600	68,200	W	W
Imports for consumption (U.S.):					
Fused aluminum oxide	213,000	131,000	138,000	180,000	164,000
Silicon carbide	172,000	182,000	240,000	268,000	190,000
Exports (U.S.):					
Fused aluminum oxide	11,000	11,900	10,700	8,910	8,860
Silicon carbide	20,000	14,200	16,100	11,600	8,150
Consumption, apparent (U.S.)					
Fused aluminum oxide	NA	NA	NA	NA	NA
Silicon carbide	NA	NA	NA	NA	NA
Price, range of value, dollars per ton:					
Fused aluminum oxide, regular	358	353	370	361	352
Fused aluminum oxide, high-purity	468	576	570	550	550
Silicon carbide	495	490	490	610	600
Net import reliance[1] as a percent of apparent consumption (U.S.)	NA	NA	NA	NA	NA

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

Import Sources (1995-98): Fused aluminum oxide crude: Canada, 68%; China, 15%; and other, 17%. Fused aluminum oxide grain: China, 51%; Canada, 14%; Austria, 13%; and other, 22%. Silicon carbide crude: China, 78%; Canada, 15%; and other, 7%. Silicon carbide grain: China, 53%; Brazil, 15%; Norway, 13%; Germany, 5%; and other, 14%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
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: Not applicable.

Government Stockpile: Until early 1999, the Department of Defense stored silicon carbide in the National Defense Stockpile (NDS). In the first quarter of 1999, however, the Department of Defense sold all of the silicon carbide remaining in the stockpile. No further stockpiling of silicon carbide by the Department of Defense is anticipated. If current disposal rates and sale schedules continue, all fused aluminum oxide in the NDS will be sold by yearend 2003.

Stockpile Status—9-30-99[2]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 1999**	**Disposals FY 1999**
Fused aluminum oxide, crude	55,860	35,774	55,860	58,967	58,967
Fused aluminum oxide, grain	18,749	507	18,749	5,443	2,713
Silicon carbide, crude	—	872	—	8,165	4,191

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ABRASIVES (MANUFACTURED)

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

World Production Capacity:

	Fused aluminum oxide capacity		Silicon carbide capacity	
	1998	1999[e]	1998	1999[e]
United States and Canada	220,000	220,000	90,000	90,000
Argentina	—	—	5,000	5,000
Australia	50,000	50,000	—	—
Austria	60,000	60,000	—	—
Brazil	50,000	50,000	43,000	43,000
China	450,000	450,000	450,000	450,000
France	40,000	40,000	16,000	16,000
Germany	80,000	80,000	36,000	36,000
India	40,000	40,000	5,000	5,000
Japan	50,000	50,000	60,000	60,000
Mexico	—	—	30,000	30,000
Norway	—	—	80,000	80,000
Venezuela	—	—	40,000	40,000
Other countries	80,000	80,000	185,000	185,000
World total (rounded)	1,100,000	1,100,000	1,000,000	1,000,000

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

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

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix B for definitions.

ALUMINUM[1]

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

Domestic Production and Use: In 1999, 12 companies operated 23 primary aluminum reduction plants. Montana, Oregon, and Washington accounted for 40% of the production; Maryland, New York, Ohio, and West Virginia, 20%; other States, 40%. Based on published market prices, the value of primary metal production in 1999 was $5.5 billion. Aluminum consumption, by an estimated 25,000 firms, was centered in the East Central United States. Transportation accounted for an estimated 38% of domestic consumption in 1999; packaging, 24%; building, 14%; electrical, 8%; consumer durables, 7%; and other, 9%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production: Primary	3,375	3,577	3,603	3,713	3,800
Secondary (from old scrap)	1,510	1,570	1,530	1,500	1,400
Imports for consumption	2,980	2,810	3,080	3,550	4,000
Exports	1,610	1,500	1,570	1,590	1,700
Shipments from Government stockpile excesses	—	—	57	([2])	—
Consumption, apparent[3]	6,300	6,610	6,720	7,090	7,500
Price, ingot, average U.S. market (spot), cents per pound	85.9	71.3	77.1	65.5	65.5
Stocks: Aluminum industry, yearend	2,000	1,860	1,860	1,930	1,950
LME, U.S. warehouses, yearend[4]	45	33	8	13	20
Employment, primary reduction, number	17,800	18,200	18,000	18,200	17,500
Net import reliance[5] as a percent of apparent consumption	23	22	23	27	30

Recycling: Aluminum recovered in 1999 from purchased scrap was about 3.5 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 (1995-98): Canada, 62%; Russia, 17%; Venezuela, 5%; Mexico, 3%; and other, 13%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Unwrought (in coils)	7601.10.3000	2.6% ad val.
Unwrought (other than aluminum alloys)	7601.10.6000	Free.
Waste and scrap	7602.00.0000	Free.

Depletion Allowance: Not applicable.[1]

Government Stockpile: None.

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ALUMINUM

Events, Trends, and Issues: Domestic primary aluminum production continued to increase, a trend which began in 1995. Domestic smelters operated at about 90% of rated or engineered capacity.

Two merger agreements involving major aluminum companies were announced during the year. Alcoa Inc. and Reynolds Metals Co. announced plans to merge,[6] and a three-way merger involving Alcan Aluminium Ltd., Pechiney, and Algroup of Alusuisse-Lonza Holding AG was also announced.[7] At the beginning of October, both groups were still awaiting approval from the U.S. Department of Justice.

Once again, U.S. imports for consumption increased significantly. Russia remained second only to Canada as a major shipper of aluminum materials to the United States. By the end of August, U.S. imports of aluminum ingots from Russia were close to the level of Russian ingot imports for all of 1998. U.S. exports of aluminum also continued to increase in 1999.

The price of primary aluminum ingot in the United States trended upward through September 1999. In January, the average monthly U.S. market price for primary ingot quoted by Platt's Metals Week was 58.8 cents per pound; by September the price had risen to 71.3 cents per pound. Prices on the London Metal Exchange (LME) followed the trend of U.S. market prices. The monthly average LME cash price for September was 67.7 cents per pound. Prices in the aluminum scrap markets paralleled the general trend of primary ingot prices. The buying price for aluminum used beverage can scrap, as quoted by American Metal Market, increased from a 44- to 45-cent-per-pound range at the beginning of the year to a 48- to 50-cent-per-pound range at the end of September.

World production continued to increase as temporarily idled capacity and new capacity expansions were brought on-stream. Aluminum demand in the United States and Western Europe remained strong with indications that the economic crises in Asia were easing. Despite fluctuations during the year, inventories of metal held by producers, as reported by the International Primary Aluminium Institute, and LME inventories were at approximately the same levels at the end of September as they were at the beginning of the year.

World Smelter Production and Capacity:

	Production		Yearend capacity	
	1998	1999[e]	1998	1999[e]
United States	3,713	3,800	4,210	4,260
Australia	1,630	1,700	1,760	1,770
Brazil	1,200	1,200	1,220	1,220
Canada	2,370	2,380	2,360	2,360
China	2,100	2,200	2,580	2,640
France	400	400	430	430
Norway	996	1,000	996	996
Russia	3,010	3,100	3,160	3,190
South Africa	650	650	676	676
Venezuela	580	570	640	640
Other countries	5,470	5,740	7,040	7,240
World total (rounded)	22,100	22,700	25,100	25,400

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

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

[e]Estimated.
[1]See also Bauxite and Alumina.
[2]Less than ½ unit.
[3]Domestic primary metal production + recovery from old aluminum scrap + net import reliance.
[4]Includes aluminum alloy.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]Alcoa Inc., 1999, Alcoa and Reynolds agree to merge: Pittsburgh, PA, Alcoa news release, August 19, 1 p.
[7]Alcan Aluminium Ltd., 1999, Alcan, Pechiney, and Algroup sign definitive three-way combination agreement: Montreal, Canada, Alcan press release, September 16, 2 p.

ANTIMONY

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

Domestic Production and Use: One silver mine in Idaho produced antimony as a byproduct, and an additional very small amount of antimony was recovered as a byproduct of the smelting of lead and silver-copper ores. Primary antimony metal and oxide was produced by five companies at processing plants that used foreign feedstock and a small amount of domestic feed material. Two plants were in Texas, and three other plants were in Idaho, Montana, and New Jersey. The estimated value of primary antimony metal and oxide produced in 1999 was $54 million. Secondary antimony was recovered, mostly in alloy form, at lead smelters; its value, based on the price of antimony metal, was about $11 million. The estimated distribution of antimony uses was as follows: flame retardants, 55%; transportation, including batteries, 18%; chemicals, 10%; ceramics and glass, 7%; and other, 10%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production: Mine (recoverable antimony)[1]	262	242	356	242	480
Smelter: Primary	23,500	25,600	26,400	24,000	24,800
Secondary[2]	10,500	7,780	7,550	7,710	5,000
Imports for consumption	36,600	37,600	39,300	34,600	34,000
Exports of metal, alloys,[3] oxide, and waste and scrap[3]	8,200	4,450	3,880	4,170	3,600
Shipments from Government stockpile	1,130	4,300	2,930	4,160	3,000
Consumption, apparent[4]	43,300	45,000	46,600	42,700	36,480
Price, metal, average, cents per pound[5]	228	147	98	72	77
Stocks, yearend	10,600	11,000	10,800	10,600	13,000
Employment, plant, number[e]	100	100	100	80	80
Net import reliance[6] as a percent of apparent consumption	75	82	83	81	85

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

Import Sources (1995-98): Metal: China, 79%; Mexico, 7%; Hong Kong, 5%; Kyrgyzstan, 5%; and other, 4%. Ore and concentrate: China, 39%; Bolivia, 27%; Australia, 10%; Canada, 10%; and other, 14%. Oxide: China, 42%; Mexico, 15%; South Africa, 14%; Bolivia, 13%; and other, 16%. Total: China, 57%; Bolivia, 12%; Mexico, 9%; South Africa, 7%; and other, 15%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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: 23% (Domestic), 15% (Foreign).

Government Stockpile: Government stockpile sales of antimony continued for the seventh year, after being resumed in 1993 for the first time since 1988. Public Law 103-160 provided the authorization for the sales. During the year, the Defense Logistics Agency (DLA) held sales for antimony on the fourth Tuesday of the month, with the format still being the negotiated bid process. The DLA announced that its Annual Materials Plan for fiscal year 1999 permitted the disposal of up to 5,000 tons of antimony, the same amount allotted in 1998. Antimony was stockpiled in eight DLA depots, with the largest inventories stored in New Haven, IN, and Somerville, NJ.

Stockpile Status—9-30-99[7]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Antimony	13,853	1,424	13,853	4,536	4,551

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ANTIMONY

Events, Trends, and Issues: In 1999, antimony production from domestic source materials was derived mainly from the recycling of lead-acid batteries. Recycling plus the small U.S. mine output supplied less than one-fifth of the estimated domestic demand.

The price of antimony metal experienced a slight decline during 1999. The price started the year at $0.70 per pound; by spring it had declined to $0.69 per pound, and by fall it had slipped to $0.67 per pound. Industry observers attributed the price erosion, now in its fifth year, to continuing large supplies from China.

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

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[8]	Reserve base[8]
	1998	1999[e]		
United States	242	480	80,000	90,000
Bolivia	6,000	5,000	310,000	320,000
China	120,000	120,000	900,000	1,900,000
Kyrgyzstan	100	200	120,000	150,000
Russia	4,000	3,000	350,000	370,000
South Africa	3,500	3,000	240,000	250,000
Tajikistan	1,200	1,200	50,000	60,000
Other countries	5,000	5,000	25,000	75,000
World total (may be rounded)	140,000	138,000	2,100,000	3,200,000

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

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

[e]Estimated.
[1]Data for 1995-98 from 10-K reports. Estimate for 1999 based on 10-Q reports for the first two quarters.
[2]After an intensive review in 1997, secondary antimony figures were revised downward to reflect a changing industry pattern.
[3]Gross weight.
[4]Domestic mine production + secondary production from old scrap + net import reliance (see footnote 6).
[5]New York dealer price for 99.5% to 99.6% metal, c.i.f. U.S. ports.
[6]Defined as imports - exports + adjustments for Government and industry stock changes.
[7]See Appendix B for definitions.
[8]See Appendix C for definitions.

ARSENIC

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

Domestic Production and Use: Arsenic is not recovered from domestic ores; all arsenic metal and compounds consumed in the United States are imported. More than 95% of the arsenic consumed is in compound form, principally arsenic trioxide, which is subsequently converted to arsenic acid. Production of chromated copper arsenate (CCA), a wood preservative, accounts for more than 90% of the domestic consumption of arsenic trioxide. CCA is manufactured primarily by three companies. Another company uses arsenic acid to produce arsenical herbicides. Arsenic metal is consumed in the manufacture of nonferrous alloys, principally lead alloys for use in lead-acid batteries. It is estimated that about 15 tons per year of high-purity arsenic is used in the manufacture of semiconductor material. The value of arsenic metal and compounds consumed domestically in 1999 was estimated at $20 million.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Imports for consumption:					
Metal	557	252	909	997	1,000
Compounds	22,100	21,200	22,800	29,300	29,000
Exports, metal	430	36	61	177	100
Estimated consumption[1]	22,300	21,400	23,700	30,100	30,000
Value, cents per pound, average:[2]					
Metal (China)	66	40	32	45	45
Trioxide (Mexico)	33	33	31	32	32
Net import reliance[3] as a percent of apparent consumption	100	100	100	100	100

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

Import Sources (1995-98): Metal: China, 88%; Hong Kong, 4%; Japan, 3%; and other, 5%. Trioxide: China, 50%; Chile, 25%; Mexico, 9%; and other, 16%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Metal	2804.80.0000	Free.
Trioxide	2811.29.1000	Free.
Sulfide	2813.90.1000	Free.
Acid[4]	2811.19.1000	2.3% ad val.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: None.

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ARSENIC

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

During 1999, the Minnesota Pollution Control Agency held a hearing on possibly banning the use of CCA within the State. A decision was expected by yearend.

Because of the toxicity of arsenic and its compounds, environmental regulation is expected to become increasingly stringent. This should adversely affect the demand for arsenic in the long term, but have only minor impacts in the near term.

World Production, Reserves, and Reserve Base:

	Production (Arsenic trioxide)		Reserves and reserve base[5] (Arsenic content)
	1998	1999[e]	
United States	—	—	
Belgium	1,500	2,000	
Chile	8,400	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 at 80,000 tons.
China	15,500	16,000	
France	2,000	2,000	
Ghana	5,000	5,000	
Kazakhstan	1,500	2,000	
Mexico	3,000	3,000	
Russia	1,500	1,500	
Other countries	2,400	2,000	
World total	40,800	41,500	

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

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

[e]Estimated.
[1]Estimated to be the same as net imports.
[2]Calculated from Bureau of the Census import data.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]Tariff is free for Canada, Israel, Caribbean Basin countries, and designated Beneficiary Andean and developing countries.
[5]See Appendix C for definitions.

ASBESTOS

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: One firm in California accounted for 100% of domestic production. Asbestos was consumed in roofing products, 56%; friction products, 20%; gaskets, 12%; and other, 12%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production (sales), mine	9	10	7	6	6
Imports for consumption	22	22	21	16	15
Exports[1]	15	15	20	18	19
Shipments from Government stockpile excesses	—	—	—	3	5
Consumption, apparent	22	22	21	16	15
Price, average value, dollars per ton, f.o.b.	W	W	W	W	W
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number	30	30	30	30	30
Net import reliance[2] as a percent of apparent consumption	32	32	5	6	7

Recycling: Insignificant.

Import Sources (1995-98): Canada, 99%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Asbestos	2524.00.0000	Free.

Depletion Allowance: 23% (Domestic), 10% (Foreign).

Government Stockpile:

Stockpile Status—9-30-99[3]
(Metric tons)

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Amosite	29,229	—	29,229	—	—
Chrysotile	197	—	197	18,144	5,220
Crocidolite	33	2,161	33	—	—

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ASBESTOS

Events, Trends, and Issues: Domestic sales of asbestos were unchanged from those of 1998. Imports decreased by 6% and exports increased by 6% from those of 1998, according to the U.S. Bureau of the Census. Apparent consumption decreased by 6%. Some exports were likely to have been reexports, asbestos-containing products, or nonasbestos products. Exports of asbestos fiber were estimated to be approximately 6,000 tons. Almost all of the asbestos consumed 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]
	1998	1999[e]		
United States	6	6	Moderate	Large
Brazil	170	170	Moderate	Moderate
Canada	330	300	Large	Large
China	250	250	Large	Large
Kazakhstan	125	125	Large	Large
Russia	650	650	Large	Large
South Africa	20	20	Moderate	Moderate
Zimbabwe	140	125	Moderate	Moderate
Other countries	149	144	Large	Large
World total	1,840	1,790	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 as possible asbestos substitutes for products in which the reinforcement properties of fibers were not required. No single substitute was as versatile and as cost effective as asbestos.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]May include nonasbestos materials and reexports.
[2]Defined as imports - exports + adjustments for Government and industry stock changes. Most domestic production is exported; imports account for almost all of domestic consumption.
[3]See Appendix B for definitions.
[4]See Appendix C for definitions.

BARITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Barite sales by domestic producers in 1999 decreased significantly from the 1998 level of 476,000 tons to about 375,000 tons; however, the value decreased to a lesser extent, to about $10 million, since higher valued product was sold by the producers' beneficiation plants. Sales came from three States, with the preponderance coming from Nevada. Georgia was the second largest seller. In 1999 an estimated 1.4 million tons of ground barite was sold from six States from both domestic production and imports by domestic crushers and grinders. Nearly 85% of the barite sold in the United States was used as a weighting agent in oil- and gas-well-drilling fluids, mostly in the Gulf of Mexico region with smaller amounts used in the Pacific coast, western Canada, and Alaska areas. 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 is part of the mold-release compounds. Barite has become part of the friction products (brake and clutch pads) for transportation vehicles. Because barite strongly reduces X-rays and gamma rays, it is used in cement vessels that contain radioactive materials, gastrointestinal X-ray "milkshakes," and the faceplates and funnelglass of cathode-ray tubes used for television sets and computer monitors. Non-oil-well-drilling end uses tend to track the general U.S. economy rather than energy prices.

Salient Statistics—United States:		**1995**	**1996**	**1997**	**1998**	**1999[e]**
Sold or used, mine		543	662	692	476	375
Imports for consumption:	Crude barite	965	1,470	2,210	1,850	750
	Ground barite	80	70	31	20	25
	Other	10	14	12	13	14
Exports		16	31	22	15	10
Consumption, apparent[1] (crude barite)		1,570	2,170	2,920	2,340	1,140
Consumption[2] (ground and crushed)		1,370	1,870	2,180	1,890	1,500
Price, average value, dollars per ton, mine		19.15	22.21	22.45	22.70	40.00
Employment, mine and mill, number[e]		400	350	380	410	300
Net import reliance[3] as a percent of apparent consumption		65	70	76	80	67

Recycling: None.

Import Sources (1995-98): China, 80%; India, 13%; Mexico, 3%; Morocco, 2%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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: 15% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Barite is used primarily in petroleum well drilling and, historically, has had a positive relationship to petroleum price trends and drill rig usage. The domestic demand for barite collapsed in early 1998 and has continued at a lower level through 1999. Starting in early 1998, the number of onshore oil rigs and gas rigs in the United States has taken a 1½-year slide following the decline in crude oil prices. Onshore oil rigs in the United States declined from about 396 rigs in February 1998 to about 122 rigs in February 1999, then stayed at or below 140 through November. Onshore gas rigs in the United States declined steadily from about 645 rigs in January 1998 to about 360 rigs in April 1999 then increased again, reaching 580 in September 1999. Drill rigs in Canada, a market for western U.S. barite grinders, declined from about 510 in February 1998 to a seasonal low of about 100 in May 1998, rising to between 140 and 230 rig count through the yearend. Canadian 1999 counts of drill rigs followed the same monthly pattern but did not rise above 1998 counts until September 1999. In February 1999, an Organization of Petroleum Exporting Countries meeting had concluded with an agreement to withhold production. Mexico and Norway joined the agreement. Average "light, sweet crude" oil futures prices rose steadily from $11.68 for March 1 to $24.50 per barrel for quoted as of October 4.

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BARITE

Onshore oil rigs did not respond to the average futures oil price increases in 1999, while onshore gas rigs increased without a significant average futures gas price increase. Canadian rig count after July 1999 rose further than the count rose over the same time period in 1998, and U.S. gas rig count rose to about 580 rigs from about 360 in May 1999. It is not clear why the gas directed rig count responded to rising oil prices. Perhaps American exploration oil companies do not trust the stability of the capacity withholding agreement, or American gas suppliers and drillers hoped to substitute for increasingly expensive oil supplies with relatively stable gas prices in certain consuming industries. An alternative explanation was put forward that the small drillers were hurt by the recent drilling recession, and the large drillers were too busy with the legal and bookkeeping problems of large consolidations.[4]

In the United States, estimated weighted average barite prices at the mine for the changed product mix sold by the domestic producers rose as the Western production sites switched to selling more ground (API grade) product for the Great Plains and Canadian drilling industry.

Imports for consumption of lower cost foreign barite was at about a 40% of 1998 levels and only twice the U.S. production rate. The major sources of imported barite have high-grade deposits, relatively low labor costs, and relatively low-cost (per ton-mile) ocean transportation (relative to land) to the U.S. Gulf Coast grinding plants. However, the Gulf of Mexico market was relatively steady at a relatively low rate of consumption. With a relatively large stockpile of unground ore in place at the beginning of the year, the Gulf grinders were not large buyers of imported ore. Meanwhile, the increased drilling took place inland, a nontraditional market for Gulf of Mexico grinders, which was better served by the inland grinders at mill sites near the mines. The high cost of overland shipping protected those grinders from imported barite ore. Nevada mines, crushers, and grinders are competitive in the California market, the Great Plains, and Canadian markets.

The principal environmental impact of chemically inert barite is the land disturbance normally associated with mining. Mud pits at petroleum well drilling sites, which contain some barite, are treated according to the chemical content exclusive of barite. The mud in the pits may be dewatered and covered, dewatered and spread over the ground, or transported to special waste handling facilities according to the base drilling fluid (water, oil, or synthetic).

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	1998	1999[e]		
United States	476	375	27,000	60,000
Canada	80	50	11,000	15,000
China	3,000	1,500	35,000	150,000
France	75	50	2,000	2,500
Germany	120	100	1,000	1,500
India	430	250	28,000	32,000
Iran	180	180	NA	NA
Kazakhstan	9	10	NA	NA
Mexico	162	150	7,000	8,500
Morocco	353	300	10,000	11,000
Thailand	110	80	9,000	15,000
Turkey	130	150	4,000	20,000
United Kingdom	75	50	100	600
Other countries	690	500	20,000	160,000
World total (may be rounded)	5,890	3,750	150,000	480,000

World Resources: In the United States, identified resources of barite are estimated to be 150 million tons, and hypothetical resources include an additional 150 million tons. The world's barite resources in all categories are about 2 billion tons, but only about 550 million tons are identified.

Substitutes: In the drilling mud market, alternatives to barite include celestite, ilmenite, iron ore, and the synthetic hematite that is manufactured in Germany. However, none of these substitutes 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]Gaddy, Dean E., 1999, Rig activity fails to bounce back despite $20/bbl oil: Oil & Gas Journal, v. 97, no. 38, September 20, p. 44.
[5]See Appendix C for definitions.

BAUXITE AND ALUMINA[1]

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

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

Salient Statistics—United States:[2]	**1995**	**1996**	**1997**	**1998**	**1999**[e]
Production, bauxite, mine	W	W	NA	NA	NA
Imports of bauxite for consumption[3]	10,900	10,800	11,300	11,600	9,500
Imports of alumina[4]	4,000	4,330	3,830	4,050	4,200
Exports of bauxite[3]	120	154	97	108	170
Exports of alumina[4]	1,040	918	1,270	1,280	1,100
Shipments of bauxite from Government stockpile excesses[3]	874	612	1,430	3,300	2,000
Consumption, apparent, bauxite and alumina (in aluminum equivalents)[5]	4,330	4,380	4,210	5,000	4,600
Price, bauxite, average value U.S. imports (f.a.s.) dollars per ton	24	27	25	23	22
Stocks, bauxite, industry, yearend[3]	1,730	1,930	2,260	1,860	1,500
Net import reliance,[6] bauxite and alumina, as a percent of apparent consumption	99	100	100	100	100

Recycling: None.

Import Sources (1995-98):[7] Bauxite: Guinea, 38%; Jamaica, 30%; Brazil, 17%; Guyana, 9%; and other, 6%. Alumina: Australia, 72%; Suriname, 8%; Jamaica, 7%; and other, 13%. Total: Australia, 33%; Guinea, 21%; Jamaica, 20%; Brazil, 10%; and other, 16%.

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 1999 had normal-trade-relations status.

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

Government Stockpile:

Stockpile Status—9-30-99[8]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 1999**	**Disposals FY 1999**
Bauxite, metal grade:					
Jamaica-type	7,320	2,370	7,320	2,030	1,350
Suriname-type	2,280	1,870	2,280	1,520	1,520
Bauxite, refractory-grade, calcined	45	59	4	29	[9]29

Events, Trends, and Issues: World output of bauxite and alumina for 1999 increased slightly to accommodate the modest increase in world primary aluminum metal production.

Domestic alumina production, however, decreased owing to the closure of Kaiser Aluminum & Chemical Corp.'s, Gramercy, LA, refinery. On July 5, the digestion area of the refinery was damaged in an explosion. As of October 1999, Kaiser had begun the first phase of rebuilding the damaged portion of the plant. Demolition and site preparation work were scheduled to be completed by yearend 1999, and the company hoped to have the plant operating at a partial production level by mid-2000 and at full production by yearend 2000.[10]

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BAUXITE AND ALUMINA

Spot prices for metallurgical-grade alumina, as published by Metal Bulletin, drifted upward during the first half of the year and then rose dramatically following the explosion at Gramercy. The published price range began the year at $145 to $160 per ton. By the end of June, the price range had increased slowly to $155 to $165 per ton. By the end of October, however, the price had risen to $260 to $280 per ton.

The revised fiscal year (FY) Annual Materials Plan (AMP) submitted by the Defense National Stockpile Center proposed the sale of 3.56 million dry metric tons of metallurgical-grade bauxite (2.03 million tons of Jamaica-type and 1.52 million tons of Suriname-type) during the period October 1, 1999, to September 30, 2000. In addition, the revised FY 2000 AMP provided for the sale of 4,060 calcined metric tons of refractory-grade bauxite from the National Defense Stockpile. These are the maximum amounts that could be sold under the new AMP and not necessarily the amounts that would actually be offered for sale.

World Bauxite Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[11]	Reserve base[11]
	1998	1999[e]		
United States	NA	NA	20,000	40,000
Australia	44,600	46,500	3,200,000	7,000,000
Brazil	11,700	11,800	3,900,000	4,900,000
China	8,200	8,500	720,000	2,000,000
Guinea	15,000	15,000	7,400,000	8,600,000
Guyana	2,600	1,800	700,000	900,000
India	5,700	7,000	1,500,000	2,300,000
Jamaica	12,600	11,600	2,000,000	2,000,000
Russia	3,450	3,500	200,000	200,000
Suriname	4,000	3,700	580,000	600,000
Venezuela	5,100	4,500	320,000	350,000
Other countries	8,950	9,000	4,100,000	4,700,000
World total (rounded)	122,000	123,000	25,000,000	34,000,000

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

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

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]See also Aluminum. As a general rule, 4 tons of dried bauxite are required to produce 2 tons of alumina, which, in turn, provide 1 ton of primary aluminum metal.
[2]Includes U.S. Virgin Islands.
[3]Includes all forms of bauxite, expressed as dry equivalent weights.
[4]Calcined equivalent weights.
[5]The sum of U.S. bauxite production and net import reliance (all in aluminum equivalents).
[6]Defined as imports - exports + adjustments for Government and industry stock changes (all in aluminum equivalents). Treated as separate commodities, the net import reliance equaled 100% for bauxite and 42% for alumina in 1999. For the years 1995-98, the net import reliance ranged from about 99% to 100% for bauxite and from 33% to 42% for alumina.
[7]Aluminum equivalents.
[8]See Appendix B for definitions.
[9]Dry equivalent weight—44,600 metric tons.
[10]Kaiser Aluminum and Chemical Corp., [n.d.], Gramercy photos, accessed November 3, 1999, at URL http://www.kaiseral.com.
[11]See Appendix C for definitions.

BERYLLIUM

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

Domestic Production and Use: One company in Utah mined bertrandite ore and recovered beryllium hydroxide from this ore and from imported beryl. Beryllium hydroxide was shipped to a plant in Ohio, where it was converted into beryllium metal, alloys, and oxide. Another company in Pennsylvania purchased beryllium oxide and converted this material into beryllium alloys. Beryllium consumption of 240 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 about 80% of consumption.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production, mine shipments	202	211	231	243	235
Imports for consumption, ore and metal	32	20	20	50	20
Exports, metal	61	57	40	60	35
Shipments from Government stockpile excesses[1]	[2](19)	—	—	—	NA
Consumption: Apparent	198	197	240	260	240
Reported	227	234	259	270	NA
Price, dollars:					
Domestic, metal, vacuum-cast ingot, per pound	308	327	327	327	327
Domestic, metal, powder blend, per pound	385	385	385	385	385
Domestic, beryllium-copper master alloy, per pound of contained beryllium	160	160	160	160	160
Domestic, beryllium oxide, powder, per pound	70.50	77.00	77.00	77.00	77.00
Stocks, consumer, yearend	162	139	110	80	NA
Employment, number:					
Mine, full-time equivalent employees[e]	25	25	25	NA	NA
Primary refineries[e]	400	400	400	NA	NA
Net import reliance[3] as a percent of apparent consumption	E	E	4	8	2

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

Import Sources (1995-98): Ore, metal, scrap, and master alloy: Kazakhstan, 25%; Russia, 21%; Canada, 17%; Germany, 9%; and other, 28%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Beryllium ore and concentrates	2617.90.0030	Free.
Beryllium oxide or hydroxide	2825.90.1000	3.7% ad val.
Beryllium-copper master alloy	7405.00.6030	Free.
Beryllium unwrought:		
Waste and scrap	8112.11.3000	Free.
Other	8112.11.6000	8.5% ad val.
Beryllium, wrought	8112.19.0000	5.5% ad val.

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

Government Stockpile:

Stockpile Status—9-30-99[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Beryl ore (11% BeO)	387	124	387	73	73
Beryllium-copper master alloy	166	32	166	45	45
Beryllium metal	345	18	73	18	18

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BERYLLIUM

Events, Trends, and Issues: For the first one-half year, sales of beryllium products decreased compared with those of the previous year, affected most by delays in defense spending and a slowdown in the aerospace industry. Additionally, demand for copper beryllium alloys from the aerospace, oil and gas, and undersea cable system markets was weak. Imports for consumption of ore and metal decreased, with Canada providing all of the ore imports and Russia as the leading supplier of metal imports. Metal exports were down; the United Kingdom, Japan, Canada, and the Netherlands were the major recipients. Beryllium price quotations remained unchanged.

For fiscal year (FY) 1999, ending September 30, 1999, the Defense National Stockpile Center (DNSC) sold about 1,810 tons of beryl ore (about 73 tons of contained beryllium) valued at about $158,000, about 1,130 tons of beryllium copper master alloy (BCMA) (about 45 tons of contained beryllium) valued at about $6.3 million, and about 18 tons of beryllium metal valued at about $2.4 million from the National Defense Stockpile. The DNSC also proposed maximum disposal limits in FY 2000 of about 3,630 tons of beryl ore (about 145 tons of contained beryllium), about 1,360 tons of BCMA (about 54 tons of contained beryllium), 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. Under the Clean Air Act, the Environmental Protection Agency issues standards for certain hazardous air pollutants, including beryllium, and the Occupational Safety and Health Administration issues standards for airborne beryllium particles. In order 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; collection of dust, fumes, and mists at the source of deposition in dust collectors; medical programs; and other procedures to provide safe working conditions.

World Mine Production, Reserves, and Reserve Base:

	Mine production	
	1998	1999[e]
United States	243	235
China[e]	55	55
Kazakhstan[e]	4	4
Russia[e]	40	40
Other countries	2	2
World total	344	336

Reserves and reserve base[5]

The United States has very little beryl that can be economically handsorted from pegmatites. The Spor Mountain area, Utah, 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: No quantitative information is available on foreign resources of beryllium-bearing minerals and rocks.

Substitutes: Although the cost of beryllium is high compared with that of other materials, it is used in applications in which its properties are crucial. Graphite, steel, and titanium may be substituted for beryllium metal in some applications, and phosphor bronze may be substituted for beryllium-copper alloys, but these substitutions can result in substantial loss in performance. In some applications, aluminum nitride may be substituted for beryllium oxide.

[e]Estimated. E Net exporter. NA Not available.
[1]Data in parentheses denote stockpile acquisitions.
[2]Data represent the difference between the estimated beryllium content of beryl shipped for upgrading and stockpile receipts of beryllium metal. These data are not included in net import reliance calculations.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[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 on June 30, 1997. Bismuth is contained in some domestically mined lead ores, but no byproduct bismuth was produced. Forty-four companies, mostly in the eastern United States, accounted for an estimated three-fourths of the bismuth consumed in 1999. The value of bismuth consumed was estimated at almost $18 million. About 42% of the bismuth was used in pharmaceuticals and chemicals; 39% in fusible alloys, solders, and cartridges; 17% in metallurgical additives; and 2% in other uses.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production, refinery	W	W	W	—	—
Imports for consumption, metal	1,450	1,490	2,170	2,720	2,200
Exports, metal, alloys, scrap	261	151	206	245	220
Shipments from Government stockpile excesses	139	137	229	—	—
Consumption, reported	2,150	1,520	1,530	2,000	2,050
Price, average, domestic dealer, dollars per pound	3.85	3.65	3.50	3.60	3.85
Stocks, yearend, consumer	390	122	213	150	80
Employment, refinery, number of workers[e 1]	30	30	30	—	—
Net import reliance[2] as a percent of apparent consumption	W	W	W	100	100

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

Import Sources (1995-98): Belgium, 34%; Mexico, 30%; United Kingdom, 16%; China, 10%; and other, 10%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Articles thereof, including waste and scrap	8106.00.0000	Free.

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

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

Stockpile Status—9-30-99[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Bismuth	—	—	—	—	—

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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. Other major areas of development included bismuth shot for waterfowl hunting, bismuth-containing solders, and lubricating greases, especially extreme pressure lubricants. A new area of development was the use of bismuth in galvanizing. Bismuth was also used in ceramic glazes, crystal ware, and pigments.

World lead mine production has increased moderately in recent years, but world primary lead refinery production has not increased—limiting the amount of bismuth that can be produced as a lead byproduct. Bismuth was also recovered from some copper ores and from tungsten ores, especially in Asia. World mine and refinery production of bismuth decreased in 1999. The domestic price increased from $3.15 per pound to $3.40 per pound during the first quarter, increased to $3.75 per pound by the middle of the second quarter, and fell back to $3.70 per pound by the start of the third quarter. The price increased to $4.50 per pound during the third quarter and stabilized above $4.00 per pound for the first time since 1995. The average price for the year increased for the second year in a row. It rose from $3.60 to about $3.85 per pound.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	1998	1999[e]		
United States	—	—	9,000	14,000
Australia	—	—	18,000	27,000
Bolivia	650	650	10,000	20,000
Canada	180	180	5,000	30,000
China	600	700	20,000	40,000
Japan	150	150	9,000	18,000
Kazakhstan	115	115	5,000	10,000
Mexico	1,200	600	10,000	20,000
Peru	832	760	11,000	42,000
Other countries	150	150	15,000	35,000
World total (rounded)	3,880	3,310	110,000	260,000

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

Substitutes: Antibiotics, magnesia, and alumina can replace bismuth in pharmaceutical applications. Titanium dioxide-coated mica flakes and fish scale extracts are substitutes in pigment uses. Indium can replace bismuth in low-temperature solders. Resins can replace bismuth alloy jigs used for holding metal shapes during machining. Glycerine-filled glass bulbs can replace bismuth alloys as a triggering device for fire sprinklers. Selenium, tellurium, and lead could replace bismuth in free-machining alloys.

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Data for first 6 months of 1997, until shutdown of only domestic refiner.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.
[4]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 1999 was $500 million. Domestic production of boron minerals, primarily as sodium borates, by four companies was centered in southern California. The largest producer operated an open pit tincal and kernite mine and associated compound plants. A second firm, using Searles Lake brines as raw material, accounted for the majority of the remaining output. A third company continued to process small amounts of calcium and calcium sodium borates. A fourth company used an in-situ process. Principal consuming firms were in the North Central and Eastern States. The reported distribution pattern for boron compounds consumed in the United States in 1998 was as follows: glass products, 71%; soaps and detergents, 5%; agriculture, 4%; fire retardants, 4%; and other, 16%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production[1]	728	581	604	587	657
Imports for consumption, gross weight:					
Borax	9	11	54	14	22
Boric acid	16	25	26	23	29
Colemanite	45	44	44	47	47
Ulexite	153	136	157	170	170
Exports, gross weight:					
Boric acid	75	42	92	106	100
Refined sodium borates	588	381	473	453	450
Consumption: Apparent	312	234	483	412	529
Reported	NA	367	403	NA	NA
Price, dollars per ton, granulated pentahydrate borax in bulk, carload, works[2]	324	375	340	340	341
Stocks, yearend[3]	NA	NA	NA	NA	NA
Employment, number	900	900	900	900	900
Net import reliance[4] as a percent of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1995-98): Boric acid: Chile, 37%; Turkey, 32%; Bolivia, 16%; Italy, 6%; other, 9%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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, 15% (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 1999 and exported about one-half of domestic production. All production was from California. Exported materials competed with borax, boric acid, colemanite, and ulexite primarily from Turkey, the largest producer of boron ore in the world.

Importation of borates from northern Chile continued. Ulexite is mined in Chile for the production of boric acid, synthetic colemanite, and refined ulexite for use in ceramics, insulating and reinforcing fiberglass, and agriculture. Other South American countries that exported boron ore and compounds to the United States are Bolivia and Peru.

The in-situ borate project produced synthetic calcium borate product that was being tested for usage in the glass industry.

The boron, sodium bicarbonate, and sodium sulfate production from underground brines in California continued and the company plans a sale of the assets to be finalized in early 2000.

The only domestic underground operation continued production during the year.

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

	Production—all forms		Reserves[6]	Reserve base[6]
	1998	1999[e]		
United States	1,170	1,270	40,000	80,000
Argentina	270	270	2,000	9,000
Bolivia	12	12	4,000	19,000
Chile	160	160	8,000	41,000
China	140	140	27,000	36,000
Iran	1	1	1,000	1,000
Kazakhstan	30	30	14,000	15,000
Peru	40	40	4,000	22,000
Russia	1,000	1,000	40,000	100,000
Turkey	1,550	1,550	30,000	150,000
World total (rounded)	4,370	4,470	170,000	470,000

World Resources: Large domestic reserves of boron materials occur in California, chiefly in sediments and their contained brines. Extensive resources also occur in Turkey. Small deposits are being mined in South America. World resources are adequate, at current levels of consumption, for the foreseeable future.

Substitutes: Substitution for boron materials is possible in applications such as soaps, detergents, enamel, and insulation. In soaps, sodium and potassium salts of fatty acids are the usual cleaning and emulsion agents. Borates in detergents can be replaced by chlorine bleach or enzymes. Some enamels use other glass producing substances, such as phosphates. Insulation substitutes include foams and mineral wools.

[e]Estimated. E Net exporter. NA Not available.
[1]Minerals and compounds sold or used by producers; includes both actual mine production and marketable products.
[2]Chemical Market Reporter.
[3]Stocks data are not available and are assumed to be zero for net import reliance and apparent consumption calculations.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]Gross weight of ore in thousand metric tons.
[6]See Appendix C for definitions.

BROMINE

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

Domestic Production and Use: The quantity of bromine sold or used in the United States from four companies operating in Arkansas and Michigan accounted for 100% of elemental bromine production valued at an estimated $230 million. Arkansas continued to be the Nation's leading bromine producer, and bromine was the leading mineral commodity in terms of value produced in the State.

In January 1999, a new elemental bromine plant started production of calcium bromide and sodium bromide in Manistee, MI. Nameplate capacity is 14,000 tons per year of elemental bromine.

A new bromine compounds plant producing fire retardant used a new continuous process that does not produce methyl bromide as a coproduct began to operate in Arkansas in the third quarter of 1999.

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

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production[1]	218	227	247	230	231
Imports for consumption, elemental bromine and compounds[2]	14	14	11	10	10
Exports, elemental bromine and compounds	8	17	14	12	12
Consumption, apparent[3]	206	225	244	235	229
Price, cents per kilogram, bulk, purified bromine	85.3	66.0	80.2	70.0	87.0
Stocks, producer, yearend, elemental bromine[e]	—	—	—	—	—
Employment, number	1,600	1,700	1,700	1,700	1,700
Net import reliance[4] as a percent of apparent consumption	—	E	E	—	E

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

Import Sources (1995-98): Israel, 86%; United Kingdom, 4%; Belgium, 3%; France, 3%; and other, 4%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/999**
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	12.8% 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	0.8¢/kg + 12.4% ad val.
Vinyl bromide, methyl	2903.30.1520	Free.

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

Government Stockpile: None.

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BROMINE

Events, Trends, and Issues: Three bromine companies accounted for 64% of world production. Two of these companies are located in the United States and accounted for about 94% of U.S. production. Legislation during the 1970's and 1980's reduced the traditional demand for bromine as a gasoline additive and in agriculture, but new end uses in specialized flame retardant chemicals have demanded increasing amounts of bromine.

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

A U.S. company signed an joint-venture agreement with a company in Jordan to build a bromine complex at Safi, Jordan. Construction was planned to begin in third quarter 2000 and be completed by 2002. Included in the construction plans is a 50,000-ton-per-year bromine plant.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	1998	1999[e]		
United States[1]	230	231	11,000	11,000
Azerbaijan	2.0	2.0	300	300
China	40.0	40.0	NA	NA
France	2.0	2.0	1,600	1,600
India	1.5	1.5	([6])	([6])
Israel	180	180	([7])	([7])
Italy	0.3	0.3	([6])	([6])
Japan	20.0	20.0	([8])	([8])
Spain	0.1	0.1	1,400	1,400
Turkmenistan	0.2	0.2	700	700
Ukraine	3.0	3.0	400	400
United Kingdom	30.0	30.0	([6])	([6])
World total (rounded)	510	510	NA	NA

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

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

[e]Estimated. E Net exporter. NA Not available.
[1]Sold or used by U.S. producers.
[2]Imports calculated from items shown in tariff section.
[3]Includes recycled product.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.
[6]From waste bitterns associated with solar salt.
[7]From the Dead Sea. See World Resources section.
[8]From seawater. See World Resources section.

CADMIUM

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

Domestic Production and Use: Primary cadmium metal in the United States is produced by two companies as a byproduct of beneficiating and refining zinc metal from sulfide ore concentrates. Secondary cadmium is recovered from spent nickel-cadmium (Ni-Cd) batteries by one company. Based on the average New York dealer price, the combined output of primary and secondary metal in 1999 was valued at about $1.1 million. About 72% of total apparent cadmium consumption was for batteries. The remaining 28% was distributed as follows: pigments, 13%; coatings and plating, 8%; stabilizers for plastics, 6%; and other uses, 1%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production, refinery[1]	1,270	1,530	2,060	1,880	1,800
Imports for consumption, metal	848	843	790	620	600
Exports of metal, alloys, and scrap	1,050	201	554	606	600
Shipments from Government stockpile excesses	220	230	161	128	120
Consumption, apparent	1,160	2,250	2,510	2,350	2,220
Price, metal, dollars per pound[2]	1.84	1.24	0.51	0.28	0.25
Stocks, yearend, producer and distributor	542	1,140	1,090	763	435
Employment, smelter and refinery, number	125	145	150	140	140
Net import reliance[3] as a percent of apparent consumption	E	32	16	20	19

Recycling: To date, cadmium recycling has been practical only for Ni-Cd batteries, some alloys, and dust from electric arc furnaces (EAF). The exact amount of recycled cadmium is not known. In 1999, the U.S. steel industry generated more than 0.6 million ton of EAF dust, typically containing 0.003% to 0.07% cadmium. At least nine States required collection of rechargeable Ni-Cd batteries.

Import Sources (1995-98): Metal: Canada, 59%; Belgium, 12%; Germany, 9%; Australia, 6%; and other, 14%.

Tariff: Item	Number	Canada and Mexico 12/31/99	Normal Trade Relations 12/31/99
Cadmium sulfide	2830.30.0000	Free	3.1% ad val.
Pigments and preparations based on cadmium compounds	3206.30.0000	Free	3.1% ad val.
Unwrought cadmium; waste and scrap; powders	8107.10.0000	Free	Free.

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

Government Stockpile:

Stockpile Status—9-30-99[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Cadmium	1,209	17	1,209	544	544

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CADMIUM

Events, Trends, and Issues: Japan is one of the largest producers and the largest net importer of refined cadmium metal. More than 60% of the cadmium consumed by Western countries goes into batteries, making batteries the principal end use. About 75% of the batteries being produced by Western manufacturers are for cellular telephones and other cordless electronic equipment. The remaining 25% are mostly used for industrial purposes, such as emergency power supplies for telephone exchanges and hospital operating rooms. Because of environmental concerns about cadmium, some of the Ni-Cd batteries in electronic equipment are being replaced by lithium-ion batteries; the latter have already captured about a 30% share of Japan's rechargeable battery market. The current consumption pattern is expected to change as the manufacture of electric vehicles accelerates in the United States, the European Union, and Japan. If this market develops as expected, recycling of Ni-Cd batteries on a large scale will be required, both for environmental reasons and to assure an adequate supply of cadmium metal.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[5]	Reserve base[5]
	1998	1999[e]		
United States	1,880	1,800	90,000	270,000
Australia	600	600	112,600	300,000
Belgium	1,320	1,300	—	—
Canada	2,310	2,300	55,000	155,000
China	2,000	2,100	13,000	35,000
Germany	1,150	1,100	6,000	8,000
Japan	2,340	2,300	10,000	15,000
Kazakhstan	900	1,000	25,000	40,000
Mexico	1,100	1,000	35,000	40,000
Russia	800	850	16,000	30,000
Other countries	5,200	5,550	237,000	325,000
World total (may be rounded)	19,600	19,900	600,000	1,200,000

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

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

[e]Estimated. E Net exporter.
[1]Primary and secondary metal.
[2]Average New York dealer price for 99.95% purity in 5-short-ton lots. Source: Platt's Metals Week.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]See Appendix C for definitions.

CEMENT

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

Domestic Production and Use: In 1999, about 81.5 million tons of portland cement and 4.0 million tons of masonry cement were produced at a total of 115 plants, spread among 37 States, by 1 State agency and about 40 companies. In addition, there were two cement plants in Puerto Rico. The ex-plant value of production, excluding Puerto Rico, was about $7.4 billion, and the dominant portland cement component was used to make concrete worth at least $30 billion. Total domestic cement consumption (sales) reached new record levels. There were 106 plants making clinker—the main intermediate product in cement manufacture—with a total calculated annual production capacity of about 83 million tons. Together with seven other facilities just for grinding clinker produced elsewhere, total finished cement (grinding) capacity at yearend amounted to about 95 million tons. If Puerto Rico is included, the clinker and cement grinding capacities become about 85 million tons and 97 million tons, respectively. The top 5 cement companies together accounted for about 41% of total U.S. clinker production and capacity, and the top 10 companies accounted for about 62%. California, Texas, Pennsylvania, Michigan, Missouri, and Alabama, in descending order, were the six largest cement-producing States and together accounted for about 50% of total U.S. production. In terms of use, cement manufacturers sold about 70% of their portland cement output to ready-mixed concrete producers; 12% to producers of concrete products, such as block, pipe, and precast slabs; 11% to contractors (largely for roadpaving); 4% to building material dealers; and 3% to miscellaneous users.

Salient Statistics—United States:[2]	1995	1996	1997	1998	1999[e]
Production, portland and masonry[3]	76,906	79,266	82,582	83,931	86,000
Production, clinker	69,983	70,361	72,686	74,523	76,100
Shipments to final customers, including exports	86,561	91,438	96,801	103,696	110,000
Imports of hydraulic cement for consumption	10,969	11,565	14,523	19,878	25,000
Imports of clinker for consumption	2,789	2,402	2,867	3,905	5,000
Exports of hydraulic cement and clinker	759	803	791	743	750
Consumption, apparent[4]	86,003	90,354	96,018	102,457	110,700
Price, average mill value, dollars per ton	67.87	71.19	73.49	76.46	78.00
Stocks, mill, yearend	5,814	5,488	5,784	5,393	5,000
Employment, mine and mill, number[e]	17,800	17,900	17,900	17,900	18,000
Net import reliance[5] as a percent of apparent consumption	11	12	14	19	23

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 (1995-98):[6] Canada, 31%; Spain, 10%; Venezuela, 10%; Greece, 9%; and other, 40%. Imports were coming from an increasing number of countries, with Asian sources (especially Thailand and China) becoming major suppliers in 1998 and 1999.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Cement clinker	2523.10.0000	Free.
White portland cement	2523.21.0000	Free.
Other portland cement	2523.29.0000	Free.
Aluminous cement	2523.30.0000	Free.
Other hydraulic cement	2523.90.0000	Free.

Depletion Allowance: Not applicable. Certain raw materials for cement production have depletion allowances.

Government Stockpile: None.

Events, Trends, and Issues: Bolstered by continued low interest rates and higher levels of public spending, particularly on highways, the construction market in 1999 continued strong and again generated record consumption levels for cement. The increased demand was met by a small increase in domestic production and a very large increase in imports. One new cement plant came on-line in Florida towards yearend and several other plants continued to be engaged in projects to upgrade their capacities. Antidumping tariffs against Mexico and Venezuela were under “sunset” review, and a decision whether or not to continue the tariffs was expected to be made in 2000.

There continued to be concern over the environmental impact of cement manufacture, particularly the emissions of carbon dioxide and cement kiln dust (CKD). A yearend 1997 accord was reached in Kyoto, Japan that would have

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CEMENT

so-called developed countries, including the United States, reduce their carbon dioxide emissions to levels below those in 1990. This accord had yet to be ratified by the U.S. Congress, and there continued much debate as to how this reduction was to be achieved and what its cost would be to the economy. The Environmental Protection Agency in June 1999 published standards for (trace material) hazardous waste emissions, and in August the agency published standards for handling CKD; the public comment period for both documents was extended to February 2000.

A number of cement companies burn a proportion of solid or liquid waste materials in their kilns as a low-cost substitute for fossil fuels. Technically, 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 applicable current and future environmental regulations and their associated costs. The overall trend, tempered by administrative constraints, appears to be towards increased use of waste fuels. A number of environmental issues, such as restrictions on silica in dust, also affect cement raw materials quarries, but these are common to other types of mines as well.

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

World Production and Capacity:

	Cement production		Yearend clinker capacity	
	1998	1999[e]	1998[e]	1999[e]
United States (includes Puerto Rico)	85,612	87,300	84,390	85,100
Brazil	[e]43,000	43,000	45,000	45,000
China	513,500	520,000	520,000	500,000
Egypt	19,203	20,000	20,000	20,000
France	[e]19,500	19,500	24,000	24,000
Germany	36,610	37,000	42,000	42,000
India	[e]85,000	87,000	90,000	92,000
Indonesia	[e]22,000	25,000	45,000	48,000
Italy	[e]35,000	35,000	46,000	46,000
Japan	81,328	80,000	95,500	90,000
Korea, Republic of	46,791	55,000	57,000	57,000
Mexico	27,744	30,000	43,000	43,000
Russia	26,726	27,000	63,000	63,000
Spain	27,943	28,000	34,000	34,000
Taiwan	19,538	21,000	24,000	24,000
Thailand	[e]30,000	34,000	45,000	45,000
Turkey	38,200	37,000	28,600	30,000
Other countries (rounded)	[e]360,000	370,000	410,000	420,000
World total (rounded)	[e]1,520,000	1,560,000	1,720,000	1,710,000

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 outside purchases, and both clinker and cement are widely traded.

Substitutes: Virtually all portland cement is utilized either in making concrete or mortars and, as such, competes with substitutes for concrete in the construction sector. These substitutes include brick clay, glass, aluminum, steel, fiberglass, wood, stone, and asphalt. There is a moderate but growing use in the United States of pozzolans and similar materials as partial or complete substitutes for portland cement for some concrete applications.

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

CESIUM

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

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

Salient Statistics—United States: Salient statistics, such as production, consumption, imports, and exports, are not available. The cesium market is very small, with annual consumption probably amounting to only a few thousand kilograms. As a result, there is no active trading of the metal and, therefore, no official market price. However, several companies publish prices for cesium and cesium compounds. These prices remain relatively stable for several years. The per-unit price for the metal or compounds purchased from these companies varies inversely with the quantity of material purchased. For example, in 1999, one company offered 1-gram ampoules of 99.98%-grade cesium metal at $63.30. The price for 100 grams of the same material from this company was $956.00, or $9.56 per gram. At another company, the price for a 1-gram ampoule of $99.95%-pure cesium was $49.40.

Recycling: None.

Import Sources (1995-98): 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 12/31/99
Alkali metals, other	2805.19.0000	5.5% ad val.
Chlorides, other	2827.39.5000	3.7% ad val.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: None.

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CESIUM

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

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

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

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

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

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

CHROMIUM

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

Domestic Production and Use: The United States consumes about 14% of world chromite ore production in various forms of imported materials (chromite ore, chromium chemicals, chromium ferroalloys, and chromium metals). Imported chromite was consumed by two chemical firms and two refractory firms to produce chromium chemicals and chromite-containing refractories, respectively. Consumption of chromium ferroalloys and metal was predominantly for the production of stainless and heat-resisting steel and superalloys, respectively. The value of chromium material consumption was about $421 million.

Salient Statistics—United States:[1]	1995	1996	1997	1998	1999[e]
Production: Mine	—	—	—	—	—
Secondary	112	98	120	105	103
Imports for consumption	416	362	350	381	429
Exports	27	51	30	62	23
Government stockpile releases	44	52	47	93	10
Consumption: Reported[2] (excludes secondary)	298	277	345	[e]280	196
Apparent[3] (includes secondary)	565	467	488	531	522
Price, chromite, yearend:					
South African, dollars per metric ton, South Africa	61	75	73	68	63
Turkish, dollars per metric ton, Turkey	144	225	180	145	145
Stocks, industry, yearend	80	74	72	58	55
Net import reliance[4] as a percent of apparent consumption	80	79	75	80	80

Recycling: In 1999, chromium contained in purchased stainless steel scrap accounted for 20% of apparent consumption.

Import Sources (1995-98): Chromium contained in chromite ore and chromium ferroalloys and metal: South Africa, 44%; Russia, 14%; Turkey, 10%; Zimbabwe, 9%; and other, 23%.

Tariff:[5] Item	Number	Normal Trade Relations 12/31/99
Ore and concentrate	2610.00.0000	Free.
Ferrochromium, high-carbon	7202.41.0000	1.9% ad val.

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

Government Stockpile: The Defense Logistics Agency, U.S. Department of Defense, submitted the Annual Materials Plan for 2000 in February 1999. In addition to the stockpile-grade uncommitted inventory listed below, the stockpile contains the following nonstockpile-grade uncommitted inventory, in thousand metric tons: 33, metallurgical chromite ore; 0.4, high-carbon ferrochromium.

Stockpile Status—9-30-99[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999	Average chromium content
Chromite ore:						
Chemical-grade	162	43.4	162	90.7	—	28.6%
Metallurgical-grade	149	187	149	227	174	28.6%
Refractory-grade	234	40.6	234	90.7	—	[e]23.9%
Chromium ferroalloys:						
Ferrochromium:						
High-carbon	645	0.137	195	22.7	20.3	71.4%
Low-carbon	275	3.12	275	22.7	2.42	71.4%
Ferrochromium-silicon	49.4	1.27	49.4	—	—	42.9%
Chromium metal	7.72	—	—	—	—	[e]100%

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; some is exported to Norway. Cuban production is relatively small. The largest chromite ore producing countries, accounting for about 80% of world production, are India, Kazakhstan, South Africa, and Turkey. South Africa alone accounts for over 40% of world production and has been the major supplier of chromium in the form of chromite ore

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CHROMIUM

and ferrochromium to Western industrialized countries. Stainless steel, the major end use market for chromium, has shown long-term growth equivalent to about one or two new ferrochromium furnaces annually. To meet this demand, South African plants were built or expanded. Production capacity expansion continues to be achieved through the addition of furnaces; however, the emphasis has shifted to expansion through plant enhancements that improve recovery and reduce cost, such as agglomeration and preheating of furnace feed and recovery from slag. South African chromite ore and ferrochromium producers financed these process changes through joint ventures with stainless steel producers in Asia. By financing capacity growth and production efficiency, consumers lower their cost and secure their supply; producers secure market share and stabilize production rates.

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

The U.S. Environmental Protection Agency regulates chromium releases into the environment. The U.S. Occupational Safety and Health Administration regulates workplace exposure.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7]	Reserve base[7]
	1998	1999[e]	(shipping grade)[8]	
United States	—	—	—	10,000
Albania	100	100	6,100	6,100
Brazil	330	330	14,000	17,000
Finland	611	610	41,000	120,000
India	1,363	1,400	27,000	67,000
Iran	200	200	2,400	2,400
Kazakhstan	1,600	1,600	320,000	320,000
Russia	130	130	4,000	460,000
South Africa	5,500	5,600	3,000,000	5,500,000
Turkey	1,600	1,600	8,000	20,000
Zimbabwe	660	660	140,000	930,000
Other countries	600	600	31,000	39,000
World total (rounded)	12,700	12,800	3,600,000	7,500,000

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

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

[e]Estimated.
[1]Data in thousand metric tons of contained chromium, unless noted otherwise.
[2]The years 1995 through 1998 include chromite ore; 1999 excludes chromite ore.
[3]Calculated demand for chromium is production + imports - exports + stock adjustment.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]In addition to the tariff items listed, certain imported chromium materials (see U.S. Code, chapter 26, sections 4661 and 4672) are subject to excise tax.
[6]See Appendix B for definitions.
[7]See Appendix C for definitions. Reserves and reserve base data are rounded to no more than two significant figures.
[8]Shipping-grade chromite ore is deposit quantity and grade normalized to 45% Cr_2O_3.

CLAYS

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: In 1999, clays were produced in most States except Alaska, Delaware, Hawaii, Rhode Island, Vermont, and Wisconsin. A total of 238 companies operated approximately 700 clay pits or quarries. The leading 20 firms supplied 50% of the tonnage and 75% of the value for all types of clay sold or used in the United States. U.S. production was estimated to be 42.2 million metric tons valued at $1.71 billion. Major domestic uses for specific clays were estimated as follows: ball clay—33% floor and wall tile, 24% sanitaryware, 11% pottery, and 32% other uses; bentonite—26% foundry sand bond, 23% pet waste absorbent, 20% drilling mud, 16% iron ore pelletizing, and 15% other uses; common clay—54% brick, 21% cement, 17% lightweight aggregate, and 8% other uses; fire clay—81% refractories and 19% other uses; fuller's earth—74% absorbent uses, 6% pesticide and related products, and 20% other uses; and kaolin—56% paper, 17% refractories, and 27% other.

Salient Statistics—United States:[1]	**1995**	**1996**	**1997**	**1998**	**1999**[e]
Production, mine:					
Ball clay	993	935	1,060	1,130	1,140
Bentonite	3,820	3,740	4,020	3,820	3,850
Common clay	25,600	26,200	24,600	24,500	24,800
Fire clay[2]	583	505	415	410	410
Fuller's earth	2,640	2,600	2,370	2,350	2,350
Kaolin	9,480	9,180	9,280	9,450	9,710
Total[3]	43,000	43,100	41,800	41,600	42,200
Imports for consumption	35	45	64	86	97
Exports	4,680	4,830	5,080	5,230	4,700
Consumption, apparent	38,500	38,300	36,800	36,500	37,600
Price, average, dollars per ton:					
Ball clay	46	44	47	45	46
Bentonite	36	36	42	46	43
Common clay	6	5	6	6	6
Fire clay	22	21	19	18	18
Fuller's earth	101	106	107	109	97
Kaolin	117	120	111	111	115
Stocks, yearend[4]	NA	NA	NA	NA	NA
Employment, number:[e] Mine	3,950	4,900	4,900	4,800	4,800
Mill	9,000	9,000	9,000	8,900	8,900
Net import reliance[5] as a percent of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1995-98): Mexico, 28%; Brazil, 24%; United Kingdom, 21%; Canada, 8%; and other, 19%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
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, 15% (Domestic and foreign); brick and tile clay used in the manufacture of common brick, drain and roofing tile, sewer pipe, flower pots, and kindred products, 5% (Domestic and foreign).

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CLAYS

Government Stockpile: None.

Events, Trends, and Issues: The amount of clay and shale sold or used by domestic producers increased slightly in 1999. Small increases were reported for ball clay, bentonite, common clay, and kaolin. Sales and use of fire clay and fuller's earth were unchanged from 1998. Imports for consumption increased to 97,000 tons in 1999 from 86,000 tons in 1998. Imports of kaolin from Brazil have risen dramatically in the past 3 years, increasing from less than 1,000 tons in 1996 to a projected 48,000 tons in 1999. Brazil, Mexico, and the United Kingdom were the major sources for imported clays. Tariffs were eliminated for many of the clay varieties. Exports decreased to 4.7 million tons in 1999 from 5.2 millions tons in 1998. Exports declined for all clay types except fuller's earth. Canada, Finland, Japan, and the Netherlands were major markets for exported clays. U.S. apparent consumption was estimated to be 37.6 million tons.

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

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

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

[e]Estimated. E Net exporter. NA Not available.
[1]Excludes Puerto Rico.
[2]Refractory uses only.
[3]Data may not add to total shown because of independent rounding.
[4]Data on stocks are not available and are assumed to be zero for apparent consumption and net import reliance calculations.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.

COBALT

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

Domestic Production and Use: The United States did not mine or refine cobalt in 1999; however, negligible amounts of byproduct cobalt were produced as intermediate products from some mining operations. U.S. supply was comprised of imports, stock releases, and secondary materials such as superalloy scrap, cemented carbide scrap, and spent catalysts. There were two domestic producers of extra-fine cobalt powder: One produced powder from imported primary metal, and another produced powder from recycled materials. In addition to the powder producers, six companies were known to be active in the production of cobalt compounds. More than 100 industrial consumers were surveyed on a monthly or annual basis. Approximately 45% of U.S. cobalt usage was in superalloys, which are used primarily in aircraft gas turbine engines; 9% was in cemented carbides for cutting and wear-resistant applications; 8% was in magnetic alloys; and the remaining 38% was in various other metallic and chemical uses. The total estimated value of cobalt consumed in 1999 was $350 million.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production: Mine	—	—	—	—	—
Secondary	1,860	2,280	2,750	3,080	3,100
Imports for consumption	6,440	6,710	8,430	7,670	8,200
Exports	1,300	1,660	1,570	1,680	1,500
Shipments from Government stockpile excesses	1,550	2,050	1,620	2,310	1,700
Consumption:					
Reported (includes secondary)	7,590	7,990	8,910	9,180	9,200
Apparent (includes secondary)	8,970	9,380	11,200	11,500	11,500
Price, average annual spot for cathodes, dollars per pound	29.21	25.50	23.34	21.43	17.00
Stocks, industry, yearend	1,080	1,070	1,090	1,000	1,000
Net import reliance[1] as a percent of apparent consumption	79	76	76	73	73

Recycling: About 3,100 tons of cobalt was recycled from purchased scrap in 1999. This represented about 34% of estimated reported consumption for the year.

Import Sources (1995-98): Cobalt content of metal, oxide, and salts: Norway, 24%; Finland, 18%; Canada, 14%; Zambia, 13%; and other, 31%.

Tariff: Item	Number	Normal Trade Relations[2] 12/31/99
Unwrought cobalt, alloys	8105.10.3000	4.4% ad val.
Unwrought cobalt, other	8105.10.6000	Free.
Cobalt matte, waste, and scrap	8105.10.9000	Free.
Wrought cobalt and cobalt articles	8105.90.0000	3.7% ad val.
Chemical compounds:		
Cobalt oxides and hydroxides	2822.00.0000	0.1% ad val.
Cobalt sulfates	2833.29.1000	1.4% ad val.
Cobalt chlorides	2827.34.0000	4.2% ad val.
Cobalt carbonates	2836.99.1000	4.2% ad val.
Cobalt acetates	2915.23.0000	4.2% ad val.
Cobalt ores and concentrates	2605.00.0000	Free.

Depletion Allowance: 23% (Domestic), 15% (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 (6.0 million pounds) during fiscal year 2000.

Stockpile Status—9-30-99[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Cobalt	12,800	495	12,800	2,720	1,960

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COBALT

Events, Trends, and Issues: In 1999, two internet web sites were established for selling cobalt. One site was established by the marketing division of a cobalt producer to sell their product, and the other was established by a brokerage firm for spot market and forward sales of cobalt from various sources.

World cobalt production is expected to continue to increase during the next few years as the Australian nickel laterite projects bring production up to planned levels. Cobalt supply during this period will also include cobalt in recycled scrap and sales from the U.S. Government's National Defense Stockpile. Demand for cobalt in any given year will depend on world economic conditions. In the near to medium term, the overall growth in cobalt demand is anticipated to be between 3% and 6% per year. In the medium to long term, cobalt supply is expected to grow faster than demand. A generally downward trend in cobalt prices would be the likely response to a growing market surplus. During the first 11 months of 1999, the average spot price of cobalt cathode varied between $8.50 per pound and $21.25 per pound.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	1998	1999[e]		
United States	—	—	—	860,000
Australia	3,300	3,700	680,000	920,000
Canada	6,000	5,900	45,000	260,000
Congo (Kinshasa)[5]	1,500	3,000	2,000,000	2,500,000
Cuba	2,200	2,200	1,000,000	1,800,000
New Caledonia[6]	1,000	1,000	230,000	860,000
Philippines	—	—	—	400,000
Russia	3,200	3,400	140,000	230,000
Zambia	7,000	7,000	360,000	540,000
Other countries	2,100	2,100	90,000	1,200,000
World total (may be rounded)	26,300	28,300	4,500,000	9,600,000

World Resources: The cobalt resources of the United States are estimated to be about 1.3 million tons. Most of these resources are in Minnesota, but other important occurrences are in Alaska, California, Idaho, Missouri, Montana, and Oregon. Although large, most domestic resources are in subeconomic concentrations that are not expected to be economical in the foreseeable future. In addition, with the exception of resources in Idaho, any cobalt production from these deposits would be as a byproduct of another metal. The identified world cobalt resources are about 11 million tons. The vast majority of these resources are in nickel-bearing laterite deposits, with most of the rest occurring in nickel-copper sulfide deposits hosted in mafic and ultramafic rocks in Australia, Canada, and Russia, and in the sedimentary copper deposits of Congo (Kinshasa) and Zambia. In addition, millions of tons of hypothetical and speculative cobalt resources exist in manganese nodules and crusts on the ocean floor.

Substitutes: Periods of high prices and concern about availability have resulted in various efforts to conserve, reduce, or substitute for cobalt. In many applications, further substitution of cobalt would result in a loss in product performance. Potential substitutes include barium or strontium ferrites, neodymium-iron-boron, or nickel-iron alloys in magnets; nickel, cermets, or ceramics in cutting and wear-resistant materials; nickel base alloys or ceramics in jet engines; nickel in petroleum catalysts; rhodium in hydroformylation catalysts; nickel or manganese in batteries; and manganese, iron, cerium, or zirconium in paints.

[e]Estimated.
[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]Formerly Zaire.
[5]Overseas territory of France.

COLUMBIUM (NIOBIUM)

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

Domestic Production and Use: There has been no significant domestic columbium-mining industry since 1959. Domestic columbium resources are of low grade, some mineralogically complex, and most are not commercially recoverable. Most metal, ferrocolumbium, other alloys, and compounds were produced by six companies with seven plants. 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 1999 was more than $60 million. Major end-use distribution of reported columbium consumption was as follows: carbon steels, 39%; superalloys, 19%; high-strength low-alloy steels, 16%; stainless and heat-resisting steels, 14%; alloy steels, 11%; and other, 1%.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production, mine	—	—	—	—	—
Imports for consumption:					
Concentrates, tin slags, other[1]	NA	NA	NA	NA	NA
Ferrocolumbium[e]	3,580	2,970	4,260	4,900	4,400
Exports, concentrate, metal, alloys[e]	370	190	70	50	150
Government stockpile releases[e 2]	—	30	130	150	NA
Consumption, reported, ferrocolumbium[e 3]	2,900	3,370	3,770	3,640	3,600
Consumption, apparent	3,800	3,800	3,900	4,000	3,900
Price: Columbite, dollars per pound[4]	2.97	3.00	3.00	3.00	3.00
Pyrochlore, dollars per pound[5]	NA	NA	NA	NA	NA
Stocks, industry, processor and consumer, yearend	NA	NA	NA	NA	NA
Employment	NA	NA	NA	NA	NA
Net import reliance[6] as a percent of apparent consumption	100	100	100	100	100

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

Import Sources (1995-98): Brazil, 74%; Canada, 12%; Germany, 4%; Russia, 3%; and other, 7%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
Columbium ores and concentrates	2615.90.6030	Free.
Columbium oxide	2825.90.1500	3.7% ad val.
Ferrocolumbium	7202.93.0000	5.0% ad val.
Columbium, unwrought:		
Waste and scrap	8112.91.0500	Free.
Alloys, metal, powders	8112.91.4000	4.9% ad val.
Columbium, wrought	8112.99.0000	4.0% ad val.

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

Government Stockpile: The Defense National Stockpile Center (DNSC) had authority under its Annual Materials Plan for fiscal year (FY) 1999 (October 1, 1998, through September 30, 1999) to sell about 181 tons of columbium contained in ferrocolumbium, about 10 tons of columbium contained in columbium carbide powder, about 91 tons of columbium contained in columbium concentrates, and about 9 tons of columbium metal ingots from the National Defense Stockpile (NDS). From November 1998 through April 1999, the DNSC sold about 178 tons of columbium contained in ferrocolumbium valued at about $2.4 million. In June and September 1999, the DNSC sold a total of about 9 tons of columbium metal ingots valued at about $474,000. The DNSC disposed of about 83 tons of columbium contained in tantalum concentrates. There were no sales of columbium carbide powder in FY 1999. The DNSC also proposed maximum disposal limits in FY 2000 of about 181 tons of columbium contained in ferrocolumbium, about 10 tons of columbium contained in columbium carbide, about 91 tons of columbium contained in columbium concentrates, and about 9 tons of columbium metal ingots. The NDS uncommitted inventories shown below include about 342 tons of columbium contained in nonstockpile-grade concentrates and about 103 tons of columbium contained in nonstockpile-grade ferrocolumbium.

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COLUMBIUM (NIOBIUM)

Stockpile Status—9-30-99[7]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Columbium carbide powder	10	—	10	10	—
Columbium concentrates	677	49	677	91	[8]83
Columbium metal	64	9	64	9	9
Ferrocolumbium	230	5	230	181	178

Events, Trends, and Issues: For the first one-half year, domestic demand for columbium ferroalloys in steelmaking was down compared with the similar period of 1998, in line with a decrease in raw steel production. Demand for columbium in superalloys also declined owing to a soft superalloy market. For the same period, overall columbium imports decreased, with the volume of ferrocolumbium imports from Brazil down by almost 10%. Brazil continued as the leading supplier, providing more than 80% of total columbium imports. Exports increased, with the United Kingdom and Mexico receiving most of the columbium materials.

The quoted price for columbium materials remained unchanged through early November, columbite ore at a range of $2.80 to $3.20 per pound of contained pentoxide, steelmaking-grade ferrocolumbium at a range of $6.75 to $7 per pound of contained columbium, and high-purity ferrocolumbium at a range of $17.50 to $18 per pound of contained columbium. Industry sources indicated in August 1999 that nickel columbium sold at about $18.50 per pound of contained columbium, and that columbium metal products sold in the range of about $24 to $100 per pound in ingot and special shape forms.

It is estimated that in 2000, domestic columbium mine production will be zero and U.S. apparent consumption will be about 4,000 tons. The majority of total U.S. demand will be met by columbium imports in upgraded forms.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[9]	Reserve base[9]
	1998	1999[e]		
United States	—	—	—	Negligible
Australia	140	150	10,000	NA
Brazil	16,000	16,000	3,200,000	5,000,000
Canada	2,300	2,300	140,000	400,000
Congo (Kinshasa)[10]	—	—	30,000	50,000
Nigeria	23	20	60,000	90,000
Other countries[11]	—	—	NA	NA
World total (rounded)	18,500	18,500	3,500,000	5,500,000

World Resources: Most of the world's identified resources of columbium are outside the United States and occur mainly as pyrochlore in carbonatite deposits. On a worldwide basis, resources are more than adequate to supply projected needs. The United States has approximately 150,000 tons of columbium resources in identified deposits, all of which were considered uneconomic at 1999 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 superalloys; and ceramics, molybdenum, tantalum, and tungsten in high-temperature applications.

[e]Estimated. NA Not available.
[1]Metal, alloys, synthetic concentrates, and columbium oxide.
[2]Net quantity including effect of upgrading program.
[3]Includes nickel columbium.
[4]Average value, contained pentoxides for material having a Nb_2O_5 to Ta_2O_5 ratio of 10 to 1.
[5]Average value, contained pentoxide.
[6]Defined as imports - exports + adjustments for Government and industry stock changes.
[7]See Appendix B for definitions.
[8]Columbium units contained in the disposal of tantalum concentrates.
[9]See Appendix C for definitions.
[10]Formerly Zaire.
[11]Bolivia, China, Russia, and Zambia also produce, or are believed 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 1999 declined to 1.66 million metric tons and was valued at about $2.8 billion. The five principal mining States, in descending order, Arizona, Utah, New Mexico, Nevada, and Montana, accounted for 99% of domestic production; copper was also recovered at mines in three other States. While copper was recovered at about 35 mines operating in the United States, 15 mines accounted for about 98% of production. Four primary and 2 secondary smelters, 6 electrolytic and 4 fire refineries, and 16 solvent extraction-electrowinning facilities were operating at yearend. Refined copper and direct melt scrap were consumed at about 35 brass mills; 17 rod mills; and 600 foundries, chemical plants, and miscellaneous consumers. Copper and copper alloy products were consumed[1] in building construction, 42%; electric and electronic products, 26%; transportation equipment, 12%; industrial machinery and equipment, 11%; and consumer and general products, 9%.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production: Mine	1,850	1,920	1,940	1,860	1,660
Refinery: Primary[2]	1,930	2,010	2,070	2,140	1,870
Secondary[3]	352	345	383	336	240
Copper from all old scrap	442	428	496	466	400
Imports for consumption:					
Ores and concentrates	127	72	44	217	150
Refined	429	543	632	683	860
Unmanufactured	825	961	999	1,190	1,230
Exports: Ores and concentrates	239	195	127	37	40
Refined	217	169	93	86	25
Unmanufactured	894	748	628	412	360
Consumption: Reported refined	2,530	2,610	2,790	2,880	2,950
Apparent unmanufactured[4]	2,540	2,830	2,950	3,010	3,090
Price, average, cents per pound:					
Domestic producer, cathode	138.3	109.0	107.0	78.6	75.7
London Metal Exchange, high-grade	133.1	104.0	103.2	75.0	71.2
Stocks, yearend, refined[5]	163	146	314	532	550
Employment, mine and mill, thousands	13.8	13.3	13.2	13.0	12.0
Net import reliance[6] as a percent of apparent consumption	7	14	13	14	27

Recycling: Old scrap, converted to refined metal and alloys, provided 400,000 tons of copper, equivalent to 13% of apparent consumption. Purchased new scrap, derived from fabricating operations, yielded 950,000 tons of contained copper; about 80% of the copper contained in new scrap was consumed at brass mills. Of the total copper recovered from scrap, brass mills recovered 67%; copper smelters and refiners,19%; ingot makers, 10%; brass mills, 67%; and miscellaneous manufacturers, foundries, and chemical plants, 4%. Copper in all old and new, refined or remelted scrap contributed 33% of the U.S. copper supply.

Import Sources (1995-98): Unmanufactured: Canada, 43%; Chile, 21%; Mexico, 15%; and other, 21%. Refined copper accounted for 58% of imports of unwrought copper.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**	**Canada and Mexico 12/31/99**
Unrefined copper; anodes	7402.00.0000	Free	Free.
Refined and alloys; unwrought	7403.00.0000	1.0% ad val.	Free.
Copper powder	7406.10.0000	Free	Free.
Copper wire (rod)	7408.11.6000	3.0% ad val.	Free.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: The stockpile of about 20,000 tons of refined copper was liquidated in 1993. The stockpile of about 8,100 tons of brass was liquidated in 1994. For details on inventories of beryllium-copper master alloys (4% beryllium), see the section on beryllium.

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COPPER

Events, Trends, and Issues: World mine capacity rose for the fifth consecutive year, rising by about 600,000 tons, 4.5% in 1999 and almost 30% since 1994. Australia, Chile, and Peru accounted for most of the increase. Production rose about 3% in 1999 and 32% since 1994.

U.S. mine capacity, however, declined in 1999 owing to indefinite closure of sulfide operations in Arizona and New Mexico in addition to other announced reductions and production fell by over 200,000 tons to 1.66 million tons. In addition to announced closures in 1999, the full effect of cutbacks during 1998 were felt in 1999. In June Broken Hill Propriety Ltd. (BHP) announced that it would cease operations at its North American properties by September, including its San Manuel Mine in Arizona and Robinson Mine in Nevada. The San Manuel smelter remained closed following its April renovation shutdown, and closure of the refinery and rod mill followed later in the year.[8] In June, Phelps Dodge Corp., which had already cut back production at its Chino Mine and closed its Cobre Mine, announced the shutdown of its Hidalgo, NM, smelter and the smaller of its two concentrators at Morenci, AZ.[9] By yearend, only four primary smelters remained open. In July 1999, an announced merger-of-equals transaction between Cyprus Amax Minerals Company and ASARCO Incorporated, initiated competition between North American copper producers for control of the U.S. copper industry. Following numerous offers and counter offers, including an attempt by Phelps Dodge to acquire the assets of both Asarco and Cyprus Amax, a realigned industry emerged by mid-October: Phelps Dodge acquired Cyprus Amax and Mexico's Grupo Mexico S.A. de C.V. acquired the assets of Asarco. (For details see Copper Mineral Industry Surveys for July and August 1999.)

The above closures and ownership changes were part of cost-cutting measures encouraged by the low prevailing copper prices and the perception that the underlying oversupply would continue at least through 2000. Worldwide exchange warehouse inventories of copper rose to 975,000 tons in August, up from 177,000 tons at yearend 1996.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[10]	Reserve base[10]
	1998	1999[e]		
United States	1,860	1,660	45,000	90,000
Australia	604	730	7,000	23,000
Canada	707	630	10,000	23,000
Chile	3,691	4,360	88,000	160,000
China	476	450	18,000	37,000
Indonesia	781	765	19,000	25,000
Kazakhstan	337	350	14,000	20,000
Mexico	385	375	15,000	27,000
Peru	522	540	19,000	40,000
Poland	415	450	20,000	36,000
Russia	515	520	20,000	30,000
Zambia	320	280	12,000	34,000
Other countries	1,590	1,530	50,000	105,000
World total (may be rounded)	12,200	12,600	340,000	650,000

World Resources: Land-based resources are estimated at 1.6 billion tons of copper, and resources in deep-sea nodules are estimated at 0.7 billion tons.

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

[e]Estimated.
[1]Some electrical components are included in each end use. Distribution by Copper Development Association, 1999.
[2]From both domestic and imported ores and concentrates.
[3]From both primary and secondary refineries.
[4]Defined as primary refined production + copper from old scrap converted to refined metal and alloys + refined imports - refined exports ± changes in refined stocks. In 1998 and 1999 general imports of 725,000 tons and 880,000 tons, respectively were used to calculate apparent consumption.
[5]Held by industry, COMEX, and London Metal Exchange warehouses in the United States.
[6]Defined as imports - exports + adjustments for Government and industry stock changes for refined copper.
[7]Value of copper content.
[8]Broken Hill Propriety Ltd., 1999, BHP 1999 profit result: Melbourne, Australia, BHP press release, June 25, 2 p.
[9]Phelps Dodge Corp., 1999, Phelps Dodge Curtails Copper Production and restructures wire and cable business: Phoenix, AZ, Phelps Dodge financial news, June 30, 2 p.
[10]See Appendix C for definitions.

DIAMOND (INDUSTRIAL)

(Data in million carats, unless otherwise noted)

Domestic Production and Use: In 1999, production reached a record high for the third consecutive year and the United States remained the world's largest market for industrial diamond. Virtually all output was synthetic grit and powder. Two firms, one in New Jersey and the other in Ohio, accounted for all of the production. Nine other firms produced polycrystalline diamond from diamond powder. Four companies recovered used industrial diamond as one of their principal operations. Most consumption was accounted for by the following industry sectors: abrasive industries, construction, machinery manufacturing, mineral services, stone and ceramic production, and transportation equipment manufacturing. Mineral services, primarily drilling, accounted for most industrial stone consumption.

Salient Statistics—United States:	1995	1996	1997[1]	1998[1]	1999[e]
Bort, grit, and dust and powder; natural and synthetic:					
Production: Manufactured diamond	115	114	125	140	154
Secondary	26	20	10	10	9
Imports for consumption	188	218	254	221	215
Exports[2]	98	105	126	104	100
Sales from Government stockpile excesses	.2	1	.7	([3])	([3])
Consumption, apparent	231	248	264	267	278
Price, value of imports, dollars per carat	.43	.46	.43	.44	.42
Net import reliance[4] as a percent of apparent consumption	39	46	49	44	41
Stones, natural:					
Production: Mine	—	([3])	([3])	([3])	([3])
Secondary	.3	.4	.5	.5	.4
Imports for consumption[5]	4.1	2.9	2.8	4.7	3.3
Exports[2]	.5	.5	.6	.8	.7
Sales from Government stockpile excesses	.3	.5	1.2	.8	.6
Consumption, apparent	4.2	3.3	3.9	5.2	3.6
Price, value of imports, dollars per carat	6.62	7.54	7.69	3.92	4.94
Net import reliance[4] as a percent of apparent consumption	86	88	87	90	89

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

Import Sources (1995-98): Bort, grit, and dust and powder; natural and synthetic: Ireland, 50%; China, 16%; Russia, 8%; and other, 26%. Stone, primarily natural: United Kingdom, 24%; Belgium, 14%; Ireland, 10%; Congo (Kinshasa),[6] 8%; and other, 44%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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: 15% (Domestic and foreign).

Government Stockpile:

Stockpile Status—9-30-99[7]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Crushing bort	—	—	—	0.065	0.063
Industrial stones	2.50	0.213	2.50	0.600	0.599

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DIAMOND (INDUSTRIAL)

Events, Trends, and Issues: The United States will continue to be the world's largest market for industrial diamond well into the 21st century and will remain a significant producer and exporter of industrial diamond as well.

World and U.S. demand for diamond grit and powder will experience growth through 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:[8]

	Mine production		Reserves[9]	Reserve base[9]
	1998	1999[e]		
United States	([3])	([3])	Unknown	Unknown
Australia	22.5	22.5	90	230
Botswana	5.0	5.0	130	200
Brazil	.6	.6	5	15
China	.9	.9	10	20
Congo (Kinshasa)[6]	13.0	13.2	150	350
Russia	10.5	10.7	40	65
South Africa	6.2	6.4	70	150
Other countries	1.2	1.2	80	200
World total (may be rounded)	59.9	60.5	580	1,200

World Resources: Natural diamond resources have been discovered in more than 35 countries. Nevertheless, nearly all industrial diamond is synthetic. 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 utilized for more than 90% of industrial applications.

[e]Estimated.
[1]Some data revised to correspond with new information published in the USGS Mineral Industry Surveys annual review of industrial diamond for 1998.
[2]Reexports no longer are combined with exports as in previous Mineral Commodity Summaries because growing volumes of U.S. reexports obscure apparent consumption rates.
[3]Less than ½ unit.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]May include synthetic miners' diamond.
[6]Formerly Zaire.
[7]See Appendix B for definitions.
[8]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 500 million carats in 1998; the largest producers included Ireland, Russia, South Africa, and the United States.
[9]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 $182 million in 1999. Production was from 7 companies with 12 processing facilities in 4 States. Three companies produced more than 75% of the total. California and Nevada were the principal producing States. Estimated end uses of diatomite were filter aids, 64%; absorbents, 14%; fillers, 12%; and other (mostly cement manufacture), 10%.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production[1]	722	729	773	725	720
Imports for consumption	([2])	2	2	2	2
Exports	144	143	140	138	140
Consumption, apparent	578	588	635	589	582
Price, average value, dollars per ton, f.o.b. plant	238	242	244	248	250
Stocks, producer, yearend	36	36	36	36	36
Employment, mine and plant, number[e]	1,000	1,000	1,000	1,000	1,000
Net import reliance[3] as a percent of apparent consumption	E	E	E	E	E

Recycling: None.

Import Sources (1995-98): France, 85%; Mexico, 5%; and other, 10%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
Siliceous fossil meals, including diatomite	2512.00.0000	Free.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: None.

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DIATOMITE

Events, Trends, and Issues: Filtration (including for beer, wine, liquors, oils, and greases) continued to be the largest end use for diatomite, also known as diatomaceous earth (D.E.). Another application is for microbial contaminants such as bacteria, viruses, and protozoa in public water systems. A U.S. company in conjunction with an international association commissioned a test project using D.E. filtration and achieved very significant results in reduction of cryptosporidium. D.E. filter aids have been successfully deployed in over 200 locations throughout the United States for the treatment of potable water.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	1998	1999[e]		
United States[1]	725	720	250,000	500,000
China	350	350		NA
Denmark[5]	375	375		NA
France	80	80	Other	2,000
Japan	190	190	countries:	NA
Korea, Republic of	50	50	550,000	NA
Mexico	60	60		2,000
Spain	40	40		NA
Former Soviet Union[6]	80	80		NA
Other countries	200	205		NA
World total (may be rounded)	2,150	2,150	800,000	Large

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

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

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

FELDSPAR

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: U.S. feldspar production in 1999 had an estimated value of $45 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 45% of the output and facilities in six other States contributed smaller quantities. Feldspar processors reported coproduct recovery of mica and silica sand.

Feldspar is ground for industry use to about 20 mesh for glassmaking and to 200 mesh or finer for most ceramic and filler applications. It was estimated that feldspar shipments went to at least 30 States and to foreign destinations, including Canada and Mexico. In ceramics and glass, feldspar functions as a flux. Estimated 1999 end-use distribution of domestic feldspar was glass, 70%, and pottery and other, 30%.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production, marketable	880	890	[e]900	[e]820	900
Imports for consumption	9	7	9	7	6
Exports	15	10	7	13	7
Consumption, apparent	874	887	[e]900	[e]814	899
Price, average value, marketable production, dollars per ton	42.50	44.27	[e]47.22	49.76	50.36
Stocks, producer, yearend[1]	NA	NA	NA	NA	NA
Employment, mine and preparation plant, number	400	400	400	400	400
Net import reliance[2] as a percent of apparent consumption	E	E	([3])	E	E

Recycling: Insignificant.

Import Sources (1995-98): Mexico, 96%; and other, 4%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
Feldspar	2529.10.0000	Free.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: None.

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FELDSPAR

Events, Trends, and Issues: Glass and ceramic whiteware, such as dinnerware, sanitaryware, and tile, continued to be major end uses of feldspar. An active housing and remodeling market resulted in an 8.7% increase in dollar value to $1.7 billion in the U.S. ceramic tile market in 1998 and a projected 6.7% increase in 1999, according to a nongovernment source. However, import penetration reached 67% of the U.S. tile market in 1998. Italy, Spain, and Mexico accounted for about 78% of all U.S. tile imports.

In dinnerware, the domestic manufacturers' share of the U.S. market fell to 27% in 1998. China supplied 39% of total imported dinnerware and the United Kingdom supplied 13%.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[4]
	1998	1999[e]	
United States	[e]820	900	Significant in the United States and assumed to be similar in other countries.
Brazil	200	220	
Colombia	55	60	
France	500	500	
Germany	450	450	
India	88	90	
Italy	2,300	2,300	
Japan	52	60	
Korea, Republic of	320	330	
Mexico	160	170	
Norway	75	80	
Portugal	100	100	
Russia	40	50	
Spain	425	425	
Thailand	600	600	
Turkey	1,000	1,000	
Uzbekistan	70	80	
Venezuela	170	160	
Other countries	655	725	
World total	8,080	8,300	

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

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

[e]Estimated. E Net exporter. NA Not available.
[1]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]Negligible.
[4]See Appendix C for definitions.

FLUORSPAR

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: There was no domestic mine production of fluorspar in 1999. There was some recovery of byproduct calcium fluoride from industrial waste streams, although it is not included in the data shown below. Material purchased from the National Defense Stockpile or imported was screened and dried for resale to customers. Domestically, an estimated 90% of reported fluorspar consumption went into the production of hydrofluoric acid (HF) in Louisiana and Texas and aluminum fluoride in Texas. HF is the primary feedstock for the manufacture of virtually all organic and inorganic fluorine-bearing chemicals, and is also a key ingredient in the processing of aluminum and uranium. The remaining estimated 10% of the reported fluorspar consumption was consumed as a flux in steelmaking, in iron and steel foundries, primary aluminum production, glass manufacture, enamels, welding rod coatings, and other uses or products. To supplement domestic fluorine supplies, about 68,200 tons of fluorosilicic acid (equivalent to 120,000 tons of 92% fluorspar) was recovered from phosphoric acid plants processing phosphate rock. Fluorosilicic acid was used primarily in water fluoridation, either directly or after processing into sodium silicofluoride, and to make aluminum fluoride for the aluminum industry.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production: Finished, all grades[e 1]	[2]51	8	—	—	—
Fluorspar equivalent from phosphate rock	98	119	121	118	120
Imports for consumption:					
Acid grade	470	474	485	462	400
Metallurgical grade	88	39	51	41	72
Fluorspar equivalent from hydrofluoric acid plus cryolite	114	131	175	204	128
Exports[3]	42	62	62	44	48
Shipments from Government stockpile	74	287	97	110	132
Consumption: Apparent[4]	599	719	551	572	552
Reported	534	527	491	538	500
Stocks, yearend, consumer and dealer[5]	405	234	375	471	413
Employment, mine and mill, number	130	5	—	—	—
Net import reliance[6] as a percent of apparent consumption	91	99	100	100	100

Recycling: An estimated 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 (1995-98): China, 65%; South Africa, 20%; Mexico, 13%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Acid grade (97% or more CaF_2)	2529.22.0000	Free.
Metallurgical grade (less than 97% CaF_2)	2529.21.0000	Free.

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

Government Stockpile: During fiscal year 1999, the Defense National Stockpile Center (DNSC) sold 75,300 tons (83,000 short dry tons) of acid grade, which exhausted the last remaining inventory of acid grade available. The DNSC sold 45,000 tons (50,000 short dry tons) of metallurgical grade. Under the proposed fiscal year 2000 Annual Materials Plan, the DNSC will be authorized to sell 45,000 tons (50,000 short dry tons) of metallurgical grade.

Stockpile Status—9-30-99[7]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Acid grade	—	250	—	109	75
Metallurgical grade	146	46	146	45	45

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FLUORSPAR

Events, Trends, and Issues: The Chinese Government revised the export license system for 1999. The revisions required that all bidding be done remotely by computer, changed the ratio of public to agreement bidding, increased the size of the nonrefundable deposit, increased the number of bidding rounds to four, and changed the method for calculating the export license fees. The results of the first round of bids for export licenses in the first quarter sent shock waves through world fluorspar markets when the export licenses jumped from $26 per ton to $56 to $60 per ton. The later round of bids lowered the export license fees to about $39 per ton, but damage had already been done and Chinese fluorspar exports for 1999 were expected to be substantially lower than in recent years. In the United States, major consumers responded by purchasing as much material as possible under 1998 export licenses that were issued before the end of 1998 at the old fixed rate of $27 per ton. Another response was to draw down company stocks while hoping prices would decrease.

In South Africa, the Vergenoeg Fluorspar Mine owned by Bayer AG of Germany was sold to Canadian mining company Metorex, which subsequently sold a 30% stake to Minerales y Productos Derivados SA of Spain.[8] Also in South Africa, the Witkop Fluorspar Mine owned by Phelps Dodge Corporation through its subsidiary Phelps Dodge Mining (Pty.) Ltd. was sold to the South African Land and Exploration Company.[9]

In complying with a 1997 amendment to the Montreal Protocol, an international agreement designed to curtail illegal trade in chlorofluorocarbons, hydrochlorofluorocarbons, and other ozone-depleting chemicals went into effect on November 10, 1999. The agreement will require countries to establish licensing systems for international sales of ozone-depleting substances.[10] The licensing system may help increase sales of replacement compounds, such as hydrofluorocarbon 134a, by making it more difficult to acquire illegal chlorofluorocarbons.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[11 12]	Reserve base[11 12]
	1998	1999[e]		
United States	—	—	—	6,000
Brazil	78	75	W	W
China	2,550	2,100	23,000	94,000
France	110	110	10,000	14,000
Kenya	70	70	2,000	3,000
Mexico	598	600	32,000	40,000
Morocco	110	110	W	W
South Africa	226	220	30,000	36,000
Spain	120	120	6,000	8,000
United Kingdom	65	30	2,000	3,000
Other countries	743	790	[13]110,000	[13]170,000
World total (may be rounded)	4,670	4,220	220,000	370,000

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

Substitutes: Olivine and/or dolomitic limestone were used as substitutes for fluorspar. Byproduct fluorosilicic acid from phosphoric acid production was used as a substitute in aluminum fluoride production.

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Shipments.
[2]Includes fluorspar from National Defense Stockpile reprocessed by Ozark-Mahoning Co., Illinois.
[3]Exports are all general imports reexported or National Defense Stockpile material exported.
[4]Excludes fluorspar equivalent of fluorosilicic acid, hydrofluoric acid, and cryolite.
[5]Industry stocks plus National Defense Stockpile material committed for sale pending shipment.
[6]Defined as imports - exports + adjustments for Government and industry stock changes.
[7]See Appendix B for definitions.
[8]African Mining, 1999, Spanish fluorspar leader takes stake in Vergenoeg: African Mining Bulletin, no. 101, electronic issue, July 5, unpaginated.
[9]Industrial Minerals, 1999, Phelps Dodge fluorspar sold to S.A. Land & Exploration for $12.3m: Industrial Minerals, no. 382, July, p. 13.
[10]Chemical Market Reporter, 1999, Treaty on CFCs trade set to take effect: Chemical Market Reporter, v. 256, no. 10, September 6, p. 6.
[11]See Appendix C for definitions.
[12]Measured as 100% calcium fluoride.
[13]Includes Brazil and Morocco.

GALLIUM

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

Domestic Production and Use: No domestic primary gallium recovery was reported in 1999. 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 $11.2 million. Gallium arsenide (GaAs) components represented about 95% of domestic gallium consumption. About 44% of the gallium consumed was used in optoelectronic devices, which include light-emitting diodes (LED's), laser diodes, photodetectors, and solar cells. Integrated circuits represented 55% 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 consumer goods, medical equipment, industrial components, telecommunications, and aerospace applications. Integrated circuits were used in defense applications and high-performance computers.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999**[e]
Imports for consumption	18,100	30,000	19,100	26,300	26,000
Exports	NA	NA	NA	NA	NA
Consumption: Reported	16,900	21,900	23,600	26,900	27,000
Apparent	NA	NA	NA	NA	NA
Price, yearend, dollars per kilogram, 99.99999%-pure	425	425	595	595	640
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, refinery, number[e]	20	20	20	20	20
Net import reliance[1] as a percent of apparent consumption	NA	NA	NA	NA	NA

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

Import Sources (1995-98): France, 51%; Russia, 20%; Canada, 8%; Kazakhstan, 7%; and other, 14%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
Gallium metal	8112.91.1000	3.0% ad val.
Gallium arsenide wafers, undoped	2851.00.0010	2.8% ad val.
Gallium arsenide wafers, doped	3818.00.0010	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

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GALLIUM

Events, Trends, and Issues: The French gallium producer sold its operations in France and Germany to a U.S.-based specialty chemicals manufacturer for an undisclosed sum. These include a 20,000-kilogram-per-year refinery in Salindres, France, and a 20,000-kilogram-per-year production plant in Stade, Germany. Not included in the sale was the gallium recovery facility in Pinjarra, Western Australia, which has been mothballed since 1997. The U.S. firm announced that it would increase gallium production capacity at the Stade plant within the next 1 to 3 years, depending on market growth. A new gallium refinery in Japan began operation in July. The additional facility was expected to double the company's refinery capacity to 100,000 kilograms per year; the new facility will refine the company's impure gallium production, scrap GaAs and gallium phosphide, and imported crude gallium.

Several U.S. GaAs manufacturers either completed plant expansions during the year or announced plans to significantly increase their production capacities within the next 2 years. These expansions primarily are driven by increased demand for wireless communication products, particularly cellular telephone components. Many of the new facilities have been designed to handle 6-inch wafers, the next generation in size, compared to the current industry standard of 4-inch wafers.

Commercial shipments of blue and blue-violet gallium nitride (GaN)-based laser diodes and blue LED's began early in the year from a Japanese firm. Large-scale applications for the blue laser diodes include digital videodisk players, laser printers, and lithography systems, while the blue LED's can be used in full-color displays and serve as a springboard for the development of pure white LED's. In Europe, Japan, and the United States, electronics firms are forming joint ventures to develop and manufacture white LED's for lighting applications. The newly developed GaN technology can be used for making the white LED's.

World Production, Reserves, and Reserve Base: Data on world production of primary gallium were unavailable because data on the output of the few producers were considered to be proprietary. However, in 1999, world primary production was estimated to be about 75,000 kilograms, with Australia, Kazakhstan, and Russia as the largest producers. Countries with smaller output were China, Germany, Hungary, Japan, Slovakia, and Ukraine. Refined gallium production was estimated to be about 65,000 kilograms. France was the largest producer of refined gallium, using as feed material crude gallium produced in Australia. Japan and the United States were the other large gallium-refining countries. Gallium was recycled from new scrap in Germany, Japan, the United Kingdom, and the United States.

Gallium occurs in very small concentrations in many rocks and ores of other metals. Most gallium was produced as a byproduct of treating bauxite, and the remainder was produced from zinc-processing residues. Significant reserves of gallium also occur in oxide minerals derived from surficial weathering of zinc-lead-copper ores. Only part of the gallium present in bauxite and zinc ores was recoverable, and the factors controlling the recovery were proprietary. Therefore, a meaningful estimate of current reserves could not be made. The world bauxite reserve base is so large that much of it will not be mined for many decades; hence, most of the gallium in the bauxite reserve base can be considered to have only long-term availability.

World Resources: Assuming that the average content of gallium in bauxite is 50 parts per million (ppm), U.S. bauxite resources, which are mainly subeconomic deposits, contain approximately 15 million kilograms of gallium. About 2 million kilograms of this metal 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 LED's. Indium phosphide components can be substituted for GaAs-based infrared laser diodes, and GaAs competes with helium-neon lasers in visible laser diode applications. Silicon is the principal competitor for GaAs in solar cell applications. Because of their enhanced properties, GaAs-based integrated circuits are used in place of silicon in many defense-related applications, and there are no effective substitutes for GaAs in these applications.

[e]Estimated. NA Not available.

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

GARNET, INDUSTRIAL[1]

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

Domestic Production and Use: Garnet for industrial use was mined in 1999 by five firms, three in New York, one in Montana, and one in Idaho. Output of crude garnet was valued at more than $6 million, while refined material sold or used was valued at $11 million. Major end uses for garnet were abrasive blasting media, 45%; water filtration, 15%; waterjet cutting, 10%; and abrasive powders, 10%.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production (crude)[2]	46,300	60,900	64,900	74,000	64,400
Sold by producers[2]	39,900	46,200	53,600	51,900	45,200
Imports for consumption[e]	7,000	9,000	10,000	20,000	15,000
Exports[e]	8,000	12,000	12,000	12,000	10,000
Consumption, apparent	38,000	34,500	46,300	39,900	43,400
Price, range of value, dollars per ton[3]	50-1,500	50-2,000	50-2,000	50-2,000	50-2,000
Stocks, producer[e 4]	5,900	14,600	19,900	39,900	46,700
Employment, mine and mill, number	180	210	250	230	230
Net import reliance[5] as a percent of apparent consumption	E	E	E	E	E

Recycling: Relatively small amounts of garnet reportedly are recycled.

Import Sources (1995-98[e]): Australia, 75%; India, 20%; and China, 5%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
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: 15% (Domestic and foreign).

Government Stockpile: None.

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GARNET, INDUSTRIAL

Events, Trends, and Issues: During 1999, stock accumulations of garnet produced as byproduct increased while the garnet market continued to decline. This caused the producer stocks to be high. Two of the three garnet mines in the western half of the United States (both in Montana) were still being offered for sale in 1999. Although U.S. garnet sales declined during 1999, some forecasts indicate that domestic and foreign markets for industrial garnet may grow in the next several years. Markets for blasting media and water jet cutting are expected to lead the demand. China may join Australia and India as an important garnet exporter early in the next decade.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1998	1999[e]		
United States	74,000	64,400	5,000,000	25,000,000
Australia	60,000	60,000	1,000,000	7,000,000
China	30,000	30,000	Moderate to Large	Moderate to Large
India	50,000	50,000	500,000	20,000,000
Other countries	10,000	10,000	6,500,000	20,000,000
World total (may be rounded)	224,000	214,000	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, and serpentinites, and in high-temperature intrusive contacts 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 are concentrated in coarsely crystalline gneiss near North Creek, NY. Significant domestic resources of garnet also 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, the Czech Republic, Pakistan, 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]Data revised to correspond with new information published in the USGS Mineral Industry Surveys annual review of industrial garnet for 1998.
[3]Includes both crude and refined garnet; most crude concentrate is $50 to $100 per ton, and most refined material is $150 to $400 per ton.
[4]The large increase in producer stocks between 1997 and 1998 is due to the revision of stock estimating methods so that stock estimates are more accurate. Estimates were only revised back to 1998.
[5]Defined as imports - exports + adjustments for industry stock changes.
[6]See Appendix C for definitions.

GEMSTONES[1]

(Data in million dollars, unless otherwise noted)

Domestic Production and Use: Total U.S. gemstone output has decreased in recent years owing to a decline in foreign demand for freshwater shell, a major component of the domestic industry. Domestic gemstone production also included amber, agates, beryl, coral, garnet, jade, jasper, pearl, opal, quartz, sapphire, topaz, turquoise, and many other gem materials. Output of natural gemstones was primarily from Tennessee, Arizona, North Carolina, Arkansas, California, and Utah, in decreasing order. Reported output of synthetic gemstones was from five firms in North Carolina, New York, California, and Arizona, in decreasing order. There was notable production of freshwater pearl in Tennessee, turquoise in Arizona, and beryl in North Carolina and Utah. Major uses were jewelry, carvings, and gem and mineral collections.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production:[2] Natural[3]	48.7	43.6	25.0	14.3	13.5
Synthetic	26.0	24.0	21.6	24.2	49.1
Imports for consumption	6,540	7,240	8,380	9,250	10,200
Exports, including reexports[4]	2,520	2,660	2,760	2,980	3,380
Consumption, apparent[5]	4,100	4,650	5,670	6,310	6,880
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 percent of apparent consumption	98	98	99	99	99

Recycling: Insignificant.

Import Sources (1995-98 by value): Israel, 36%; Belgium, 21%; India, 21%; and other, 22%. Diamond imports accounted for 92% of the total value of gem imports.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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, other	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: 15% (Domestic and foreign).

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

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GEMSTONES

Events, Trends, and Issues: Canada's first commercial diamond mine opened during the fourth quarter of 1998 with expectations that it would make Canada a major diamond producer. The new mine is expected to account for about 6% of world diamond output value when it reaches full production levels. Additional Canadian mines scheduled to open in the next few years may double Canada's share of world production.

In 1999, the U.S. gemstone market exceeded an estimated $9 billion, accounting for at least one-third of world demand. The United States is expected to dominate global gemstone consumption well into the next century. Synthetic gemstones will gain a larger share of domestic jewelry sales. China may emerge as a major new gem market in the next decade.

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

	Mine production		Reserves and reserve base[8]
	1998	1999[e]	
United States	([9])	([9])	World reserves and reserve base of gem diamond are substantial. No reserves or reserve base data are available for other gemstones.
Angola	2,400	2,400	
Australia	18,400	18,500	
Botswana	13,500	13,500	
Brazil	300	300	
Canada	278	300	
Central African Republic	330	350	
China	230	230	
Congo (Kinshasa)[10]	2,000	2,500	
Ghana	640	650	
Namibia	1,600	1,600	
Russia	10,500	10,500	
South Africa	4,100	4,500	
Venezuela	100	120	
Other countries	622	750	
World total	55,000	56,200	

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, Canada, Russia, and Western Australia. Estimation of a reserve base is difficult to determine because of the changing economic evaluation of near-gem materials and recent discoveries in Australia, Canada, and Russia.

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

[e]Estimated.
[1]Excludes industrial diamond and garnet. See Diamond (Industrial) and Garnet (Industrial).
[2]Estimated minimum production.
[3]Includes production of freshwater shell.
[4]Reexports account for more than 90% of the totals.
[5]If reexports are not considered, apparent consumption would be significantly greater.
[6]Defined as imports - exports and reexports + adjustments for Government and industry stock changes.
[7]Data in thousands of carats of gem diamond.
[8]See Appendix C for definitions.
[9]Less than ½ unit.
[10]Formerly Zaire.

GERMANIUM

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

Domestic Production and Use: The value of domestic refinery production of germanium, based on the 1999 producer price, was about $28 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 1999. The domestic industry consisted of three germanium refineries, one each in New York, Oklahoma, and Pennsylvania, and two base metal mining operations, one in Tennessee and the other in Alaska. Both of the mining companies supplied domestic and export markets with germanium-bearing materials generated from the mining of zinc ores. The major end uses for germanium, worldwide, were fiber-optic systems, 50%; polymerization catalysts, 20%; infrared optics, 15%; electronics/solar electrical applications, 10%; and other uses (phosphors, metallurgy, and chemotherapy), 5%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production, refinery[e]	10,000	18,000	20,000	22,000	20,000
Total imports[1]	16,200	27,500	23,700	14,610	15,000
Exports	NA	NA	NA	NA	NA
Consumption[e]	27,000	25,000	28,000	28,000	28,000
Price, producer, yearend, dollars per kilogram:					
Zone refined	1,375	2,000	1,475	1,700	1,400
Dioxide, electronic grade	880	1,300	950	1,100	900
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant,[2] number[e]	110	120	115	100	85
Net import reliance[3] as a percent of apparent consumption	NA	NA	NA	NA	NA

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

Import Sources (1995-98):[4] Russia, 34%; Belgium, 25%; China, 15%; United Kingdom, 14%; and other, 12%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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: 15% (Domestic and foreign).

Government Stockpile:

Stockpile Status—9-30-99[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Germanium	50,567	865	50,567	8,000	4,854

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GERMANIUM

Events, Trends, and Issues: World refinery production of germanium increased in 1999, with slightly larger amounts brought to market by Canada and China. Output from Russia and Ukraine remained low. The recycling of scrap continued to be a significant factor. The only releases from national government stockpiles were from the United States. Decreases in world demand for polyethylene terephthalate (PET) and satellite applications resulted in a world oversupply despite expected increases in demand from fiber optics producers. One-half of total world demand is from the fiber optics sector.

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

World Refinery Production, Reserves, and Reserve Base:

	Refinery production[e]		Reserves[6]	Reserve base[6]
	1998	1999		
United States	22,000	20,000	450,000	500,000
Other countries	34,000	38,000	NA	NA
World total	56,000	58,000	NA	NA

World Resources: The available resources of germanium are associated with certain zinc and lead-zinc-copper sulfide ores. Worldwide germanium resources would increase substantially if germanium were to be recovered from ash and flue dust generated in the burning of certain coals for power generation.

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

[e]Estimated. NA Not available.

[1]Gross weight of wrought and unwrought germanium, and waste and scrap. Does not include imports of germanium dioxide and other germanium compounds for which data are not available.

[2]Employment related to primary germanium refining is indirectly related to zinc refining.

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

[4]Total imports from republics of the Former Soviet Union (Estonia, Lithuania, Russia, and Ukraine) account for 38.5% of the 1995-98 imports.

[5]See Appendix B for definitions.

[6]See Appendix C for definitions.

GOLD

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

Domestic Production and Use: Gold was produced at about 70 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 90% of the gold produced in the United States. The value of 1999 mine production was about $3.1 billion. Commercial-grade refined gold came from about two dozen producers. A few dozen companies, out of several thousand companies and artisans, dominated the fabrication of gold into commercial products. U.S. jewelry manufacturing was heavily concentrated in the New York, NY, and Providence, RI, areas with lesser concentrations in California, Florida, and Texas. Estimated uses were: jewelry and arts, 79%; electronics, 4%; dental, 2%; and other, 15%.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production: Mine	317	326	362	366	340
Refinery: Primary	([2])	([2])	270	277	260
Secondary (new and old scrap)	([2])	([2])	100	163	150
Imports[3]	126	159	209	278	210
Exports[3]	347	471	477	522	250
Consumption, reported	([2])	([2])	137	219	240
Stocks, yearend, Treasury[4]	8,140	8,140	8,140	8,130	8,140
Price, dollars per ounce[5]	386	389	332	295	285
Employment, mine and mill, number[e]	14,700	16,900	16,300	13,400	12,000
Net import reliance[6] as a percent of apparent consumption	E	E	E	E	E

Recycling: 150 metric tons of new and old scrap, equal to 63% of reported consumption, was recycled in 1999.

Import Sources (1995-98):[3] Canada, 46%; Brazil, 12%; Australia, 8%; Mexico, 7%; and other, 27%.

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

Depletion Allowance: 15% (Domestic and foreign).

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

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GOLD

Events, Trends, and Issues: Domestic gold mine production in 1999 was estimated at slightly below the record level of 1998, but high enough to maintain the United States' position as the world's second largest gold-producing nation, after South Africa. Domestic output continued to be dominated by Nevada and California, where combined production accounted for nearly 80% of the U.S. total. Between July 1998 and June 1999, 12 gold mines were closed, 2 new gold mines were opened, and 1 gold mine was reopened in the United States. During this 12-month period, the average output per mine had increased, companies merged, and the size of gold mining operations increased. Most of the larger companies were successfully replacing annual production with new reserves, but smaller companies were finding this more difficult. Estimates by an industry association indicate that worldwide gold exploration expenditures decreased for the second consecutive year, with 1997 marking the peak of exploration spending for the 1990's. The expenditures of U.S. gold producers continued to fall in 1999 owing to the declining gold price.

During the first 9 months of the year, the Engelhard Corporation's daily price of gold ranged from a low of about $254 per troy ounce, in July, to a high of over $308, in September. For most of 1999, this price range was below $275, the low price reported for all of 1998. The traditional role of gold as a store of value was not able to lift the price of gold out of its 20-year-low trading range. The market continued to be concerned about the future role of gold in the reserves of the European Central Bank, which began operation on January 1, 1999. Late in September, however, a surprise announcement by 15 European central banks to limit combined sales of gold from their official reserves to 400 metric tons per year for 5 years quickly removed the above uncertainty that was depressing gold prices.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7]	Reserve base[7]
	1998	1999[e]		
United States	366	340	5,600	6,000
Australia	312	300	4,000	4,700
Brazil	55	50	800	1,200
Canada	166	155	1,500	3,500
China[e]	178	150	NA	NA
Russia	104	105	3,000	3,500
South Africa	464	450	19,000	40,000
Uzbekistan	80	80	5,300	6,300
Other countries	735	700	9,300	11,800
World total (may be rounded)	2,460	2,330	[8]49,000	[8]77,000

Of an estimated 128,000 tons of all gold ever mined, about 15% is thought to have been lost, used in dissipative industrial uses, or otherwise unrecoverable or unaccounted for. Of the remaining 108,000 tons, an estimated 34,000 tons is official stocks held by central banks and about 74,000 tons is privately held as coin, bullion, and jewelry.

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

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

[e]Estimated. E Net exporter. NA Not available.
[1]Metric ton (1,000 kilograms) = 32,150.7 troy ounces.
[2]Survey response not sufficient for publication.
[3]Refined bullion, doré, ores, concentrates, and precipitates.
Excludes:

a. Waste and scrap.
b. Official monetary gold.
c. Gold in fabricated items.
d. Gold in coins. In 1991, the last year for which estimates are available, net imports amounted to 3.5 metric tons.
e. Net bullion flow (in metric tons) to market from foreign stocks at the New York Federal Reserve Bank: 243.9 (1995), 373.0 (1996),142.8 (1997), 309.9 (1998), and 186.5 (1999, estimated).

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

GRAPHITE (NATURAL)

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Natural graphite was not produced domestically in 1999. Natural graphite was consumed by approximately 200 firms primarily in the Northeastern and Great Lakes regions. The major uses of natural graphite did not significantly differ from those of 1998. Refractory applications, once again, led the way in use categories with 39%; brake linings was second with 14%; lubricants, 6%; dressings and molds in foundry operations, 5%; and other uses making up the remaining 36%.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production, mine	—	—	—	—	—
Imports for consumption	61	53	58	62	60
Exports	37	26	40	28	32
Consumption, apparent	24	27	18	34	28
Price, imports (average dollars per ton at foreign ports):					
Flake	658	699	622	514	550
Lump and chip (Sri Lankan)	610	675	1,010	1,200	1,100
Amorphous (Mexican)	143	134	153	192	220
Stocks, yearend	NA	NA	NA	NA	NA
Net import reliance[1] as a percent of apparent consumption	100	100	100	100	100

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

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

Import Sources (1995-98): Mexico, 28%; Canada, 27%; China, 27%; Madagascar, 8%; and other, 10%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Crystalline flake (not including flake dust)	2504.10.1000	Free.
Other	2504.90.0000	Free.

Depletion Allowance: 23% (Domestic lump and amorphous), 15% (Domestic flake), and 15% (Foreign).

Government Stockpile:

Stockpile Status—9-30-99[2]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Sri Lanka, amorphous lump	5	—	5	3	([3])
Madagascar, crystalline flake	7	4	7	—	3
Other than Sri Lanka and Madagascar crystalline	—	([3])	—	—	([3])

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GRAPHITE (NATURAL)

Events, Trends, and Issues: Graphite was near to supply-demand balance in 1999. Demand was met largely by imports of flake from Canada, China, and Madagascar; lump and chip from Sri Lanka; and amorphous graphite from China and Mexico. Graphite electrode consumption in steelmaking has been decreasing since the late 1980's because of increased efficiency by the iron and steel producers. Use of natural graphite in lubrication applications is also decreasing because of changes in requirements for lubricant compositions and in processing technologies.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	1998	1999[e]		
United States	—	—	—	1,000
Brazil	40	44	420	1,000
China	200	200	5,100	310,000
India	120	125	500	620
Madagascar	15	13	950	960
Mexico	40	48	3,100	3,100
Other countries	190	148	5,200	44,400
World total (may be rounded)	605	578	15,000	360,000

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

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

[e]Estimated. NA Not available.
[1]Defined as imports - exports + adjustments for Government and industry stock changes. Data on changes in stocks were not available and were assumed to be zero in the calculations.
[2]See Appendix B for definitions.
[3]Less than ½ unit.
[4]See Appendix C for definitions.

GYPSUM

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: In 1999, crude gypsum output exceeded 19.4 million tons valued at $134 million. The top producing States were Oklahoma, Iowa, Texas, Michigan, California, Nevada, and Indiana, which together accounted for 72% of total output. Overall, 32 companies produced gypsum at 61 mines in 19 States, and 11 companies calcined gypsum at 65 plants in 27 States. Most of domestic consumption, which totaled about 31.8 million tons, was accounted for by manufacturers of wallboard and plaster products. More than 4 million tons for cement production, almost 2 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 remaining uses. Capacity at operating wallboard plants in the United States was 30 billion square feet per year, while sales were more than 29 billion square feet, representing capacity utilization greater than 98%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production: Crude	16,600	17,500	18,600	19,000	19,400
Byproduct[1]	2,300	2,500	2,700	3,000	3,300
Calcined[2]	16,700	17,000	17,200	19,400	20,600
Wallboard products (million square feet)	24,000	23,700	24,400	26,900	29,100
Imports, crude, including anhydrite	8,160	8,050	8,420	8,680	9,200
Exports, crude, not ground or calcined	79	136	174	166	108
Consumption, apparent[3]	27,000	27,900	29,500	30,500	31,800
Price: Average crude, f.o.b. mine, dollars per ton	7.29	7.10	7.11	7.20	6.92
Average calcined, f.o.b. plant, dollars per ton	17.37	16.88	17.58	18.00	17.02
Stocks, producer, crude, yearend	1,100	1,200	1,200	1,500	1,500
Employment, mine and calcining plant, number[e]	6,500	6,300	6,000	6,000	6,000
Net import reliance[4] as a percent of apparent consumption	30	29	28	28	29

Recycling: A relatively small amount of gypsum wallboard is recycled.

Import Sources (1995-98): Canada, 68%; Mexico, 23%; Spain, 8%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Gypsum; anhydrite	2520.10.0000	Free.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: None.

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GYPSUM

Events, Trends, and Issues: Construction of new homes, commercial buildings, and office space continued to stimulate wallboard demand and boosted domestic consumption of gypsum. Some forecasts indicate that gypsum demand in North American markets will remain high for the next few years. This demand, however, will depend principally on the strength of the construction industry, particularly in the United States where more than 90% of the gypsum consumed is used for wallboard products, building plasters, and the manufacture of portland cement. Federal funding that was authorized in 1998 for road building and repair through 2003 will continue to spur gypsum consumption in the cement industry. Several large wallboard plants under construction and designed to use only byproduct gypsum will accelerate substitution significantly as they become operational within a few years.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	1998	1999[e]		
United States	19,000	19,400	700,000	Large
Australia	2,100	2,200		
Canada	8,100	8,200	450,000	Large
China	9,000	9,200		
Egypt	2,000	2,000		
France	4,500	4,500		
India	2,400	2,500		
Iran	9,000	9,000		
Italy	2,000	2,000	Reserves and reserve base are large in major producing countries, but data are not available.	
Japan	5,300	5,300		
Mexico	7,045	7,100		
Poland	1,000	1,000		
Spain	7,400	7,400		
Thailand	9,000	9,000		
United Kingdom	2,000	2,000		
Other countries	17,200	17,500		
World total (rounded)	107,000	108,000	Large	Large

World Resources: Domestic resources are adequate, but are unevenly distributed. There are no significant gypsum deposits on the eastern seaboard of the United States, where large imports from Canada augment domestic supplies for wallboard manufacturing in large metropolitan markets. 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. There is no practical substitute for gypsum in portland cement. Byproduct gypsum generated by various industrial processes is becoming more important as a substitute for mined gypsum in wallboard manufacturing, cement production, and agricultural applications.

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

HELIUM

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

Domestic Production and Use: During 1999, the estimated value of Grade-A helium (99.995% or better) extracted by private industry was about $215 million. There are 13 private industry plants (5 in Kansas, 4 in Oklahoma, and 4 in Texas) that extract helium from natural gas and produce only a crude helium product that varies from 50% to 80% helium. There are six private industry plants (two in Colorado, and one each in Oklahoma, Texas, Utah, and Wyoming) that extract helium from natural gas and produce an intermediate process stream of crude helium (about 70% helium) and continue processing the stream to produce a Grade-A helium product. There are five private industry plants (four in Kansas and one in Texas) that accept a crude helium product from other producers and the Bureau of Land Management (BLM) pipeline and purify this to a Grade-A helium product. The BLM Exell Helium Plant extracted helium from natural gas, combined this product with crude helium from the BLM pipeline, and purified it to Grade-A helium. This plant ceased operation in March 1998. The estimated 1999 domestic consumption of 78.7 million cubic meters (2.84 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:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Helium extracted from natural gas[2]	101	103	116	112	118
Withdrawn from storage[3]	(5.2)	(8.3)	(9.3)	(0.7)	(10)
Grade-A helium sales	96	95	107	112	108
Imports for consumption	—	—	—	—	—
Exports[4]	27.7	22.8	29.5	27.8	29.3
Consumption, apparent[4]	68.1	67.1	77.4	83.5	78.7
Employment, plant, number[e]	635	631	605	531	500
Net import reliance[5] as a percent of apparent consumption	E	E	E	E	E

Price: The government price for helium contained in crude helium was $1.767 per cubic meter ($49.00 per thousand cubic feet) in FY 1999. For FY 2000 the price will be $1.785 per cubic meter ($49.50 per thousand cubic feet). The price for the government-owned helium is mandated by Public Law 104-273. Private industry's estimated price for Grade-A gaseous helium was about $1.514 per cubic meter ($42 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 (1995-98): None.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
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: The Federal Helium Reserve is an operation run pursuant to Public Law 104-273. Since the BLM can no longer supply Grade-A helium to federal agencies, private suppliers that sell Grade-A helium to the federal agencies are now required to purchase a like amount of crude helium (in-kind) from the BLM. During FY 1999, BLM's Amarillo Field Office, Helium Operations (AMFO) accepted more than 24.9 million cubic meters (898 million cubic feet) of private helium for storage and redelivered nearly 25.5 million cubic meters (919 million cubic feet). Also in 1999, privately owned companies purchased nearly 6.04 million cubic meters (218 million cubic feet) of in-kind crude helium for a total net increase in privately owned storage of more than 5.46 million cubic meters (197 million cubic feet). As of September 30, 1999, 136 million cubic meters (4.9 billion cubic feet) of helium was owned by private firms, which is the largest amount to date.

Stockpile Status 9-30-99[6]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 1999**	**Disposals FY 1999**
Helium	832.4	16.6	832.4	—	6.04

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HELIUM

Events, Trends, and Issues: During 1999, merger and acquisition activity involving companies such as BOC Gases, Inc., Air Products and Chemicals Inc., and Air Liquide appear ready to significantly reshape the United States' private helium industry. The new AMOCO plant began full crude helium production replacing the decommissioned Trident plant in Kansas. There were also capacity expansions made at some of the purification plants along the BLM pipeline. The AMFO continued crude helium sales, operation of the pipeline and storage field, and collection of helium royalties and fees. There was also a proposal to expand the helium handling capacity of the Algerian plant which would have a significant impact on the private helium industry in the United States.

It is estimated that in 1999 domestic production of helium will be near 118 million cubic meters (4.25 billion cubic feet) and that U.S. consumption will be more than 78.7 million cubic meters (2.84 billion cubic feet). Exports from the United States are expected to increase slightly more than 1998 levels. With the apparent mitigation of the economic uncertainties of the previous year in Asia, normal growth patterns are expected to return.

World Production, Reserves, and Reserve Base:

	Production		Reserves[8]	Reserve base[8]
	1998	1999[e]		
United States	112	118	6,000	[9]11,100
Algeria	16	16	NA	2,100
Canada	NA	NA	NA	2,100
China	NA	NA	NA	1,100
Poland	1.4	1.4	40	280
Former Soviet Union[10]	4.2	4.2	1,700	6,700
Other countries	NA	NA	NA	2,800
World total (rounded)	134	140	NA	26,200

World Resources: The identified helium resources of the United States were estimated to be about 11.1 billion cubic meters (400 billion cubic feet) as of January 1, 1999. This includes 0.971 billion cubic meter (35 billion cubic feet) of helium stored in the Cliffside Field, 6.0 billion cubic meters (215 billion cubic feet) of helium in helium-rich natural gas (0.30% helium or more), and 4.1 billion cubic meters (148 billion cubic feet) in helium-lean natural gas (less than 0.30% helium). The Hugoton (Kansas, Texas, and Oklahoma), Panhandle West, Panoma, and Riley Ridge Fields are currently depleting gasfields and contain an estimated 4.4 billion cubic meters (159 billion cubic feet) of helium. Future supplies will probably come from known helium-rich natural gas with little fuel value and from helium-lean resources.

Helium resources of the world exclusive of the United States were estimated to be about 15.1 billion cubic meters (544 billion cubic feet). The locations and volumes of the principal deposits, in billion cubic meters, are the Former Soviet Union, 6.7; Algeria, 2.1; Canada, 2.1; China, 1.1; Poland, 0.3. As of January 1, 1999, AMFO had analyzed nearly 21,000 gas samples from 26 countries and the United States in a program to identify world helium resources.

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

[e]Estimated. E Net exporter. NA Not available.
[1]Measured at 101.325 kilopascals absolute (14.696 psia) and 15° C. 27.737 cubic meters of helium at 15° C, 101.325 kPa (absolute) = 1 Mcf of helium at 70° F and 14.7 psia.
[2]Helium content of both Grade-A and crude helium (consisting of approximately 70% helium and 30% nitrogen).
[3]Extracted from natural gas in prior years (injected in parentheses).
[4]Grade-A helium.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]See Appendix B for definitions.
[7]The author is a petroleum engineer with the Bureau of Land Management, Amarillo Field Office, Helium Operations, Amarillo, TX.
[8]See Appendix C for definitions.
[9]All domestic measured and indicated helium resources in the United States.
[10]As constituted before December 1991.

INDIUM

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: Indium was not recovered from ores in the United States in 1999. Domestically produced standard grade indium was derived from the upgrading of lower grade imported indium metal. Two companies, one each in New York and Rhode Island, were the major producers of indium metal and indium products in 1999. Several firms produced high-purity indium shapes, alloys, and compounds. Thin-film coatings, which are used in applications such as liquid crystal displays (LCD's) and electroluminescent lamps, continued to be the largest end use. Indium semiconductor compounds were used in infrared detectors, high-speed transistors, and high-efficiency photovoltaic devices. The estimated distribution of uses in 1999 was about the same as in 1998: coatings, 50%; solders and alloys, 33%; electrical components and semiconductors, 12%; and research and other, 5%. The estimated value of primary indium metal consumed in 1999, based on the annual average price, was $16 million.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production, refinery	—	—	—	—	—
Imports for consumption	85.2	33.2	85.5	75	75
Exports	NA	NA	NA	NA	NA
Consumption[e]	43	45	50	50	52
Price, annual average, dollars per kilogram (99.97% indium)	375	370	309	296	303
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, number	NA	NA	NA	NA	NA
Net import reliance[1] as a percent of apparent consumption	NA	NA	NA	NA	NA

Recycling: Small quantities of old scrap were recycled. Recycling of new scrap, the scrap from fabrication of indium products, is becoming more significant. Formerly it only occurred when the price was relatively very high and/or increasing rapidly.

Import Sources (1995-98): Canada, 44%; China, 16%; Russia, 15%; France, 8%; and other, 17%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
Unwrought, waste and scrap	8112.91.3000	Free.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile:

Stockpile Status—9-30-99[2]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 1999**	**Disposals FY 1999**
Indium	—	—	—	0.44	0.44

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INDIUM

Events, Trends, and Issues: Estimated domestic indium consumption increased slightly to about 52 tons in 1999. The indium market appeared to be approaching long-term price stability, with increases in demand met by adequate supply and greater efficiency in processing. The last indium held by the Government stockpile was sold in December 1998. In 1995, prices rose steadily over supply concerns and strong demand. In 1996, significant quantities of indium were recycled for the first time. This brought about a decrease in prices and significantly lower U.S. imports in 1996. In the following year, 1997, domestic prices fluctuated moderately, and in 1998 and 1999 they were very steady. The production of LCD's was slightly lower in 1998 than it was in 1997, but it increased in 1999. The long range outlook for the indium market remains promising.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production[e]		Reserves[3]	Reserve base[3]
	1998	1999		
United States	—	—	300	600
Belgium	15	15	([4])	([4])
Canada	40	40	700	2,000
China	50	55	400	1,000
France	50	50	([4])	([4])
Italy	12	12	([4])	([4])
Japan	30	35	100	150
Peru	4	4	100	150
Russia	25	25	200	300
Other countries	4	4	800	1,500
World total	230	240	2,600	5,700

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

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

[e]Estimated. NA Not available.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix B for definitions.
[3]Estimate based on the indium content of zinc ores. See Appendix C for definitions.
[4]Reserves for European countries are included in "Other countries."

IODINE

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

Domestic Production and Use: Iodine produced in 1999 from three companies operating in Oklahoma accounted for 100% of the elemental iodine value estimated at $25 million. The operation at Woodward, OK, continued production of iodine from subterranean brines. A second company operated a miniplant in Kingfisher County, OK, using waste brine associated with oil and a plant in Woodard, OK. A third company continued production at Vici, OK, for domestic use and export to Germany. Of the consumers that participate in the annual survey, 23 plants reported consumption of iodine in 1998. Major consumers were located in the Eastern United States. Prices of crude iodine in drums, published for November, ranged between $19 and $21 per kilogram. Imports of iodine through July averaged $16.77 per kilogram.

Establishing an accurate end-use pattern for iodine was difficult because intermediate iodine compounds were marketed before reaching their final end uses. The downstream uses of iodine were in animal feed supplements, catalysts, inks and colorants, pharmaceuticals, photographic equipment, sanitary and industrial disinfectants, stabilizers, and other.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production	1,220	1,270	1,320	1,490	1,630
Imports for consumption, crude content	3,950	4,860	6,380	5,960	6,000
Exports	1,220	2,410	2,760	2,790	2,800
Shipments from Government stockpile excesses	133	—	204	291	221
Consumption:					
Apparent	3,540	3,700	5,140	4,950	5,050
Reported	3,680	3,920	4,500	4,100	NA
Price, average c.i.f. value, dollars per kilogram, crude	9.88	12.90	14.66	16.45	16.77
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, number	35	40	40	40	40
Net import reliance[1] as a percent of apparent consumption	90	66	65	70	68

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

Import Sources (1995-98): Chile, 60%; Japan, 31%; Russia, 9%; and other, 1%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
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: 5% on brine wells (Domestic and foreign); 15% on solid minerals (Domestic and foreign).

Government Stockpile: On March 3, the Defense National Stockpile Center (DNSC) announced approximately 40,800 kilograms (90,000 pounds) of crude iodine was awarded under Solicitation of Offers DLA-Iodine-003 to one company for an approximate value of $700,000 ($17.15 per kilogram). On June 10, DNSC awarded approximately 34,900 kilograms (77,000 pounds) of crude iodine to two companies for an approximate value of $540,000 or $15.46 per kilogram. On September 1, DNSC announced the award of approximately 2,300 kilograms (5,000 pounds) of crude iodine to one company for $35,000 or $15.43 per kilogram. The Solicitation of Offers for Iodine, DLA-Iodine-003, was amended on July 23. The DNSC announced that, as of September 30, 1999, uncommitted inventory was 3,944,359 pounds. On October 29, the DNSC amended the solicitation to 454,000 kilograms (1,000,000 pounds) for fiscal year 2000 with quarterly sales of 113,000 kilograms (250,000 pounds).

Stockpile Status—9-30-99[2]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 1999**	**Disposals FY 1999**
Stockpile-grade	1,789	65	1,789	454	102

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IODINE

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

A Canadian company's iodine project in Chile that began production in January was sold to another Canadian company interested in potassium and sodium nitrate in July.

Iodine continued to be used in photographic films as digital photography closed the year at about 10% of the market. A U.S. company received Food and Drug Administration approval and began marketing an antibacterial toothpaste that used iodine.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	1998	1999[e]		
United States	1,490	1,630	550,000	550,000
Azerbaijan	300	300	170,000	NA
Chile	12,618	8,000	900,000	1,200,000
China	500	500	400,000	400,000
Indonesia	70	70	100,000	100,000
Japan	6,000	6,000	4,000,000	7,000,000
Russia	120	120	NA	NA
Turkmenistan	250	250	170,000	NA
World total (rounded)	21,300	16,900	[4]6,300,000	NA

World Resources: In addition to the fields listed in the reserve base, seawater contains 0.05 part per million iodine, or approximately 76 billion pounds. 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 in some catalytic, nutritional, pharmaceutical, animal feed, and photographic uses.

[e]Estimated. NA Not available.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix B for definitions.
[3]See Appendix C for definitions.
[4]Sum excludes countries for which data are not available.

IRON ORE[1]

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

Domestic Production and Use: The value of usable ore shipped from mines in Minnesota, Michigan, and six other States in 1999 was estimated to be $1.6 billion. Twelve iron ore production complexes with 12 mines, 10 concentration plants, and 10 pelletizing plants were in operation during the year. The mines included 11 open pits and 1 underground operation. Virtually all ore was concentrated before shipment. Nine mines operated by five companies accounted for 99.5% of production. Iron ore was consumed at 22 steel plants operating in 10 States, mostly in the Midwest.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production, usable	62.5	62.1	63.0	62.9	57.0
Shipments	61.1	62.2	62.8	63.2	56.0
Imports for consumption	17.6	18.4	18.6	17.0	13.0
Exports	5.3	6.3	6.3	6.0	6.5
Consumption: Reported (ore and total agglomerate)[3]	83.1	79.6	79.5	78.2	73.0
Apparent	72.7	72.0	73.0	71.3	68.4
Price,[4] U.S. dollars per metric ton	28.32	28.48	30.06	31.14	31.00
Stocks, mine, dock, and consuming plant, yearend, excluding byproduct ore	23.5	25.7	27.9	30.6	25.7
Employment, mine, concentrating and pelletizing plant, quarterly average, number	7,380	7,580	7,450	7,290	7,200
Net import reliance[5] as a percent of apparent consumption (iron in ore)	14	14	14	12	17

Recycling: Insignificant.

Import Sources (1995-98): Canada, 54%; Brazil, 29%; Venezuela, 11%; Australia, 4%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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:[6] 15% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Worldwide, nearly all iron ore is used in steelmaking; in the United States, steelmaking accounts for about 97% of iron ore consumption. Iron ore production and consumption are concentrated in a few countries. In 1999, iron ore was produced in at least 50 countries; the 15 largest of these countries produced nearly 96% of the world total and no other country had as much as a 1% share.

The majority of U.S. iron ore trade involves Canada. Since 1990, about 54% of U.S. imports originated in Canada and 99% of U.S. exports were shipped there. The reasons for this are ownership and proximity. Canadian steel mills have partial ownership in three of the nine iron ore operations that produce 99.5% of U.S. ore. One U.S. steelmaker and one merchant iron ore company own part of one of the three Canadian iron ore producers. The proximity of the producers and consumers, in particular in the Great Lakes region, means lower shipping costs.

From 1994 through 1998, the United States ranked sixth in iron ore production and third in pig iron production. Although world pig iron production levels have changed little over the past 20 years, production by area during that period changed considerably. Pig iron production fell in Asia, Europe, the Commonwealth of Independent States (CIS), and North America and rose in Asia. This trend is expected to continue.

Domestic iron ore production and consumption levels were lower than those of 1998 as the result of record imports of low-priced steel. Several producers temporarily closed their plants in response.

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IRON ORE

Steel consumption in the United States lagged behind that of 1998. Much of that consumption was satisfied by steel imports, which were cheaper for U.S. consumers partly because of the strength of the U.S. dollar against foreign currencies. In addition, foreign producers who could not sell steel products in their weak economies increased their exports to the United States. Flat-rolled minimills under construction or proposed were expected to add 10 million to 15 million tons of capacity to the flat-rolled market by the end of the decade. Also, tougher environmental regulations, especially those restricting coke oven gas emissions, were expected to force the closure of some older integrated facilities. However, those changes also provided potential benefits to those companies providing alternatives to scrap. Because of concern over the availability of low residue scrap, investment in alternative ironmaking technologies has become more attractive, and a number of companies have moved in that direction. One alternative to scrap is direct-reduced iron (DRI).

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

	Mine production		Crude ore		Iron content	
	1998	1999[e]	Reserves	Reserve base	Reserves	Reserve base
United States	63	57	10,000	23,000	6,400	14,000
Australia	153	150	18,000	40,000	11,000	25,000
Brazil	195	190	7,600	17,000	4,800	11,000
Canada	39	35	1,700	3,900	1,100	2,500
China	210	205	25,000	50,000	7,800	15,000
India	75	75	2,800	6,200	1,800	3,900
Kazakhstan	9	10	8,300	19,000	4,500	10,000
Mauritania	11	11	700	1,500	400	1,000
Russia	72	70	20,000	45,000	11,000	25,000
South Africa	33	33	1,000	2,300	650	1,500
Sweden	21	21	3,500	7,800	2,200	5,000
Ukraine	51	50	22,000	50,000	12,000	28,000
Other countries	88	85	17,000	38,000	10,000	23,000
World total (may be rounded)	1,020	992	140,000	300,000	74,000	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 Scrap.
[2]Agglomerates, concentrates, direct-shipping ore, and byproduct ore for consumption.
[3]Includes weight of lime, flue dust, and other additives used in producing sinter for blast furnaces.
[4]Calculated value of ore at mines.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]Analogous to depreciation, but applies to the ore reserve rather than the plant. Federal tax law allows this deduction from taxable corporate income, recognizing that an ore deposit is a depletable asset that must eventually be replaced by another deposit.
[7]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 $71 billion. The steel industry consisted of 105 companies that produced raw steel at 144 locations, with combined raw steel production capability of about 125 million tons. Indiana accounted for about 24% of total raw steel production, followed by Ohio, 16%, and Pennsylvania, 8%. Pig iron was produced by 13 companies operating integrated steel mills, with about 35 blast furnaces in continuous operation. The distribution of steel shipments was estimated as follows: warehouses and steel service centers, 20%; transportation (predominantly for automotive production), 15%; construction, 14%; cans and containers, 4%; and others, 47%. Ferrous foundries, numbering about 1,100, continued to be importers of pig iron into the United States, mainly from Brazil, Russia, and Japan.

Salient Statistics—United States:[1]	1995	1996	1997	1998	1999[e]
Pig iron production[2]	50.9	49.4	49.6	48.2	44.9
Steel production:	95.2	95.5	98.5	98.6	93.0
Basic oxygen furnaces, percent	59.6	57.4	56.2	54.9	54.5
Electric arc furnaces, percent	40.4	42.6	43.8	45.1	45.5
Continuously cast steel, percent	91.0	93.2	94.7	95.5	95.5
Shipments:					
Steel mill products	88.4	91.5	96.0	92.9	91.4
Steel castings[3]	1.1	1.2	1.2	[e]1.2	1.1
Iron castings[3]	9.8	9.8	9.8	[e]9.8	9.7
Imports of steel mill products	22.1	26.5	28.3	37.7	31.3
Exports of steel mill products	6.4	4.6	5.5	5.0	5.0
Apparent steel consumption[4]	102	108	114	118	109
Producer price index for steel mill products (1982=100)[5]	120.1	115.6	116.4	113.8	105.3
Steel mill product stocks at service centers yearend[6]	5.9	6.3	6.6	8.5	10.9
Total employment, average, number[7]					
Blast furnaces and steel mills	171,000	168,000	169,000	168,000	167,000
Iron and steel foundries	130,000	129,000	128,000	130,000	129,000
Net import reliance[8] as a percent of apparent consumption	21	20	20	27	22

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

Import Sources (1995-98): European Union, 34%; Canada, 22%; Japan, 16%; Russia, 14%; and other, 14%.

Tariff:[9] Item	Number	Normal Trade Relations[10] 12/31/99	Canada 12/31/99	Mexico 12/31/99
Pig iron	7201.10.0000	Free	Free	Free.
Carbon steel:				
Semifinished	7207.12.0050	2.1%	Free	1.6%.
Structural shapes	7216.33.0090	0.4%	Free	0.3%.
Bars, hot-rolled	7213.20.0000	1.0%	Free	0.7%.
Sheets, hot-rolled	7208.39.0030	2.4%	Free	1.9%.
Hot-rolled, pickled	7208.27.0060	2.6%	Free	2.0%.
Cold-rolled	7209.18.2550	1.6%	Free	1.2%.
Galvanized	7210.49.0090	3.2%	Free	2.6%.
Stainless steel:				
Semifinished	7218.91.0015	2.6%	Free	2.0%.
	7218.99.0015	2.6%	Free	2.0%.
Bars, cold-finished	7222.20.0075	5.3%	Free	4.2%.
Pipe and tube	7304.41.3045	3.8%	Free	Free.
Cold-rolled sheets	7219.33.0035	5%	Free	4.0%.

Depletion Allowance: Not applicable.

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IRON AND STEEL

Government Stockpile: None.

Events, Trends, and Issues: During the first 8 months of 1999, monthly pig iron and raw steel production fluctuated closely about 4.1 million tons and 8.7 million tons, respectively. Total production during this period was down for pig iron, 10%, and steel, 7%, from that of the prior year. Shipments of steel mill products during the first 7 months of 1999 were down 7% compared with that of 1998. Pig iron and steel production and steel shipments increased slightly during the first half of year.

The Asian economic problems that began with the financial crisis of 1997 continued to adversely affect the U.S. steel industry during 1999. Alleged dumping of subsidized, low-priced steel products onto the U.S. market by foreign producers may have caused average domestic steel industry prices for all products in 1999 to decline about 7% from average 1998 prices—the greatest aggregate decline in about 20 years. Current industry market prices are down from those of 1998 for hot rolled steel, 10%; cold rolled steel, 9%; and plate, 15%. The industry appealed to the Government for vigorous enforcement of trade laws in response to this dumping. Five leading U.S. steel producers filed suits against the U.S. Department of Commerce in the Court of International Trade to overturn suspension or settlement agreements.

In 1998, the constitutionality of the North American Free Trade Agreement (NAFTA) was challenged through a lawsuit filed by the United Steelworkers of America (USWA) and the Made in the USA Foundation. NAFTA was characterized by these plaintiffs as an international treaty not approved by two-thirds vote of the Senate and, therefore, illegal. In July 1999, an Alabama Federal District Court ruled that NAFTA is an international agreement dealing with commercial matters that did not have to be submitted to the U.S. Senate for ratification. The USWA planned to appeal the decision to the U.S. Court of Appeals for the 11th Circuit.

World Production:

	Pig iron		Raw steel	
	1998	1999[e]	1998	1999[e]
United States	48.2	44.9	98.6	93.0
Brazil	[e]25.0	23.7	[e]25.1	24.9
China	119	120	[e]114	120
European Union	96.3	92.6	155	153
Japan	75.0	71.1	93.5	90.6
Korea, Republic of	23.1	23.2	39.9	40.1
Russia	34.8	38.5	43.8	48.2
Ukraine	[e]20.8	22.5	24.1	26.1
Other countries	[e]98.2	84.5	187	158
World total (may be rounded)	[e]541	521	781	754

World Resources: Not applicable. See Iron Ore.

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

[e]Estimated.
[1]Production and shipments data source is the American Iron and Steel Institute (AISI); 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, Bureau of the Census.
[4]Defined as steel shipments + imports - exports + adjustments for industry stock changes + adjustment for imports of semifinished steel products.
[5]Bureau of Labor Statistics.
[6]Steel Service Center Institute.
[7]Bureau of Labor Statistics. Blast furnaces and steel mills: SIC 3312; Iron and steel foundries: SIC 3320.
[8]Defined as imports - exports + adjustments for Government and industry stock changes.
[9]All tariff percentages are ad valorem.
[10]No tariff for 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 1999 domestic purchases (receipts of ferrous scrap by all domestic consumers from brokers, dealers, and other outside sources) and exports was estimated at $4.9 billion, down about 26% from that of 1998. Manufacturers of pig iron, raw steel, and steel castings accounted for about 82% 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 18% to produce cast iron and steel products, such as motor blocks, pipe, and machinery parts. Relatively small quantities 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 1999 was an estimated 98.6 million tons, nearly the same as that produced in 1998. Net shipments of steel mill products were estimated at about 93 million tons compared with 92.9 million tons for 1998. The domestic ferrous castings industry shipped an estimated 11 million tons of all types of iron castings in 1999 and an estimated 1.2 million tons of steel castings, including investment castings.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production: Home scrap	20	20	20	20	21
Purchased scrap[2]	59	57	59	56	49
Imports for consumption[3]	2.3	2.9	3	3	6
Exports[3]	10.5	9.1	9	6	5
Consumption, reported	72	71	73	73	68
Price, average, dollars per metric ton delivered:					
No. 1 Heavy Melting composite price, Iron Age					
Average: Pittsburgh, Philadelphia, Chicago	131.29	126.0	126.02	104.07	87
Stocks, consumer, yearend	4.2	5.2	5.5	5.2	4.4
Employment, dealers, brokers, processors, number[4]	37,000	37,000	37,000	37,000	37,000
Net import reliance[5] as a percent of apparent consumption	E	E	E	E	3

Recycling: All iron and steel scrap is recycled material that is a vital raw material for the production of new steel and cast iron products. The steel and foundry industries in the United States have been structured to recycle scrap, and, as a result, are highly dependent upon scrap. The steel industry in North America has been recycling steel scrap for over 200 years. The automotive recycling industry alone recycles nearly 12 million vehicles annually through more than 200 car shredders, to supply more than 13 million tons of shredded steel scrap to the steel industry for recycling. In the United States alone, an estimated 51 million tons of steel apparently was recycled in steel mills and foundries in 1999. 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 32% home scrap (new recirculating scrap from current operations), 24% prompt scrap (produced in steel-product manufacturing plants), and 44% obsolete (old) scrap.

Import Sources (1995-98): Canada, 76%; United Kingdom, 8%; Venezuela, 5%; Mexico, 5%; and other, 6%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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: During 1999, domestic steel producers and ferrous scrap suppliers appeared to be recovering slowly from the effects of the Asian financial crisis of 1997. Prolonged scrap price depression in 1998 caused a sharp reduction in the generation, collection, and processing of scrap and eventually supply could not satisfy increasing demand. Prices in the ailing ferrous scrap market finally began to creep upwards at yearend 1998 and early 1999. The scrap supply improved in early 1999 causing scrap prices to decline significantly until midyear, when prices finally increased in response to the slowly rising trend in steel prices and the addition of scrap to mill inventory. Domestic steel production during the summer was stronger than expected, and demand for scrap was improving, especially from minimills. By the fourth quarter of 1999, the recovery in global steel markets continued to gain momentum, and scrap price rises could be seen in most steel product markets. Domestic steel consumption increased, which strengthened scrap demand and helped support scrap prices.

Ferrous scrap prices were lower, on average, during 1999 than in 1998. 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 $87 per metric ton in 1999. As reported by Iron Age Scrap Price Bulletin, the average price for nickel-bearing stainless steel scrap delivered to purchasers in Pittsburgh was about $609 per metric ton in 1999, which was only slightly higher than the 1998 average price of $592 per metric ton. Exports of ferrous scrap declined from about 5.5 million tons in 1998 to about 5.3 million tons in 1999, having an estimated value of about $802 million.

In the United States, the primary source of obsolete steel scrap is the automobile. The recycling rate for automobiles for the 5-year period 1994-98 was about 96%. The recycling rates for appliances and steel cans for the past 5 years overall were about 75% and 57%, respectively. Recycling rates for construction materials for 1998 were about 88% for plates and beams and 43% for rebar and other materials. The recycling rates for appliance, can, and construction steel are expected to increase not only in the United States, but also in emerging industrial countries. As environmental regulations increase, recycling becomes more profitable and convenient, and public interest in recycling continues to increase.

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

World Resources: Not applicable.

Substitutes: About 1.3 million tons of direct-reduced iron was used in the United States in 1999 as a substitute for iron and steel scrap.

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

IRON AND STEEL SLAG

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Ferrous slags are valuable coproducts of iron- and steelmaking. In 1999, about 19 million tons of domestic iron and steel slags, valued at about $150 million[1] (f.o.b), were consumed. Of this, iron or blast furnace slag accounted for about 65% of the tonnage sold and was worth about $128 million. Steel slags, produced from open hearth,[2] basic oxygen, and electric arc furnaces accounted for the remainder. There were 15 slag-processing companies, servicing either iron and steel or just steel facilities at about 100 locations: iron slags at about 30 sites in a dozen States and steel slags at about 90 sites in about 30 States. The North Central region (Illinois, Indiana, Michigan, Ohio) was the source of about 61% of total sales of slag of domestic origin. The major uses for iron slag were for road bases, 40%; asphaltic aggregate and cement and concrete applications, 33%; and fill, 15%. Steel slags were mainly used for asphaltic aggregate, 30%; fill, 28%; and road bases, 23%. About 90% of iron and steel slag shipments was by truck, generally to customers within approximately 80 kilometers of the plant. Rail and waterway transport each accounted for about 5% of shipments, but these included destinations farther afield.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production, marketed[3]	21,000	20,500	18,900	18,400	19,000
Imports for consumption	280	346	663	700	920
Exports	4	3	9	10	12
Consumption, apparent[4]	21,300	20,800	19,600	19,000	19,900
Price average value, dollars per ton, f.o.b. plant	7.00	6.90	7.70	8.00	8.50
Stocks, yearend	NA	NA	NA	NA	NA
Employment, number[e]	2,500	2,500	2,500	2,700	2,750
Net import reliance[5] as a percent of reported consumption	1	2	3	4	5

Recycling: No longer regarded largely as waste, ferrous slags are viewed as valuable byproducts of iron- and steelmaking and are among the most voluminous of recycled materials. Apart from the large outside markets for slag in the construction sector, some iron and steel slags are used internally—being recycled to the furnaces as ferrous and flux feed. Entrained metal, particularly in steel slag, is routinely recovered during slag processing for return to the furnaces. However, data for such furnace feed uses are unavailable.

Import Sources (1995-98): Year-to-year import data for ferrous slags show great variations in both tonnages and unit values; many of the data contain unresolved discrepancies. Slag was imported in 1995-96 mainly from Canada and South Africa; prior sources were mainly Canada and Japan. Data for 1998 only: France, 37%; Brazil, 10%; United Kingdom, 9%; Italy, 8%; other, 36%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
Granulated slag	2618.00.0000	Free.
Basic slag	3103.20.0000	Free.
Ferrous scale	2619.00.9000	Free.
Slag, dross, scalings, from manufacture of iron and steel	2619.00.3000	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

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IRON AND STEEL SLAG

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

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

World Mine Production, Reserves, and Reserve Base: Not strictly applicable because slag is not a mining product, per se. Production data for the world are unavailable, but it may be estimated that current annual world iron and steel slag output is on the order of 250 to 300 million tons, based on typical ratios of slag to crude iron and steel output.

World Resources: Not applicable.

Substitutes: Crushed stone and sand and gravel are common aggregate substitutes in the construction sector. Certain rock types, as well as silica fume and fly ash, are pozzolan substitutes in blended cements and concrete. Fly ash represents the bulk of the substitutes, with about 2 million tons of the total 9 million tons used going into cement manufacture, either as raw feed or cement additive.

[e]Estimated. NA Not available.
[1]The reported value of $150 million (obtained from annual survey of processors) represents the quantities sold rather than processed and excludes the value of any entrained metal that may be recovered during slag processing and returned to the iron and, especially, steel furnaces. Value data for such recovered metal were unavailable.
[2]Sales of open hearth furnace steel slag were from stockpiles; there was no domestic open hearth steel production in 1999.
[3]Data for actual production of marketable slag are unavailable and the data shown are for sales, largely from stockpiles. Production may be estimated as equivalent to 25% to 30% of crude (pig) iron production and 10% to 15% of crude steel output.
[4]Defined as production + imports - exports.
[5]Defined as imports - exports. Data are unavailable to allow adjustments for changes in stocks.

KYANITE AND RELATED MINERALS

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: One firm in Virginia, with integrated mining and processing operations, produced kyanite from hard-rock open pit mines. One company produced synthetic mullite in Georgia. It was estimated that 90% of the kyanite-mullite output was used in refractories: 55% for smelting and processing ferrous metals, 20% for nonferrous metals, and 15% for glassmaking and ceramics. Nonrefractory uses accounted for the remainder.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production: Mine	W	W	W	[e]90	90
Synthetic mullite	W	W	W	[e]39	39
Imports for consumption (andalusite)	3	11	8	10	10
Exports[e]	35	35	35	35	35
Shipments from Government stockpile excesses	—	—	1	—	—
Consumption, apparent	W	W	W	[e]104	104
Price, average, dollars per metric ton:					
U.S. kyanite, raw	144	154	154	157	158
U.S. kyanite, calcined	248	262	262	267	268
Andalusite, Transvaal, South Africa, 57.5% Al_2O_3	190	190	190	190	200
Andalusite, Transvaal, South Africa, 59.5% Al_2O_3	210	230	230	230	225
Stocks, producer	NA	NA	NA	NA	NA
Employment, kyanite mine and plant, number[e]	150	150	150	150	150
Net import reliance[1] as a percent of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1995-98): South Africa, 100%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
Andalusite, kyanite, and sillimanite	2508.50.0000	Free.
Mullite	2508.60.0000	Free.

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

Government Stockpile:

Stockpile Status—9-30-99[2]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 1999**	**Disposals FY 1999**
Kyanite, lump	0.1	—	0.1	—	—

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KYANITE AND RELATED MINERALS

Events, Trends, and Issues: An andalusite-producing company in South Africa reportedly was sold to another South African producer of the mineral. The sale included the world's largest andalusite mine, with a production capacity of 120,000 tons per year. This will mean that there are now only two producers in South Africa.

The iron and steel industry continued to be the largest consumer of refractories in general; in the latter part of 1999 there was a world surplus of steel, according to the International Iron and Steel Federation. Even in times of activity and growth in the user industries, strong international competition exists among refractory suppliers to extend the useful life of the materials they provide.

The trend toward monolithic refractories was expected to continue. In Japan, monolithics comprise 60% of the annual refractories production. Monolithics are cheaper and easier to install than bricks and shapes.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[3]
	1998	1999[e]	
United States	[e]90	90	Large in the United States and South Africa; may be large in other countries.
France	45	45	
India	14	15	
South Africa	250	250	
Other countries	8	10	
World total	407	410	

World Resources: Large resources of kyanite and related minerals are known to exist in the United States. The chief resources are in deposits of micaceous schist and gneiss mostly in the Appalachian area and in Idaho. Other resources are in aluminous gneiss in southern California. These resources are not economical to mine at present, but some may be eventually. The characteristics of kyanite resources in the rest of the world are thought to be similar to those in the United States.

Substitutes: Two types of synthetic mullite (fused and sintered), superduty fire clays, and high-alumina materials are substitutes for kyanite in refractories. Principal raw materials for synthetic mullite are bauxite, kaolin and other clays, and silica sand.

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix B for definitions.
[3]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 1999, based on the average U.S. producer price, was $500 million. Seven lead mines in Missouri plus lead-producing mines in Alaska, Colorado, Idaho, and Montana yielded most of the total. Primary lead was processed at two smelter-refineries in Missouri and a smelter in Montana. Of the 28 plants that produced secondary lead, 16 had annual capacities of 15,000 tons or more and accounted for more than 98% of secondary production. Lead was consumed at about 170 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 20% 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:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production: Mine, lead in concentrates	394	436	459	493	520
Primary refinery	374	326	343	337	350
Secondary refinery, old scrap	963	1,030	1,040	1,060	1,050
Imports for consumption, lead in concentrates	3	7	18	33	30
Exports, lead in concentrates	66	60	42	72	70
Imports for consumption, refined metal, wrought and unwrought	271	278	272	275	300
Exports, refined metal, wrought and unwrought	57	61	53	40	35
Shipments from Government stockpile excesses, metal	34	39	26	50	55
Consumption: Reported	1,560	1,540	1,620	1,630	1,700
Apparent	1,570	1,630	1,610	1,700	1,750
Price, average, cents per pound:					
North American Producer	42.3	48.8	46.5	45.3	44
London Metal Exchange	28.6	35.1	28.3	24.0	23
Stocks, metal, producers, consumers, yearend	94	80	101	88	65
Employment: Mine and mill (peak), number	1,200	1,200	1,200	1,200	1,100
Primary smelter, refineries	600	500	450	450	450
Secondary smelters, refineries	1,800	1,800	1,800	1,800	1,700
Net import reliance[1] as a percent of apparent consumption	17	17	14	18	20

Recycling: About 1.1 million tons of secondary lead was produced, an amount equivalent to 68% of domestic lead consumption. Nearly all of it was recovered from old (post-consumer) scrap. About 1.0 million tons (equivalent to 62% of domestic lead consumption) was recovered from used batteries alone.

Import Sources (1995-98): Lead in concentrates: Peru, 37%; Canada, 20%; Australia, 15%; Mexico, 8%; and other, 20%. Metal, wrought and unwrought: Canada, 69%; Mexico, 23%; Peru, 5%; and other, 3%. Total lead content: Canada, 67%; Mexico, 22%; Peru, 7%; Australia, 1%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations[2] 12/31/99
Unwrought (refined)	7801.10.0000	2.5% ad val.

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

Government Stockpile:

Stockpile Status—9-30-99[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Lead	251	13	251	54	54

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LEAD

Events, Trends, and Issues: During 1999, the price for lead decreased in the U.S. and world markets. The average North American Producer and London Metal Exchange (LME) prices for the first 9 months of the year were about 3% and 4%, respectively, below the averages for 1998. Despite a continued demand for lead, particularly in the North American market, overall market softness remained during 1999 owing to an increase in exports of lead concentrates from China to markets in industrialized countries and to an increase in the level of LME stocks. U.S. mine production and primary refinery production increased by about 5% and 4%, respectively, while secondary refinery production declined by about 1%. One mine was permanently closed in July as a result of declining reserves and falling market prices for lead. A major secondary smelter was closed indefinitely at the end of October, pending improvements in the price of lead. U.S. apparent consumption of lead increased, particularly owing to the increased demand for replacement batteries as warmer temperatures persisted and automotive-battery failures increased during the summer months. In addition, demand for industrial-type stationary and traction batteries continued to grow.

Production and shipments of lead concentrates were begun during the year at a new polymetallic mine in Spain. Mining and milling also were resumed at a mine in Spain, following the closure of operations in April 1998 when a tailings dam failure resulted in the flooding of a significant portion of the neighboring land. A major Sardinian primary lead-zinc complex was sold during 1999, completing a sales process that had lasted nearly 3 years.

The International Lead and Zinc Study Group at its 44th Session in Paris during October projected world demand for lead to increase by 2.6% to 6.2 million tons in 1999. Demand for lead increased in Asia as several countries began a noticeable economic recovery. European demand was expected to remain at a level near that of 1998. Only a small surplus of refined lead was expected in the worldwide market in 1999 as production increases were anticipated in several countries, including Australia, Belgium, China, and Kazakhstan, more than offsetting expected production declines in Canada, Mexico, and some eastern European countries.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	1998	1999[e]		
United States	493	520	6,500	20,000
Australia	618	630	17,000	36,000
Canada	189	160	2,300	12,000
China	556	560	9,000	30,000
Kazakhstan	30	40	2,000	2,000
Mexico	175	130	1,000	2,000
Morocco	76	90	500	1,000
Peru	260	270	2,000	3,000
South Africa	84	80	2,000	3,000
Sweden	140	120	500	1,000
Other countries	479	440	21,000	33,000
World total (may be rounded)	3,100	3,040	64,000	143,000

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.
[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 1999, lime producers at 116 plants in 36 States and Puerto Rico sold or used 20.5 million tons (22.6 million short tons) of lime valued at about $1.24 billion, an increase of about 400,000 tons (440,000 short tons) and an increase of about $20 million from 1998 levels. Six companies, operating 45 plants, accounted for about 76% of the total output. Principal producing States, each with production over 1 million tons, were Alabama, Kentucky, Missouri, Ohio, Pennsylvania, and Texas. These six States produced about 11.5 million tons (12.7 million short tons) or 56% of the total output. Major markets for lime were steel, flue gas desulfurization, mining, construction, pulp and paper, precipitated calcium carbonate, and water treatment.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production[3]	18,500	19,200	19,700	20,100	20,500
Imports for consumption	289	262	274	231	142
Exports	72	50	80	56	60
Consumption, apparent[4]	18,700	19,400	19,900	20,300	20,600
Quicklime average value, dollars per ton at plant	56.77	56.68	57.80	57.60	56.00
Hydrate average value, dollars per ton at plant	72.09	79.64	80.20	78.90	79.00
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and plant, number	5,500	5,600	5,600	5,600	5,600
Net import reliance[5] as a percent of apparent consumption	([6])	1	1	1	([6])

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

Import Sources (1995-98): Canada, 90%; Mexico, 9%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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: 15% (Domestic and foreign), for limestone produced and used for lime production.

Government Stockpile: None.

Events, Trends, and Issues: The merger of the Carmeuse North America Group and Lafarge S.A.'s North American lime operations was finalized in February. Later in the year, Carmeuse acquired from parent company Oglebay Norton the stock of Global Stone Detroit Lime Co. in Michigan and Global Stone Ingersoll Ltd. in Ontario, Canada.[7] Carmeuse shut down the lime kiln at its plant at Woodville, OH, but will continue to produce stone at the facility. The Woodville plant had been acquired from Lafarge as part of the merger. The shutdown of the Woodville lime plant was due in part to the startup in October of Carmeuse's newly renovated dolomitic lime plant at Maple Grove, OH, which will have the advantage of being newer, larger, and able to produce the higher purity lime required by Carmeuse's customers (J.M. McKinnon, Blade Business Writer, Toledo Blade, November 4, 1999, Bettsville lime operation thrives, accessed November 18, 1999, at URL http://www.toledoblade.com/editiorial/biz/9k04bett.htm). While divesting itself of lime operations in the Midwest, Oglebay Norton's Global Stone Corp. strengthened its presence in the Mid-Atlantic and Southeast by acquiring the W.S. Frey Co. lime plant at Clearbrook, VA.[8] Chemical Lime Co. acquired APG Lime Corp. from parent company Global Industrial Technologies Inc. The acquisition included one lime plant in Texas, two in Virginia, and a joint-venture plant in South Carolina.[9] The South Carolina joint venture, called Palmetto Lime LLC, began lime production in the summer of 1999.

Problems persisted in the domestic steel industry and total steel production decreased by 4% to 5% compared with 1998, although the trade imbalance that adversely affected U.S. steel mills in 1998 was expected to return to pre-1998 levels. Steel remains the largest market for lime and is particularly important in the Midwest and Southeast.

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LIME

Phase II of the Clean Air Act Amendments of 1990 goes into effect January 1, 2000. Phase II controls generally limit sulfur dioxide emissions to the same level as for post-1978 powerplants: 1.2 pounds of sulfur dioxide per million Btu. To achieve these emissions levels, utilities will retrofit scrubbers, switch to low-sulfur coal, blend low-sulfur with high-sulfur coal, cofire with natural gas, repower with advanced technology boilers, or perhaps even close the plant. Plants may also trade emission allowance credits issued to them by the Environmental Protection Agency. This is expected to benefit the flue gas desulfurization lime market.

World Lime Production and Limestone Reserves and Reserve Base:

	Production		Reserves and reserve base[10]
	1998	**1999[e]**	
United States	20,100	20,500	Adequate for all countries listed.
Belgium	1,750	1,800	
Brazil	5,700	5,700	
Canada	2,514	2,500	
China	21,000	22,000	
France	2,800	2,800	
Germany	7,600	7,800	
Italy[11]	3,500	3,500	
Japan (quicklime only)	8,100	8,200	
Mexico	6,600	6,600	
Poland	2,500	2,500	
Romania	1,700	1,750	
South Africa (sales)	1,500	1,600	
United Kingdom	2,500	2,500	
Other countries	28,100	28,000	
World total (rounded)	116,000	118,000	

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

[e]Estimated. NA Not available.
[1]Data are for quicklime, hydrated lime, and refractory dead-burned dolomite. Excludes Puerto Rico, unless noted.
[2]See Appendix A for conversion to short tons.
[3]Sold or used by producers.
[4]Stocks data are not available; stock changes are assumed to be zero for apparent consumption and net import reliance calculations.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]Less than 1/2 unit.
[7]North American Minerals News, 1999, North American lime industry: North American Minerals News, no. 53, October, p. 8-10.
[8]National Lime Association, 1999, Global Stone acquires assets of W.S. Frey: Limelites, v. 65. no. 4, p. 6.
[9]Global Industrial Technologies, 1999, Global Industrial Technologies reports first quarter results; completes sale of APG Lime: Dallas, TX, Global Industrial Technologies press release, April 14, 4 p.
[10]See Appendix C for definitions.
[11]Includes hydraulic lime.

LITHIUM

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

Domestic Production and Use: Chile was the largest lithium chemical producer in the world, followed by China, the United States, Russia, and Argentina, in descending order of production. Australia and Canada 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 two companies produced lithium compounds for domestic consumption as well as for export to other countries, 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:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production	W	W	W	W	W
Imports for consumption	1,140	884	975	2,590	2,440
Exports	1,900	2,310	2,200	1,400	700
Consumption: Apparent	W	W	W	W	W
Estimated	2,600	2,700	2,800	2,800	2,800
Price, yearend, dollars per kilogram:					
Lithium carbonate	4.34	4.34	4.47	4.47	4.47
Lithium hydroxide, monohydrate	5.62	5.51	5.74	5.74	5.74
Stocks, producer, yearend	W	W	W	W	W
Employment, mine and mill, number[e]	230	230	230	100	100
Net import reliance[1] as a percent of apparent consumption	E	E	E	W	W

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

Import Sources (1995-98): Chile, 76%; Argentina, 20%, and other, 4%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
Other alkali metals	2805.19.0000	5.5% ad val.
Lithium oxide and hydroxide	2825.20.0000	3.7% ad val.
Lithium carbonate:		
U.S.P. grade	2836.91.0010	3.7% ad val.
Other	2836.91.0050	3.7% ad val.

Depletion Allowance: 23% (Domestic), 15% (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. Two mines in North Carolina closed, one in 1986 and one in 1998, when their operating companies were able to supply the lithium carbonate required for production of downstream lithium compounds and to meet customer requirements from their brine deposits in South America. Subsurface brines have become the dominant raw material for lithium carbonate production worldwide because of lower production costs as compared to the costs for hard rock ores. Most of the lithium minerals mined in the world were consumed as ore concentrates rather than feedstock for lithium carbonate and other lithium compounds.

The U.S. company with a brine operation in Argentina announced plans to produce only lithium chloride at that operation. The company will meet its lithium carbonate requirements with material purchased from a producer in Chile. The increased production of low-cost lithium carbonate in South America has caused operations in China and Russia to close. Operations in those countries were able to import lithium carbonate from Chile at less than the cost of producing the material domestically.

In addition to the closure of facilities in other parts of the world, increased production in South America continued an oversupply situation that kept prices for lithium carbonate low for the past 3 years, although U.S. company price lists do not reflect that trend. Actual prices paid may have been as much as 50% lower than list prices. Lower prices may benefit the lithium industry in the long run by expanding the use of lithium materials into new high-volume, but price sensitive markets.

Interest in lithium batteries for electric vehicles (EV's) continued and research was ongoing. Lithium batteries could power the majority of future EV's, but the precise battery type and the timetable for implementation were still in question. Early battery designs indicated potential for significant growth in demand for lithium metal for use in batteries. More recent battery research has focused on the use of lithium carbonate rather than lithium metal to avoid some of the safety issues involved when dealing with lithium metal. Use of lithium carbonate simplified the manufacturing process and lowered the cost of lithium battery materials.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[2]	Reserve base[2]
	1998	1999[e]		
United States	W	W	38,000	410,000
Argentina[e]	1,130	1,200	NA	NA
Australia[e]	2,100	2,100	150,000	160,000
Bolivia	—	—	—	5,400,000
Brazil	32	30	910	NA
Canada	700	700	180,000	360,000
Chile	4,700	5,000	3,000,000	3,000,000
China	3,000	2,500	NA	NA
Namibia[e]	28	30	NA	NA
Portugal	160	160	NA	NA
Russia[e]	2,000	1,800	NA	NA
Zimbabwe	1,000	1,000	23,000	27,000
World total (may be rounded)	[3]15,000	[3]15,000	[4]3,400,000	[5]9,400,000

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

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

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

MAGNESIUM COMPOUNDS[1]

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

Domestic Production and Use: Seawater and natural brines accounted for about 70% of U.S. magnesium compounds production. Magnesium oxide and other compounds were recovered from seawater by four companies in California, Delaware, and Florida; from well brines by three companies in Michigan; and from lake brines by two companies in Utah. Magnesite was mined by one company in Nevada, and olivine was mined by two companies in North Carolina and Washington. About 57% of the magnesium compounds consumed in the United States was used for refractories. The remainder was consumed in agricultural, chemical, construction, environmental, and industrial applications.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production	360	389	402	366	370
Imports for consumption	328	240	259	344	300
Exports	54	66	56	49	50
Consumption, apparent	634	563	605	661	620
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant, number[e]	600	600	600	600	550
Net import reliance[2] as a percent of apparent consumption	43	31	34	45	40

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

Import Sources (1995-98): China, 67%; Canada, 8%; Austria, 4%; Greece, 3%; and other, 18%.

Tariff:[3] **Item**	**Number**	**Normal Trade Relations 12/31/99**
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); magnesite, dolomite, and magnesium carbonate, 15% (Domestic and foreign); magnesium chloride (from brine wells), 5% (Domestic and foreign); and olivine, 23% (Domestic) and 15% (Foreign).

Government Stockpile: None.

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MAGNESIUM COMPOUNDS

Events, Trends, and Issues: China remained the principal source for U.S. caustic-calcined and dead-burned magnesia imports. In spite of the export licensing requirements imposed by the Chinese Government, magnesia exports from China to the United States continued to rise.

The year was marked by consolidation of the U.S. magnesium compounds industry. In May, the U.S. magnesite mining firm, which also operated refractories manufacturing facilities, was purchased by a United Kingdom-based industrial minerals producer. The merger of the 2 companies will result in a firm with manufacturing sites in 70 countries and annual sales estimated at $1.2 billion. One of the largest U.S. refractories manufacturers, with a magnesium compounds plant in Michigan, was acquired in August by a multinational refractories firm that has an estimated 10% share of the total world refractories market and has more than 30 locations on 5 continents. A separate U.S. magnesium compounds and salt producer in Michigan was acquired by a multinational specialty chemicals firm; the acquisition creates a firm with about $6.5 billion in annual sales.

Citing competition from cheap imports of fused magnesia from China, the sole Indian seawater magnesia producer suspended operations at its 50,000-ton-per-year plant in February. This plant had come on-stream in 1998. Work continued on several magnesite mining projects in Australia. Most of the magnesite is expected to be used to produce magnesium metal, but these properties could represent additional sources of magnesite for traditional applications. Most of the Australian operations are not scheduled to come on-stream until at least 2003.

World Mine Production, Reserves, and Reserve Base:

	Magnesite production		Magnesite reserves and reserve base[4]	
	1998	1999[e]	Reserves	Reserve base
United States	W	W	10,000	15,000
Australia	103	100	NA	NA
Austria	187	190	15,000	20,000
Brazil	86	90	45,000	65,000
China[e]	690	700	750,000	1,000,000
Greece	187	190	30,000	30,000
India	107	100	30,000	45,000
Korea, North[e]	460	460	450,000	750,000
Russia[e]	245	250	650,000	730,000
Serbia and Montenegro	29	10	5,000	10,000
Slovakia[e]	288	290	20,000	30,000
Spain	144	130	10,000	30,000
Turkey	461	300	65,000	160,000
Other countries	100	100	420,000	480,000
World total (may be rounded)	[5]3,090	[5]2,910	2,500,000	3,400,000

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

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

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

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

MAGNESIUM METAL[1]

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Two companies in Utah and Washington produced primary magnesium in 1999. An electrolytic process was used at the plant in Utah to recover magnesium from lake brines, and a thermic process was used to recover magnesium from dolomite in Washington. The aluminum industry remained the largest consumer of magnesium, accounting for 48% of domestic primary metal use. Magnesium was a constituent in aluminum-base alloys that were used for packaging, transportation, and other applications. Castings and wrought magnesium products accounted for 31% of U.S. consumption of primary metal; desulfurization of iron and steel, 11%; cathodic protection, 3%; reducing agent in nonferrous metals production, 3%; and other uses, 4%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production: Primary	142	133	125	106	W
Secondary (new and old scrap)	65	71	78	76	80
Imports for consumption	35	47	65	83	80
Exports	38	41	41	35	30
Consumption: Reported, primary	109	102	100	103	105
Apparent	171	162	185	185	174
Price, yearend:					
Metals Week, U.S. spot Western, dollars per pound, average	2.09	1.75	1.65	1.57	1.50
Metal Bulletin, free market, dollars per metric ton, average	4,138	2,525	2,525	1,975	2,450
Stocks, producer and consumer, yearend	21	26	21	22	W
Employment, number[e]	1,400	1,400	1,400	800	800
Net import reliance[2] as a percent of apparent consumption	E	E	16	25	29

Recycling: In 1999, about 32,000 tons of the secondary production was recovered from old scrap.

Import Sources (1995-98): Canada, 52%; Russia, 22%; China, 12%; Israel, 5%; and other, 9%.

Tariff: Item	Number	Normal Trade Relations 12/31/99	Canada and Israel 12/31/99
Unwrought metal	8104.11.0000	8.0% ad val.	Free.
Unwrought alloys	8104.19.0000	6.5% ad val.	Free.
Wrought metal	8104.90.0000	14.8¢/kg on Mg content + 3.5% ad val.	Free.

Depletion Allowance: Dolomite, 15% (Domestic and foreign); magnesium chloride (from brine wells), 5% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: Free market magnesium prices generally trended slightly upward during 1999. At the beginning of the year, free market prices were about $2,300 per ton; by the end of October, this price had increased to about $2,500 per ton.

One of the U.S. magnesium producers experienced delays in its cell upgrade program at its Rowley, UT, facility. Originally scheduled for completion by the end of 2000, the upgrading program is not expected to be completed until mid-2001 or 2002.

The International Trade Administration (ITA) established the following antidumping duties for pure magnesium from Canada: 0% for August 1, 1996, to July 31, 1997, and 0% for August 1, 1997, to July 31, 1998. The countervailing duty for pure and alloy magnesium from Canada was established at 2.02% ad valorem for calendar year 1997. The ITA also determined that the company to which the duties apply does not qualify for revocation of the antidumping order because the company does not have 3 consecutive years of sales in commercial quantities at fair market values. The ITA began administrative reviews of the aforementioned determinations in October; antidumping duties for pure magnesium are to be reviewed for August 1, 1998, to July 31, 1999, and countervailing duties for pure and alloy magnesium are to be reviewed for calendar year 1998.

The largest Canadian magnesium producer postponed the proposed expansion of its Becancour, Quebec, primary

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MAGNESIUM METAL

magnesium plant. The 25,000-ton-per-year expansion, which was originally announced in June 1997, to be completed in 2000, has been delayed by 1 to 2 years. Three firms are investigating recovery of magnesium from asbestos mine tailings in Canada. One firm plans to begin production at a 58,000-ton-per-year facility in Asbestos, Quebec, by the second half of 2000.

In China, several of the larger magnesium producers in China announced plans to increase production capacity for magnesium and magnesium alloys in 1999, but at the same time, many small plants that had closed during 1998 remained closed because of low prices. Of the estimated 200 magnesium plants in China, only about 50 to 60 were operating by yearend.

Both of the Russian magnesium producers planned to increase production capacity in 2000. One of the producers signed a long-term agreement with an aluminum producer to supply magnesium to its worldwide operations. The additional capacity is needed to supply the contract. The other producer plans to install new technology that is claimed to be about $300 per ton less in production costs and also is less polluting. One of the two Ukrainian magnesium producers closed because it was $226 million in debt.

In Australia, development continued on a number of new magnesium projects. Six new projects have been proposed for the country, with a total of 438,000 tons of annual capacity, most of which are planned to begin commercial production in 2003 or 2004. One company produced its first magnesium test ingot at a demonstration plant near Gladstone, Queensland, in September. The company plans to study and refine its patented production technology over the next 6 months with the goal of completing construction of a 90,000-ton-per-year plant by 2002, with commercial production scheduled for 2004.

Studies continued for construction of new magnesium plants in the Netherlands and Congo (Brazzaville). Results of a prefeasibility study of a magnesium plant in the Netherlands indicate that a demonstration plant with a capacity of 10,000 to 15,000 tons per year can be operating by 2005, and a full-scale plant of 40,000 tons per year can be in operation by 2008 for a total investment of $10 million. A feasibility study completed for the proposed 60,000-ton-per-year magnesium plant in Congo (Brazzaville) indicated that magnesium could be produced at an operating cost of 55 cents per pound, assuming electrical rates of 16 cents per kilowatt hour. In addition to building new magnesium plants around the world, new recycling capacity was planned in Germany, Japan, and the United Kingdom.

World Primary Production, Reserves, and Reserve Base:

	Primary production	
	1998	1999[e]
United States	106	W
Brazil	9	9
Canada[4]	77	80
China[e]	67	55
France	14	14
Israel	15	20
Kazakhstan[e]	9	10
Norway	28	30
Russia[e]	42	45
Serbia and Montenegro	1	1
Ukraine[e]	1	1
World total	369	[5]265

Reserves and reserve base[3]

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 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 billions of tons, and magnesium can be recovered from seawater at places along world coastlines where salinity is high.

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

[e]Estimated. E Net exporter. W Withheld to avoid disclosing company proprietary data.
[1]See also Magnesium Compounds.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions.
[4]Includes secondary.
[5]Excludes the United States.

MANGANESE

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

Domestic Production and Use: Manganese ore containing 35% or more manganese was not produced domestically in 1999. Manganese ore was consumed mainly by about 15 firms with plants principally in the Eastern and Midwestern United States. The majority of ore consumption was related to steel production, directly in pig iron manufacture and indirectly through upgrading ore to ferroalloys and metal. Ore was used otherwise for such nonmetallurgical purposes as producing 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 24%, 14%, and 13%, respectively, of total manganese demand. Most of the rest went to a variety of other iron and steel applications. Value of domestic consumption was estimated from foreign trade data as about $380 million.

Salient Statistics—United States:[1]	**1995**	**1996**	**1997**	**1998**	**1999**[e]
Production, mine[2]	—	—	—	—	—
Imports for consumption:					
Manganese ore	394	478	355	332	535
Ferromanganese	310	374	304	339	325
Silicomanganese[3]	305	323	306	346	265
Exports:					
Manganese ore	15	32	84	8	2
Ferromanganese	11	10	12	14	14
Shipments from Government stockpile excesses:[4]					
Manganese ore	115	128	115	97	81
Ferromanganese	18	(2)	31	37	28
Consumption, reported:[5]					
Manganese ore[6]	486	478	510	499	500
Ferromanganese	348	326	337	[e]340	330
Consumption, apparent, manganese[7]	676	776	628	776	745
Price, average value, 46% to 48% Mn metallurgical ore, dollars per mtu cont. Mn, c.i.f. U.S. ports	2.40	2.55	2.44	2.40	2.26
Stocks, producer and consumer, yearend:					
Manganese ore[6]	309	319	275	196	210
Ferromanganese	33	27	21	[e]26	30
Net import reliance[8] as a percent of apparent consumption	100	100	100	100	100

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

Import Sources (1995-98): Manganese ore: Gabon, 56%; Australia, 14%; Mexico, 14%; Brazil, 7%; and other, 9%. Ferromanganese: South Africa, 39%; France, 25%; Australia, 9%; Mexico, 8%; and other, 19%. Manganese contained in all manganese imports: South Africa, 28%; Gabon, 16%; Australia, 14%; France, 11%; and other, 31%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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: 23% (Domestic), 15% (Foreign).

Government Stockpile: In addition to the data tabulated, the stockpile contained additional uncommitted inventories of nonstockpile-grade materials, as follows, in tons: natural battery ore, 16,800; chemical ore, 81; and metallurgical ore, 331,000.

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MANGANESE

Stockpile Status—9-30-99[9]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Battery: Natural ore	95	1	95	27	4
Synthetic dioxide	3	—	3	3	—
Chemical ore	143	1	143	36	3
Metallurgical ore	602	114	602	227	46
Ferromanganese:					
High-carbon	862	28	673	45	45
Electrolytic metal	6	0.5	6	2	1

Events, Trends, and Issues: The late 1998 linking of Australian and South African manganese production facilities was followed in 1999 by another major consolidation that combined Gabonese ore production with smelter production in Norway and the United States. Trends through the first three quarters of 1999 indicated decreases in year-average prices for manganese ferroalloys in the same range as the decline of 7% in f.o.b. ore price. Manganese is an essential element for people, animals, and plants, but it can be harmful in excessive amounts. Thus, manganese can be an industrial poison, but generally is not a hazard.

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

	Mine production 1998	Mine production 1999[e]	Reserves[11]	Reserve base[11]
United States	—	—	—	—
Australia	729	800	28,000	75,000
Brazil	[e]819	600	21,000	56,000
China	[e]1,200	1,200	40,000	100,000
Gabon	[e]966	1,000	45,000	150,000
India	[e]610	600	24,000	36,000
Mexico	[e]187	180	4,000	9,000
South Africa	[e]1,300	1,270	370,000	4,000,000
Ukraine	[e]755	570	135,000	520,000
Other countries	[e]472	515	Small	Small
World total (rounded)	[e]7,040	6,740	680,000	5,000,000

World Resources: Land-based resources are large but irregularly distributed; those of the United States are very low grade and have potentially high extraction costs. South Africa and the Former Soviet Union (FSU) account for more than 80% of the world's identified resources; South Africa accounts for more than 80% of the total exclusive of China and the FSU.

Substitutes: There is no satisfactory substitute for manganese in its major applications.

[e]Estimated.
[1]Manganese content typically ranges from 35% to 54% for manganese ore and from 74% to 95% for ferromanganese.
[2]Excludes insignificant quantities of low-grade manganiferous ore.
[3]Imports more nearly represent amount consumed than does reported consumption; internal evaluation indicates that reported consumption of silicomanganese is considerably understated.
[4]Net quantity. Data in parentheses denote increases in inventory.
[5]Total manganese consumption cannot be approximated from consumption of manganese ore and ferromanganese because of the use of ore in making manganese ferroalloys and metal.
[6]For 1996-99, exclusive of that at iron and steel plants.
[7]Thousand metric tons, manganese content; based on estimates of average content for all significant components except imports, for which content is reported.
[8]Defined as imports - exports + adjustments for Government and industry stock changes.
[9]See Appendix B for definitions.
[10]Thousand metric tons, manganese content.
[11]See Appendix C for definitions
.

MERCURY

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

Domestic Production and Use: Recovery of mercury from obsolete or wornout items remains the primary source of domestic mercury production. Several companies in the eastern and central United States recovered mercury from a variety of secondary sources such as batteries, chlor-alkali wastewater sludges, dental amalgams, electrical apparatus, fluorescent light tubes, and measuring instruments. Domestic mine production of mercury was limited to a very small quantity of byproduct production from fewer than 10 gold mines in California, Nevada, and Utah. The value of mercury used in the United States was estimated at approximately $2 million. It was estimated that approximately 35% of the mercury consumed domestically was used in the manufacture of chlorine and caustic soda and 30% for electrical and electronic applications. The remaining 35% was used for applications such as measuring and control instruments and dental amalgams.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production: Mine	W	W	W	W	W
Secondary, industrial	534	446	389	[e]400	400
Imports for consumption (gross weight)	377	340	164	128	100
Exports (gross weight)	179	45	134	63	50
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption: Reported	436	372	346	[e]400	400
Price, average value, dollars per flask:					
D.F. Goldsmith	247.40	261.65	NA	NA	NA
Free market	NA	NA	159.52	139.84	160.00
Stocks, industry, yearend[2]	321	446	203	[e]200	200
Net import reliance[3] as a percent of apparent consumption	NA	NA	NA	NA	NA

Recycling: About 400 tons of mercury was recovered from old scrap in 1999.

Import Sources (1995-98): Russia, 26%; Canada, 25%; Kyrgyzstan, 13%; Spain, 10%; and other, 26%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Mercury	2805.40.0000	1.7% ad val.

Depletion Allowance: 23% (Domestic), 15% (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—9-30-99[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Mercury	4,435	—	4,435	690	—

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MERCURY

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

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

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	1998	1999[e]		
United States	W	W	—	7,000
Algeria	370	400	2,000	3,000
Italy	—	—	—	69,000
Kyrgyzstan	620	600	7,500	13,000
Spain	500	500	76,000	90,000
Other countries	830	800	38,000	61,000
World total (may be rounded)	2,320	2,300	120,000	240,000

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

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

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]One metric ton (1,000 kilograms) = 29.0082 flasks.
[2]Consumer stocks only.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]See Appendix C for definitions.

MICA (NATURAL), SCRAP AND FLAKE[1]

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Scrap and flake mica production, excluding low-quality sericite, was estimated to be 94,000 metric tons in 1999. North Carolina accounted for about 51% of U.S. production. The remaining output came from Georgia, New Mexico, South Carolina, and South Dakota. Scrap mica was recovered principally from mica and sericite schist and as a byproduct from feldspar, kaolin, and industrial sand beneficiation. The majority of domestic production was processed into small particle-size mica by either wet or dry grinding. Primary uses were joint compound, paint, roofing, oil well drilling additives, and rubber products. The value of 1999 scrap mica production was estimated at $9.7 million. Ground mica sales in 1998 were valued at $31.2 million. There were nine domestic producers of scrap and flake mica.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production:[2 3] Mine	108	97	114	87	94
Ground	98	103	110	104	113
Imports, mica powder and mica waste	22	18	23	23	27
Exports, mica powder and mica waste	7	8	8	8	13
Consumption, apparent[4]	112	107	122	137	146
Price, average, dollars per ton, reported:					
Scrap and flake	52	81	83	87	103
Ground:					
Wet	974	1,032	1,080	909	1,000
Dry	174	182	176	179	180
Stocks, producer, yearend[e]	13	7	NA	NA	NA
Employment, mine, number[e 5]	360	NA	347	367	360
Net import reliance[6] as a percent of apparent consumption	5	4	9	24	23

Recycling: None.

Import Sources (1995-98): Canada, 61%; India, 29%; Finland, 5%; Japan, 2%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Mica powder	2525.20.0000	Free.
Mica waste	2525.30.0000	Free.

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

Government Stockpile: None.

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MICA (NATURAL), SCRAP AND FLAKE

Events, Trends, and Issues: Domestic production of ground mica increased in 1999. The increase was primarily the result of higher production in Georgia. Part of the production shortfall from the closing of the mine at Bessemer City, NC, was offset by increased production from operations in Deep Step, GA, and Newell, SD, and from increased capacity in Spruce Pine, NC. The final permits were obtained to begin development of a mica mine near Black Canyon, AZ. Development of the mica deposit was expected to commence in the final quarter of 1999. 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]
	1998	1999[e]		
United States[2]	87	94	Large	Large
Brazil	4	4	Large	Large
Canada	17	17	Large	Large
India	1	1	Large	Large
Korea, Republic of	38	38	Large	Large
Russia	100	100	Large	Large
Other countries	41	40	Large	Large
World total	288	294	Large	Large

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

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

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

MICA (NATURAL), SHEET[1]

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: A minor amount of sheet mica, estimated at less than 500 kilograms, was produced in 1999, incidental to scrap and flake mica production and the mining of gemstone-bearing pegmatites. The domestic consuming industry was dependent on imports and shipments of U.S. Government stockpile excesses to meet demand for sheet mica. During 1999, an estimated 3,400 tons of unworked mica split block and mica splittings valued at $1.5 million was consumed by 14 companies in 7 States, mainly in the East and Midwest. Most was fabricated into parts for electronic and electrical equipment. An additional estimated 1,900 tons of imported worked mica valued at $12.8 million was also consumed.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production, mine[e]	([2])	([2])	([2])	([2])	([2])
Imports, plates, sheets, and strips; worked mica; split block; splittings; other > $0.55/kg	4,230	6,330	5,760	4,380	5,310
Exports, plates, sheets, and strips; worked mica; crude and rifted into sheet or splittings > $0.55/kg	935	831	1,060	1,280	1,400
Shipments from Government stockpile excesses	511	1,110	326	557	804
Consumption, apparent	3,800	6,540	5,030	3,660	4,710
Price, average value, dollars per kilogram, muscovite and phlogopite mica, reported:					
Block	59	55	28	26	27
Splittings	1.86	1.75	1.69	1.67	1.70
Stocks, fabricator and trader, yearend	NA	NA	NA	NA	NA
Net import reliance[3] as a percent of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1995-98): India, 63%; Belgium, 12%; Germany, 11%; China, 5%; and other, 9%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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: 23% (Domestic), 15% (Foreign).

Government Stockpile:

Stockpile Status—9-30-99[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Block:					
Muscovite	287	277	287	([5])	443
Phlogopite	53	6	53	—	6
Film, muscovite	1	([2])	1	([5])	9
Splittings:					
Muscovite	5,233	57	5,233	([5])	317
Phlogopite	234	—	234	([5])	29

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MICA (NATURAL), SHEET

Events, Trends, and Issues: Demand for sheet mica increased in 1999. Imports of splittings from India increased as demand for electrical equipment increased, especially transformers. Imports remained the principal source of sheet mica, and shipments from U.S. Government stockpile excesses continued to be a significant source of supply. The availability of good quality mica remained in short supply. There were no environmental problems associated with the manufacture of mica products.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1998	1999[e]		
United States	([2])	([2])	Very small	Small
India	2,100	2,000	Very large	Very large
Russia	1,500	1,500	Moderate	Large
Other countries	200	200	Moderate	Large
World total	3,800	3,700	Large	Large

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

Substitutes: Many materials can be substituted for mica in numerous electrical and electronic uses. Substitutes include acrylic, Benelex®, cellulose acetate, Delrin®, Duranel® N, fiberglass, fishpaper, Kapton®, Kel F®, Kydex®, Lexan®, Lucite®, Mylar®, nylon, nylatron, Nomex®, Noryl®, phenolics, Plexiglass®, polycarbonate, polyester, styrene, Teflon®, vinyl-PVC, and vulcanized fiber. Mica paper made from scrap mica can be substituted for sheet mica in electrical and insulation applications.

[e]Estimated. NA Not available.
[1]See also Mica (Natural), Scrap and Flake.
[2]Less than ½ unit.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]The total disposal plan for all categories of mica in the National Defense Stockpile, except phlogopite block, is undifferentiated at 1,025 metric tons (2,260,000 pounds).
[6]See Appendix C for definitions.

MOLYBDENUM

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

Domestic Production and Use: In 1999, molybdenum, valued at about $256 million (based on average oxide price), was produced by eight mines. Molybdenum ore was produced at three mines in Colorado, New Mexico, and Idaho, whereas five mines in Arizona, Montana, New Mexico, and Utah recovered molybdenum as a byproduct. Three plants converted molybdenite (MoS_2) concentrate to molybdic oxide, from which intermediate products, such as ferromolybdenum, metal powder, and various chemicals, were produced. Iron and steel producers accounted for about 75% of the molybdenum consumed. Major end-use applications were as follows: machinery, 35%; electrical, 15%; transportation, 15%; chemicals, 10%; oil and gas industry, 10%; and others, 15%.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production, mine	60,900	54,900	60,900	53,300	44,100
Imports for consumption	11,500	13,400	13,200	14,400	11,900
Exports, all primary forms	51,300	49,600	62,100	46,300	38,400
Consumption: Reported	19,900	20,900	20,000	19,000	15,700
Apparent	20,200	21,200	23,000	24,500	18,400
Price, average value, dollars per kilogram[1]	17.50	8.30	9.46	5.90	5.80
Stocks, mine and plant concentrates, product, and consumer materials	12,400	9,900	11,400	16,200	15,400
Employment, mine and plant, number	700	800	700	600	475
Net import reliance[2] as a percent of apparent consumption	E	E	E	E	E

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

Import Sources (1995-98): United Kingdom, 29%; Chile, 23%; China, 20%; Canada, 14%; and other, 14%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
Molybdenum ore and concentrates, roasted	2613.10.0000	12.8¢/kg + 1.8% ad val.
Molybdenum ore and concentrates, other	2613.90.0000	17.8¢/kg.
Molybdenum chemicals:		
Molybdenum oxides and hydroxides	2825.70.0000	3.2% ad val.
Molybdates of ammonium	2841.70.1000	4.3% ad val.
Molybdates, all others	2841.70.5000	3.7% ad val.
Molybdenum pigments: Molybdenum orange	3206.20.0020	3.7% ad val.
Ferroalloys: Ferromolybdenum	7202.70.0000	4.5% ad val.
Molybdenum metals:		
Powders	8102.10.0000	9.1¢/kg + 1.2% ad val.
Unwrought	8102.91.1000	13.9¢/kg + 1.9% ad val.
Waste and scrap	8102.91.5000	Free.
Wrought	8102.92.3000	6.6% ad val.
Wire	8102.93.0000	4.4% ad val.
Other	8102.99.0000	3.7% ad val.

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

Government Stockpile: None.

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MOLYBDENUM

Events, Trends, and Issues: U.S. mine output of molybdenum in 1999 decreased to the lowest level since 1993. The decline reflected reduced prices. Reported consumption, exports, and U.S. producer inventories were each about 17% below those of 1998.

Prices of concentrates and molybdenum products moderated toward the end of the year. The domestic price for technical-grade molybdic oxide averaged $5.80 per kilogram of contained molybdenum during 1999, a decline of 2% from that of 1998. Mine capacity utilization was 55%. Two mines in Arizona stopped recovering molybdenum in 1999. The Morenci Mine recovered no molybdenum. The San Manuel Mine closed, and the equipment was removed in midyear. During the fourth quarter of the year, there was realignment of producers, with Phelps Dodge Corp. purchasing Cyprus Amax and Grupo Mexico S.A. de C.V. purchasing ASARCO Incorporated. (For details see Copper Mineral Industry Surveys for July and August 1999.)

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	1998	1999[e]	(thousand metric tons)	
United States	53,300	44,100	2,700	5,400
Armenia	2,500	2,500	20	30
Canada	7,991	8,000	450	910
Chile	25,298	25,000	1,100	2,500
China	30,000	33,000	500	1,000
Iran	600	700	50	140
Kazakhstan	100	200	130	200
Mexico	5,949	6,000	90	230
Mongolia	2,000	2,000	30	50
Peru	4,344	4,000	140	230
Russia	2,000	3,000	240	360
Uzbekistan	500	500	60	150
Other countries	—	—	—	590
World total (may be rounded)	135,000	129,000	5,500	12,000

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

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

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

NICKEL

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

Domestic Production and Use: The only nickel smelter in the United States—a ferronickel operation near Riddle, OR—closed in April 1998 because of low nickel prices. The adjoining mine on Nickel Mountain has been idle since 1996. Limited amounts of byproduct nickel are recovered from copper and palladium-platinum ores mined in the western United States. On a monthly or annual basis, 174 facilities reported nickel consumption. The principal consuming State was Pennsylvania, followed by West Virginia and Ohio. Approximately 47% of the primary nickel consumed went into stainless and alloy steel production, 34% into nonferrous alloys and superalloys, 13% into electroplating, and 6% into other uses. Ultimate end uses were as follows: transportation, 29%; chemical industry, 14%; electrical equipment, 10%; construction, 8%; fabricated metal products, 8%; petroleum, 7%; household appliances, 7%; machinery, 6%; and other, 11%. Estimated value of apparent primary consumption was $830 million.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production: Mine	1,560	1,330	—	—	—
Production: Plant	8,290	15,100	16,000	4,290	—
Shipments of purchased scrap:[1]	98,400	84,900	97,600	89,900	90,100
Imports: Ore	8,200	15,000	17,600	1,420	—
Imports: Primary	149,000	142,000	147,000	148,000	138,000
Imports: Secondary	7,930	8,060	11,000	8,500	6,960
Exports: Primary	9,750	13,100	16,400	8,440	7,410
Exports: Secondary	41,800	33,600	40,200	35,100	28,200
Consumption: Reported, primary	125,000	119,000	121,000	116,000	122,000
Consumption: Reported, secondary	64,500	59,300	68,400	63,300	68,800
Consumption: Apparent, primary	151,000	147,000	154,000	149,000	137,000
Consumption: Total[2]	216,000	206,000	222,000	213,000	206,000
Price, average annual, London Metal Exchange:					
Cash, dollars per metric ton	8,228	7,501	6,927	4,630	6,024
Cash, dollars per pound	3.732	3.402	3.142	2.100	2.732
Stocks: Government, yearend	19,800	15,900	8,530	2,600	—
Stocks: Consumer, yearend	12,400	13,100	16,100	15,800	12,700
Stocks: Producer, yearend[3]	12,700	13,300	12,600	13,100	10,200
Employment, yearend, number: Mine	17	8	7	7	7
Employment, yearend, number: Smelter	253	253	264	6	6
Employment, yearend, number: Port facility	25	23	22	1	1
Net import reliance[4] as a percent of apparent consumption	60	59	56	64	63

Recycling: About 69,000 tons of nickel was recovered from purchased scrap in 1999. This represented about 38% of reported consumption for the year.

Import Sources (1995-98): Canada, 38%; Russia, 16%; Norway, 14%; Australia, 9%; and other, 23%.

Tariff: Item	Number	Canada and Mexico 12/31/99	Normal Trade Relations 12/31/99
Nickel oxide, chemical grade	2825.40.0000	Free	Free.
Ferronickel	7202.60.0000	Free	Free.
Nickel oxide, metallurgical grade	7501.20.0000	Free	Free.
Unwrought nickel, not alloyed	7502.10.0000	Free	Free.

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

Government Stockpile:

Stockpile Status—9-30-99[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Nickel	—	—	—	3,810	1,990

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 slightly greater than that of 1998, but still short of the near-record high of 1.36 million tons reached in 1997. The U.S. International Trade Commission issued several countervailing duty and antidumping rulings in 1998-99 that slowed a surge in stainless steel imports. Imported steels accounted for 37% of total U.S. stainless steel consumption in 1998, up from 33% in 1997.

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NICKEL

World nickel demand grew faster than supply in 1999, allowing the London Metal Exchange (LME) cash price to partially recover from its lowest level in more than a decade. For the week ending November 19, 1999, the LME cash price for 99.8%-pure nickel averaged $7,878 per metric ton ($3.57 per pound). Twelve months earlier, the cash price was $4,163 per ton ($1.89 per pound). Resumption of economic growth in parts of East Asia has encouraged consumption of stainless steel worldwide, strengthening nickel prices. Since 1975, demand for stainless has grown at an average rate of 4.5% per year. This growth rate is projected to continue or accelerate over the next 20 years. Advances in pressure acid leach (PAL) technology have made it possible to develop laterite deposits in Australia. The completion of a natural gas pipeline from the North West Shelf to Kalgoorlie in 1996 spurred development of three laterite deposits in Western Australia. All three of the new PAL operations began producing metal in early 1999, after overcoming startup problems associated with the new technology. In Canada, the Provincial Government of Newfoundland and Labrador was expected to finally approve development of the huge Voisey's Bay nickel-copper sulfide deposit near Nain. The project has undergone extensive environmental and socioeconomic review because of its significant impact on the Province. Drilling crews are exploring several other promising districts in northern Canada—the Lac Rocher region southeast of James Bay, the Ungava Nickel Belt in northern Quebec, South Voisey's Bay, and an area in Manitoba northeast of the Thompson Nickel Belt. New ore bodies also have been found in and around existing mines in the Sudbury district of Ontario. In the United Kingdom, a facility producing nickel foam and fine powders was upgraded and expanded to meet growing demand from manufacturers of nickel-metal hydride and nickel-cadmium batteries. Two Japanese automotive manufacturers are mass producing a hybrid automobile that uses an electric motor to power the vehicle in low-speed, stop-and-go city driving, and switches to an internal combustion engine for higher speeds. A regenerative braking system recovers part of the vehicle's kinetic energy. The kinetic energy is converted to electrical energy and stored in a nickel-based battery for later reuse by the motor.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1998	1999[e]		
United States	—	—	43,000	2,500,000
Australia	143,513	138,000	9,100,000	11,000,000
Botswana	21,000	23,800	780,000	830,000
Brazil	36,764	45,800	670,000	6,000,000
Canada	208,201	203,000	6,300,000	15,000,000
China	48,700	51,000	3,700,000	7,900,000
Colombia	29,422	34,400	560,000	1,100,000
Cuba	65,300	66,000	5,500,000	23,000,000
Dominican Republic	41,600	43,000	720,000	1,300,000
Greece	16,985	17,100	450,000	900,000
Indonesia	74,063	83,900	3,200,000	13,000,000
New Caledonia	129,200	103,000	4,500,000	15,000,000
Philippines	12,840	14,000	410,000	11,000,000
Russia	250,000	250,000	6,600,000	7,300,000
South Africa	36,411	37,900	2,500,000	12,000,000
Zimbabwe	12,749	12,300	240,000	260,000
Other countries	16,000	15,100	450,000	12,000,000
World total (rounded)	1,140,000	1,140,000	46,000,000	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.
[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 B for definitions.
[6]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 26 companies at 42 plants in the United States for most of 1999. Because of persistent low prices, several producers permanently closed plants during the second half of the year and several were closed for extended shutdowns. As a result, U.S. ammonia producers operated significantly below rated capacity. Fifty-eight percent of total U.S. ammonia production capacity was centered in Louisiana, Oklahoma, and Texas because of their large reserves of natural gas, the dominant domestic feedstock. The United States remained the world's second largest ammonia producer and consumer following China. Urea, ammonium phosphates, ammonium nitrate, nitric acid, and ammonium sulfate were the major derivatives of ammonia in the United States, in descending order of importance.

Approximately 85% of U.S. apparent domestic ammonia consumption was for fertilizer use, including anhydrous ammonia for direct application, urea, ammonium nitrates, ammonium phosphates, and other nitrogen compounds. Ammonia was also used to produce plastics, synthetic fibers, and resins, explosives, and numerous other chemical compounds.

Salient Statistics—United States:[1]	**1995**	**1996**	**1997**	**1998**	**1999**[e]
Production[2]	13,000	13,400	13,300	14,700	11,000
Imports for consumption	2,630	3,390	3,530	3,460	4,800
Exports	319	435	395	614	800
Consumption, apparent	15,300	16,400	15,800	18,100	14,900
Stocks, producer, yearend	959	881	1,530	1,050	1,200
Price, dollars per ton, average, f.o.b. Gulf Coast[3]	191	190	173	121	110
Employment, plant, number[e]	2,500	2,500	2,500	2,500	2,200
Net import reliance[4] as a percent of apparent consumption	15	19	16	18	26

Recycling: None.

Import Sources (1995-98): Trinidad and Tobago, 50%; Canada, 36%; Mexico, 7%; Venezuela, 2%; and other, 5%. In addition, the United States imports significant quantities of ammonia from Russia and Ukraine, but the Bureau of the Census quantity data are suppressed, so these data are not included in the calculation of import sources.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
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.

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NITROGEN (FIXED)—AMMONIA

Events, Trends, and Issues: Continued low ammonia prices, high natural gas prices, and high industry stock levels for the past 2 years led to reduced ammonia production in the United States in 1999. Four ammonia plants were permanently closed during the year in Clinton, IA; Lawrence, KS; Luling, LA; and LaPlatte, NE. In addition, one plant in Donaldsonville, LA, was shut down indefinitely in August. These closures represent about 10% of the total U.S. production capacity. U.S. companies extended maintenance shutdowns for many plants or temporarily closed portions of plants, taking additional capacity off-stream during the year in an attempt to alleviate the oversupply. Firms building new ammonia plants in Coffeyville, KS, and Beaumont, TX, also postponed commissioning of these plants because of the oversupply. As a result of these closures, ammonia prices began to rebound; by the end of October the average U.S. Gulf Coast ammonia price had risen to $118 per short ton after reaching a low of $104 per short ton in June.

In spite of the U.S. ammonia oversupply, new ammonia capacity came on-stream in Egypt, Norway, and Pakistan in 1999, and significant new capacity is planned for 2000. Analysts, however, predict that ammonia demand will increase in 2000 because of strong industrial demand in Asia, where the economy is beginning to pick up, and steady demand for ammonia to make upgraded fertilizer products.

At the request of several U.S. producers, the International Trade Commission (ITC) began an investigation of imports of fertilizer-grade ammonium nitrate from Russia. After a preliminary investigation, the ITC concluded that there was reasonable indication that the U.S. industry was materially injured by ammonium nitrate sold at less than fair value. The ITC plans to conduct antidumping and countervailing duty investigations.

Nitrogen compounds are also an environmental concern. Overfertilization and the subsequent runoff of excess fertilizer may contribute to nitrogen accumulation in watersheds. Nitrogen in excess fertilizer runoff has been theorized to be a cause of the hypoxic zone that occurs in the Gulf of Mexico in 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]
	1998	1999[e]	
United States	14,700	11,000	Available atmospheric nitrogen and sources of natural gas for production of ammonia are considered adequate for all listed countries.
Canada	3,900	4,350	
China	26,500	28,000	
Germany	2,500	2,350	
India	10,000	9,800	
Indonesia	3,600	3,500	
Japan	1,580	1,600	
Mexico	1,450	980	
Netherlands	2,350	2,500	
Pakistan	1,800	1,800	
Russia	6,500	6,000	
Trinidad and Tobago	2,270	2,550	
Ukraine	3,300	3,300	
Other countries	25,100	25,200	
World total (rounded)	106,000	101,000	

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

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

[e]Estimated.
[1]U.S. Department of Commerce (DOC) data unless otherwise noted.
[2]Annual and preliminary data as reported in Bulletins MA28B and MQ28B (DOC).
[3]Source: Green Markets.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.

PEAT

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

Domestic Production and Use: The estimated f.o.b. plant value of marketable peat production in the contiguous United States was about $16.5 million in 1999. Peat output in Alaska was valued at $190,000, according to the Alaska Department of Natural Resources. Peat was harvested and processed by about 60 producers in 20 of the contiguous States, and several producers in Alaska. Florida, Michigan, and Minnesota were the largest producing States, in order of quantity produced. Reed-sedge peat accounted for about 60% of the total volume followed by sphagnum moss, 25%; humus and hypnum moss accounted for the remaining 15%. Approximately 95% of domestic peat was sold for horticulture/agriculture usage, including general soil improvement, potting soils, earthworm culture, nursery business, and golf course maintenance and construction, in order of importance. Other applications included seed inoculants, vegetable cultivation and mushroom culture, mixed fertilizers, and packing for flowers and plants. In the industrial sector, peat found widespread use as an oil absorbent, an efficient filtration medium for the removal of waterborne contaminants in mine waste streams, and municipal storm drainage. Peat also was used as an effective sterile absorbent in feminine hygiene products and disposable diapers

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production	648	549	661	676	633
Commercial sales	660	640	753	785	775
Imports for consumption	669	667	754	761	800
Exports	20	19	22	30	30
Consumption, apparent[2]	1,170	1,240	1,310	1,420	1,460
Price, average value, f.o.b. mine, dollars per ton	25.80	28.90	23.23	24.07	26.11
Stocks, producer, yearend	384	342	421	408	350
Employment, mine and plant, number[e]	650	800	800	800	800
Net import reliance[3] as a percent of apparent consumption	44	56	50	52	57

Recycling: None.

Import Sources (1995-98): Canada, 99%; and other, 1%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
Peat	2703.00.0000	Free.

Depletion Allowance: 5% (Domestic).

Government Stockpile: None.

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PEAT

Events, Trends, and Issues: Restrictions placed on wetlands development by Federal and State agencies have led to the closure of many domestic peat bogs over the past 10 years. During the same period, domestic demand, especially for sphagnum peat, has grown substantially. These factors have helped the Canadian sphagnum peat industry, with its vast reserves, to capture a greater percentage of the U.S. market. In 1999, imports from Canada were on pace to reach another record of 800,000 tons, while sales of domestic peat were slightly less than last year. Apparent consumption of all types of peat increased for the fifth consecutive year owing to growing demand for plants, ornamental trees, and natural turf.

The outlook for the domestic peat industry will be influenced by several variables, including future regulations restricting the use of wetlands, the ability to permit new bogs, growth of composted yard wastes and other organic materials, and imports from Canada.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	1998	1999[e]		
United States	676	633	15,000	6,400,000
Belarus[e]	300	300	([5])	([5])
Canada	1,130	1,200	22,000	30,000,000
Estonia[e]	1,000	1,000	([5])	([5])
Finland[e]	7,400	7,500	64,000	6,400,000
Germany[e]	2,980	3,000	42,000	450,000
Ireland	4,800	4,500	160,000	820,000
Latvia	450	450	([5])	([5])
Lithuania	195	200	([5])	([5])
Russia[e]	3,000	3,000	([5])	([5])
Sweden	1,050	1,000	([5])	([5])
Ukraine[e]	1,000	1,000	([5])	([5])
United Kingdom[e]	500	500	([5])	([5])
Other countries	1,000	1,000	4,900,000	160,000,000
World total (rounded)	25,500	25,300	5,200,000	200,000,000

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

Substitutes: Natural organic materials may be composted and compete in certain applications. The superior water-holding capacity and physiochemical properties of peat limit substitution alternatives.

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

PERLITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: The estimated value (f.o.b. mine) of processed perlite produced in 1999 was $22.9 million. Crude ore production came from 11 mines operated by 9 companies in 7 Western States. New Mexico continued to be the major producing State. Processed ore was expanded at 62 plants in 31 States. The principal end uses were building construction products, 71%; horticultural aggregate,10%; filter aid, 9%; fillers, 7%; and other, 3%.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production[1]	700	684	706	685	726
Imports for consumption[e]	84	125	135	150	152
Exports[e]	40	38	38	42	42
Consumption, apparent	744	771	803	793	836
Price, average value, dollars per ton, f.o.b. mine	27.93	28.25	33.04	31.91	31.59
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill	125	125	135	140	150
Net import reliance[2] as a percent of apparent consumption	6	11	12	14	13

Recycling: Not available.

Import Sources (1995-98): Greece, 100%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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: A recently opened mine in Utah was expected to be sold by yearend 1999. A perlite mine in Oregon was purchased by an Eastern coal producer. Closure and reclamation of a mine near Florence, CO, continued.

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

Domestic perlite continued to encounter transportation cost disadvantages in some areas of the Eastern United States compared with Greek imports. However, Western U.S. perlite exports to Canada partially offset imports into the Eastern United States.

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

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

	Production		Reserves[3]	Reserve base[3]
	1998	1999[e]		
United States	685	726	50,000	200,000
Greece	425	425	50,000	300,000
Japan	200	200	([4])	([4])
Turkey	150	160	([4])	([4])
Other countries	380	400	600,000	1,500,000
World total (may be rounded)	1,840	1,910	700,000	2,000,000

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

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

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

PHOSPHATE ROCK

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Phosphate rock ore was mined by 11 firms in 4 States, and upgraded into an estimated 41.5 million tons of marketable product valued at $1.21 billion, f.o.b. mine. Florida and North Carolina accounted for 85% of total domestic output, with the remainder produced in southeastern Idaho and northwestern Utah. About 90% of U.S. phosphate rock demand was for the conversion into wet-process phosphoric acid and superphosphoric acid, which were used as intermediates in the manufacture of granular and liquid ammonium phosphate fertilizers. More than 50% of the wet-process phosphoric acid produced was exported in the form of upgraded granular diammonium and monoammonium phosphate fertilizer, triple superphosphate fertilizer, and merchant grade phosphoric acid. Calcium phosphate animal feed supplements were manufactured from defluorinated phosphate rock and defluorinated phosphoric acid. Phosphate rock mined by two western companies was used as feedstock for elemental phosphorus production at two wholly owned electric furnace facilities in Idaho. Elemental phosphorus was used to produce high-purity phosphoric acid and phosphorus compounds, which were used in a variety of industrial applications.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production[1]	43,500	45,400	45,900	44,200	41,500
Sold or used by producers	43,700	43,500	42,100	43,700	42,900
Imports for consumption	1,800	1,800	1,830	1,760	2,100
Exports	2,760	1,570	335	378	320
Consumption[2]	42,700	43,700	43,600	45,000	44,700
Price, average value, dollars per ton, f.o.b. mine[3]	21.75	23.40	24.40	25.46	29.12
Stocks, producer, yearend	5,710	6,390	7,910	7,920	6,800
Employment, mine and beneficiation plant, number	5,000	5,000	5,000	5,000	5,000
Net import reliance[4] as a percent of apparent consumption	E	—	—	3	7

Recycling: None.

Import Sources (1995-98): Morocco, 99%; and other, 1%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
Natural calcium phosphates:		
Unground	2510.10.0000	Free.
Ground	2510.20.0000	Free.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: In 1999, the domestic phosphate rock production decreased as producers in Florida reduced stocks and adjusted output to meet demand. Production in North Carolina was down owing to production difficulties, while Western mine production remained about the same as last year. Consumption of phosphate rock dropped slightly as fertilizer production slowed in the second half of the year. The largest phosphate producer permanently closed one of its six mines because of depleted reserves and temporarily closed two other mines to reduce existing stocks and prolong mine life. The company also continued with permitting procedures for two new mines that will be necessary to replace existing mines, which will be depleted of reserves within the next decade. Imports reached a record high because of an increase in production capacity at one fertilizer plant. Exports of phosphate rock have leveled after dropping significantly from 1995 to 1997.

Domestic consumption of phosphatic fertilizers was lower in 1999 primarily because of a reduction in the total acres of corn planted, which was caused by high stocks, low prices, and a reduction in Government assistance payments. Application rates for corn and other crops also were affected by wet weather in the Spring planting season. Exports sales of diammonium phosphate (DAP) remained about the same as last year, however shipments to India were delayed for several months because the Government was late in enacting fertilizer subsidies. Shipments of other fertilizers were lower than last year. The drop in demand early in the year resulted in high fertilizer stocks, primarily of DAP. In response to the weak market conditions and to reduce stocks, several phosphate fertilizer plants were closed temporarily in 1999. However, one DAP plant, which had been closed since 1992, reopened in Manatee County, FL.

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PHOSPHATE ROCK

New phosphate rock mines were commissioned in 1999 in Australia and Canada, thus eliminating the need for imports of phosphate rock in to the respective countries. New facilities in Australia, India, and Pakistan were anticipated to add 4.2 million tons of DAP capacity to that region over the next 2 years. This will have an impact on U.S. DAP exports, as the Indian subcontinent and Australia have been the second and third largest markets, respectively, for U.S. companies after China.

The increased need for world food production assures the long-term growth in world phosphate rock demand. The United States remains the world's largest producer and consumer of phosphate rock and the leader in fertilizer production and exports. U.S. mine production will likely decrease slightly in 2000, as producers reduce stocks and adjust output. U.S. producers will face greater international competition, as new production capacity for both phosphate rock and fertilizers will be added over the next several years. Domestic phosphate rock consumption was expected to decrease this year because of high grain and fertilizer stocks and projected deceases in total planted corn acreage. The export market will continue to be the determining factor for phosphate rock demand.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	1998	1999[e]		
United States	44,200	41,500	1,000,000	4,200,000
Brazil	4,270	4,500	330,000	370,000
China	25,000	20,000	500,000	1,200,000
Israel	4,100	4,100	180,000	180,000
Jordan	5,900	6,000	900,000	1,700,000
Morocco and Western Sahara	24,000	24,000	5,700,000	21,000,000
Russia	9,800	11,000	150,000	1,000,000
Senegal	1,300	1,600	50,000	160,000
South Africa	2,800	3,000	1,500,000	2,500,000
Syria	2,500	2,500	60,000	100,000
Togo	2,200	2,200	30,000	60,000
Tunisia	7,950	7,800	100,000	600,000
Other countries	11,000	10,000	1,000,000	2,500,000
World total (rounded)	145,000	138,000	12,000,000	36,000,000

World Resources: Phosphate rock resources occur principally as sedimentary marine phosphorites. Significant igneous occurrences are found in 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.

Substitutes: There are no substitutes for phosphorus in agriculture.

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

PLATINUM-GROUP METALS

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

Domestic Production and Use: The United States has only one active platinum-group metals (PGM) mine. The mine, located near Nye, MT, processed more than 400,000 metric tons of ore and recovered 10,200 kilograms of palladium and 3,200 kilograms of platinum in 1999. Small quantities of PGM were also recovered as byproducts of copper refining by two companies in Texas and Utah. Automobile catalysts continued to be the largest demand sector for PGM. In the United States, more than 110,000 kilograms of PGM were used by the automotive industry in the manufacture of catalysts. Oxidation catalysts are also used in other air pollution abatement processes to remove organic vapors, odors, or carbon monoxide. Chemical uses include catalysts for organic synthesis, e.g., in hydrogenation, dehydrogenation, and isomerization. Platinum alloys, in cast or wrought form, are commonly used for jewelry. Platinum, palladium, and a variety of complex gold-silver-copper alloys are used as dental restorative materials. The primary medical use of PGM is in cancer chemotherapy. Other medical uses include platinum-iridium alloys in prosthetic and biomedical devices.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Mine production:[1] Platinum	1,590	1,840	2,610	3,240	3,200
Palladium	5,260	6,100	8,400	10,600	10,200
Imports for consumption, refined:					
Platinum	71,500	75,800	77,300	97,200	75,300
Palladium	124,000	146,000	148,000	176,000	195,000
Rhodium	9,600	9,650	14,400	13,400	14,500
Ruthenium	7,520	15,600	11,500	9,230	9,500
Iridium	1,450	1,810	1,860	2,060	2,600
Osmium	73	329	54	71	20
Exports, refined:					
Platinum	15,000	12,700	23,000	14,300	19,800
Palladium	26,000	26,700	43,800	36,700	38,900
Rhodium	741	187	282	811	100
Price,[2] dollars per troy ounce:					
Platinum	425.36	397.97	396.58	372.50	365.00
Palladium	153.35	130.39	184.14	290.00	320.00
Rhodium	463.30	300.00	298.99	620.00	900.00
Employment, mine, number	500	500	550	620	620

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

Import Sources (1995-98): Platinum: South Africa, 59%; United Kingdom,14%; Russia, 9%; Germany, 5%; and other, 13%. Palladium: Russia, 48%; South Africa, 18%; United Kingdom, 9%; Belgium, 8%; and other, 17%.

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

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

Government Stockpile:

Stockpile Status—9-30-99[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Platinum	10,649	—	10,649	—	3,113
Palladium	34,196	—	18,729	—	4,668
Iridium	784	3.11	2.18	—	136

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PLATINUM-GROUP METALS

Events, Trends, and Issues: In 1998, the lone U.S. primary PGM producer completed expansion construction work at its mine which increased its milling rate to 3,000 tons per day. In 1999, the company focused on increasing underground development in the mine to support the added capacity. Advancement of its East Boulder Project, near Big Timber, MT, began with the arrival of a 4.6-meter diameter tunnel-boring machine (TBM). At the end of February 1999, the TBM had advanced more than one-third of the distance to the J-M Reef. The tunneling process was projected to reach the ore body, about 18,500 feet from the portal entrance, by the end of 1999. A second TBM also began excavating a second parallel tunnel. Completion of the second tunnel will allow underground infrastructure construction, providing additional access and ventilation. East Boulder will be Stillwater's second producing mine, located on the western end of the J-M Reef and 13 miles west of the Stillwater Mine. The project is permitted for 2,000 tons per day and is expected to produce between 14,000 and 15,600 kilograms of palladium and platinum at a cost of production of $140 to $160 per ounce.

The operator of the Stillwater mine was granted a Record of Decision by the Montana Department of Environmental Quality which removed tonnage limitations at the mine and authorized construction of a long-term tailings facility.

The price of rhodium rose sharply in 1999, as demand by industrial users was reinforced by investor buying.

World supplies of PGM are expected to increase substantially in the next 5 years, according to the plans of major non-South African PGM mining companies. More than 50,000 kilograms of additional output could come from projects underway in Canada and the United States.

World Mine Production, Reserves, and Reserve Base:

	Mine production				PGM	
	Platinum		Palladium		Reserves[4]	Reserve base[4]
	1998	1999[e]	1998	1999[e]		
United States[2]	3,240	3,200	10,600	10,200	730,000	810,000
Canada	7,570	7,300	4,810	4,800	310,000	380,000
Russia	17,000	17,500	47,000	47,000	6,200,000	6,600,000
South Africa	117,000	120,000	57,300	60,000	63,000,000	69,000,000
Other countries	1,550	2,100	2,930	3,000	700,000	750,000
World total (may be rounded)	146,000	150,000	123,000	125,000	71,000,000	78,000,000

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

Substitutes: Some motor vehicle manufacturers have substituted palladium for the higher priced platinum in catalytic converters. Although palladium is less resistant to poisoning by sulfur and lead than platinum, it may be useful in controlling emissions from diesel-powered vehicles.

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.
[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 1999, the value of production of marketable potash, f.o.b. mine, was about $320 million, owing to price increases over 1998. Domestic potash production was from Michigan, New Mexico, and Utah. The majority of the production was from southeastern New Mexico, where two companies operated four mines. New Mexico potash ore was beneficiated by flotation, heavy media separation, and dissolution-recrystallization, and provided more than 70% of the U.S. total producer sales.

In Utah, of the three potash operations, one company brought underground potash to the surface by solution mining. The potash was recovered from the brine by solar evaporation to crystals and flotation. Another Utah company collected subsurface brines from an interior basin for solar evaporation to crystals and flotation. The third Utah company collected lake brines for solar evaporation to crystals, flotation, and dissolution-recrystallization. In Michigan, a company used deep well solution mining and recovery by mechanical evaporation. The fertilizer industry used about 90% of the U.S. potash sales and the chemical industry used about 10%. More than 50% of the potash was produced as potassium chloride (muriate of potash). Potassium sulfate (sulfate of potash) and potassium magnesium sulfate (sulfate of potash-magnesia), required by certain crops and soils, were also sold.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production, marketable	1,480	1,390	1,400	[1]1,300	[1]1,300
Imports for consumption	4,820	4,940	5,490	4,780	4,600
Exports	409	481	466	480	470
Consumption, apparent	5,820	5,890	6,500	[2]5,700	[2]5,400
Price, dollars per metric ton of K_2O, average, muriate, f.o.b. mine[3]	137	133	140	145	145
Stocks, producer, yearend	312	265	[1]200	[1]300	[1]300
Employment, number: Mine	900	880	850	730	660
Mill	840	810	800	780	725
Net import reliance[4] as a percent of apparent consumption	75	77	[5]80	[5]80	[5]80

Recycling: None.

Import Sources (1995-98): Canada, 93%; Russia, 4%; Belarus, 1%; and other, 2%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
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: 15% (Domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: The world's largest potash producers operated at reduced capacity for another year owing to potential oversupply. The Canadian potash industry operated for the first half of the year at about 69% of capacity. The Former Soviet Union potash producers continued operating at reduced capacity while many operated at normal capacity as Asian economic problems caused a reduction of foodstuff trade, leading to lower grain prices, and grain storage problems in grain-producing and -exporting countries. Consequently, potash sales were slightly lower relative to a year earlier as farmers reduced their purchases for spring and fall potash application. In the United States, many potash prices rose slightly or stayed steady then declined in late summer for unclear reasons. Canadian producer sales for the first half of the year were down about 10% relative to last year, and the Asian market sales offered little hope for improvement as of October. There were some capacity shutdowns to maintain stocks at reasonable levels. The Asian potash consumers continued purchasing potash to maintain local food production and reduce imports of food, while the North American potash consumption declined owing to lower grain prices.

French production decreased owing to the approaching end of minable reserves. Belarus, Germany, and Russia faced marginally increasing demand in their home market.

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POTASH

The Boulby potash mine on the east coast of England has reported minor flooding along the conveyor belt gallery to the southern section of the mine. The inflow was noticed in mid-March. Production was slightly reduced and extra pumps were added to remove the brines. In France, the Marie-Louise mill was shut down at the end of July while the mine continued to produce ore and ship it to the last refinery, Amélie, which is expected to close in the year 2004.

A subsidiary of a Norwegian fertilizer firm signed a joint-venture agreement with a western Canadian exploration and development firm, operating in Thailand, which includes a commitment of 75% of the lifetime production for 20% funding of the expected $400 million capital cost for a new mine. Production capacity was estimated to be 1.2 million tons of muriate of potash. The Canadian firm that has been developing the mine site is searching for another 20% funding before continuing. The Norwegian fertilizer firm also formed a joint venture with a Chilean potassium nitrate producer for marketing that product in Europe. The Government of the Russian Federation levied a 5% export tariff on potash.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1998	1999[e]		
United States	[1]1,300	[1]1,300	100,000	300,000
Azerbaijan[e]	5	5	NA	NA
Belarus	3,400	3,540	800,000	1,000,000
Brazil	243	260	50,000	600,000
Canada	9,000	8,100	4,400,000	9,700,000
Chile	22	20	10,000	50,000
China	120	120	320,000	320,000
France	656	430	2,000	NA
Germany	3,200	3,300	710,000	850,000
Israel	1,500	1,580	[7]40,000	[7]580,000
Jordan	850	1,100	[7]40,000	[7]580,000
Russia	3,500	4,170	1,800,000	2,200,000
Spain	635	710	20,000	35,000
Ukraine	60	70	25,000	30,000
United Kingdom	575	450	22,000	30,000
Other countries	—	—	50,000	140,000
World total (rounded)	25,100	25,200	8,400,000	17,000,000

World Resources: Estimated domestic potash resources total about 6 billion tons. Most of this lies at depths between 6,000 and 10,000 feet in a 1,200-square-mile area of Montana and North Dakota as an extension of the Williston Basin deposits in Saskatchewan, Canada. The Paradox Basin in Utah contains approximately 2 billion tons, mostly at depths of more than 4,000 feet. An unknown, but large potash resource lies about 7,000 feet under central Michigan. The U.S. reserve figure above contains approximately 62 million tons of reserves in central Michigan. Estimated world resources total about 250 billion tons. The potash deposits in the Former Soviet Union contain large amounts of carnallite; it is not clear if this can be mined in a free market, competitive economy. Large resources, about 10 billion tons and mostly carnallite, occur in Thailand.

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

[e]Estimated. NA Not available.
[1]Rounded to the nearest 0.1 million 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 is equally divided between Israel and Jordan.

PUMICE AND PUMICITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: The estimated value of pumice and pumicite sold or used in 1999 was $13.7 million. Domestic output came from 14 producers in 6 States. The principal producing States were California, New Mexico, and Oregon, with combined production accounting for about 82% of the national total. The remaining production was from Arizona, Idaho, and Kansas. About 64% of the pumice was consumed for building blocks, and the remaining 36% was used in abrasives, concrete, stone-washing laundries, and other applications.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production, mine[1]	529	612	577	583	617
Imports for consumption	238	215	265	286	350
Exports[e]	16	13	12	22	20
Consumption, apparent	728	814	830	847	947
Price, average value, dollars per ton, f.o.b. mine or mill	25.00	24.20	27.90	21.90	22.18
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number	60	70	70	75	75
Net import reliance[2] as a percent of apparent consumption	30	25	30	31	35

Recycling: Not available.

Import Sources (1995-98): Greece, 88%; Turkey, 5%; Ecuador, 3%; Italy, 3%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Crude or in irregular pieces, including crushed pumice	2513.11.0000	Free.
Other	2513.19.0000	Free.

Depletion Allowance: 5% (Domestic and foreign).

Government Stockpile: None.

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PUMICE AND PUMICITE

Events, Trends, and Issues: The amount of pumice and pumicite sold or used in 1999 was essentially unchanged when compared with that of 1998. Imports increased over 14% compared with that of 1998 as more Greek pumice was brought into the eastern half of the United States. Total consumption reached an 11-year high, at 947,000 tons. Consumption increased because of increased demand from lightweight-block and -concrete producers. Stone-washing laundry use of pumice continued to decline in 1999.

It is estimated that in 2000 domestic mine production of pumice and pumicite will be about 650,000 tons, with U.S. apparent consumption at approximately 975,000 tons. Imports, mainly from Greece, continue to maintain markets on the East Coast and Gulf Coast States of the United States.

Although pumice and pumicite were plentiful in the Western United States, changes in laws and public land designations could make many deposits decreasingly accessible to mining. Pumice and pumicite were sensitive to mining costs and should domestic production cost increase, it was expected that imports and competing materials might replace domestic pumice in many markets.

All domestic mining of pumice in 1999 was by open pit methods and generally occurred in relatively remote areas where land use conflicts were not severe. Although the generation and disposal of reject fines in mining and milling resulted in a dust problem at some operations, the environmental impact was restricted to a small geographical area.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	1998	1999[e]		
United States[1]	583	617	Large	Large
Chile	480	480	NA	NA
France	480	500	NA	NA
Germany	600	600	NA	NA
Greece	1,650	1,700	NA	NA
Italy	5,100	5,100	NA	NA
Spain	600	600	NA	NA
Turkey	800	800	NA	NA
Other countries	1,170	1,200	NA	NA
World total (rounded)	11,500	11,600	NA	NA

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

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

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

QUARTZ CRYSTAL (INDUSTRIAL)

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: Domestic production of cultured quartz crystal in 1999 remained near 1998 levels. Lascas[1] mining and processing in Arkansas was stopped at the end of 1997, but three U.S. firms continued to produce cultured quartz crystals by using imported and stockpiled lascas as feed material. Electronic applications accounted for most industrial uses of quartz crystal; other uses included special optical applications.

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

Salient Statistics—United States: Production of cultured quartz crystals was estimated to be about 200 metric tons. Trade data for cultured quartz crystal and devices with mounted quartz crystal are available but lascas import data are not available. Exports of cultured quartz crystals were about 100 tons and imports were about 23 tons in 1999. The average value of exports and imports was $267,000 per ton and $495,000 per ton, respectively. Other salient statistics were not available.

Recycling: None.

Import Sources (1995-98): The United States is 100% import reliance. Brazil, Germany, and Madagascar are reportedly the major sources for lascas. Other possible sources of lascas include China, South Africa, and Venezuela.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Sands:		
Other than natural	2506.10.0010	Free.
Other	2506.10.0050	Free.
Quartzite	2506.21.0000	Free.
Piezo-electric quartz	7104.10.0000	3% ad val.

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

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QUARTZ CRYSTAL (INDUSTRIAL)

Government Stockpile:

Stockpile Status—9-30-99[2]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Quartz crystal	105	([3])	—	—	—

Events, Trends, and Issues: A new producer of lascas was operating in startup mode in Canada. The producer intends to ship lascas to U.S. cultured quartz producers. An Elkhart, IN, crystal fabricator was reconsidering its plan to permanently close its Carlisle, PA, facility.

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 (e.g., personal computers, electronic games, and cellular telephones), particularly in the United States, will continue to promote domestic production. The growing global electronics market may require additional production capacity worldwide.

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

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

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

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

RARE EARTHS[1]

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

Domestic Production and Use: Rare earths were mined by one company in 1999. Bastnasite, a rare-earth fluocarbonate mineral, was mined as a primary product by a firm in Mountain Pass, CA. The United States was a leading producer and processor of rare earths and continued to be a major exporter and consumer of rare-earth products. Domestic ore production was valued at an estimated $32 million. Refined rare-earth products were produced primarily by two companies; one with operations in Phoenix, AZ, and Freeport, TX; and another with a plant in Chattanooga, TN. The estimated value of refined rare earths consumed in the United States was more than $600 million. The approximate distribution in 1998 by end use was as follows: automotive catalytic converters, 35%; petroleum refining catalysts, 10%; glass polishing and ceramics, 31%; permanent magnets, 5%; metallurgical additives and alloys, 14%; phosphors, 3%; and miscellaneous, 2%.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production: Bastnasite concentrates	[2]22,200	[2]20,400	[e]10,000	[e]5,000	5,000
Imports:[3] Thorium ore (monazite)	22	56	11	—	—
Rare-earth metals, alloys	905	429	529	953	1,270
Cerium compounds	2,740	3,180	1,810	4,940	4,080
Mixed REO's	678	879	974	2,530	8,430
Rare-earth chlorides	1,250	1,070	1,450	1,680	1,760
Rare-earth oxides, compounds	6,500	10,300	7,070	3,720	5,600
Ferrocerium, alloys	78	107	121	117	122
Exports:[3] Rare-earth metals, alloys	444	250	991	724	1,010
Cerium compounds	5,120	6,100	5,890	4,640	4,240
Other rare-earth compounds	1,550	2,210	1,660	1,630	1,560
Ferrocerium, alloys	3,470	4,410	3,830	2,450	1,900
Consumption, apparent[4]	W	W	19,400	11,500	17,700
Price, dollars per kilogram, yearend:					
Bastnasite concentrate, REO basis	2.87	2.87	2.87	2.87	2.87
Monazite concentrate, REO basis	0.44	0.48	0.73	0.73	0.73
Mischmetal, metal basis, metric ton quantity[5]	8-11	7-11	8-12	6-8	5-7
Stocks, producer and processor, yearend	W	W	W	W	W
Employment, mine and mill, number	NA	NA	327	183	100
Net import reliance[4] as a percent of apparent consumption	6	18	E	56	72

Recycling: Small quantities, mostly permanent magnet scrap.

Import Sources (1995-98): Monazite: Australia, 75%; and France, 25%; Rare-earth metals, compounds, etc.: China, 75%; France, 19%; Japan, 3%; United Kingdom, 1%; and other, 2%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
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: Percentage method, monazite, 23% on thorium content and 15% on rare-earth content (Domestic), 15% (Foreign); bastnasite and xenotime, 15% (Domestic and foreign).

Government Stockpile: None.

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RARE EARTHS

Events, Trends, and Issues: Domestic demand for rare earths in 1999 was higher than that of 1998. U.S. imports of rare earths increased in most trade categories, however, domestic mine production remained lower than historical levels because of a blocked wastewater pipe at the mine at Mountain Pass, CA. Significant delays in governmental approvals to repair or install a new pipe have resulted in consideration of alternative processes and evaporative systems. Domestic rare-earth exports were lower in most trade categories, primarily the result of continued depressed markets in southeast Asia. The overall trend is for increased use of rare earths in automotive catalytic converters, permanent magnets, and rechargeable batteries.

The U.S. Department of Energy provided $750,000 in funding to researchers at its Ames Laboratory and Astronautics Corp. of America to build a prototype rotary magnetic-refrigeration unit. The magnetic-refrigeration unit is based on a rare-earth alloy of gadolinium, silicon, and germanium.[6]

The *22nd Rare-Earth Research Conference* was held in Argonne, IL, from July 11-15, 1999. The conference *Rare-Earth-Doped Materials and Devices IV* is scheduled for January 22-28, 2000, in San Jose, CA. The *4th International Conference on f-elements* is planned for September 17-21, 2000, in Madrid, Spain.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e]		Reserves[7]	Reserve base[7]
	1998	1999		
United States	5,000	5,000	13,000,000	14,000,000
Australia	—	—	5,200,000	5,800,000
Brazil	1,400	1,400	280,000	310,000
Canada	—	—	940,000	1,000,000
China[8]	65,000	65,000	43,000,000	48,000,000
India	2,700	2,700	1,100,000	1,300,000
Malaysia	350	250	30,000	35,000
South Africa	—	—	390,000	400,000
Sri Lanka	120	120	12,000	13,000
Former Soviet Union[9]	2,000	2,000	19,000,000	21,000,000
Other countries	—	—	21,000,000	21,000,000
World total (rounded)	76,600	76,500	100,000,000	110,000,000

World Resources: Rare earths are relatively abundant in the Earth's crust, but discovered minable concentrations are less common than for most other ores. U.S. and world resources are contained primarily in bastnasite and monazite. Bastnasite deposits in China and the United States constitute the largest percentage of the world's rare-earth economic resources, while monazite deposits in Australia, Brazil, China, India, Malaysia, South Africa, Sri Lanka, Thailand, and the United States constitute the second largest segment. Xenotime, rare-earth-bearing (ion adsorption) clays, loparite, phosphorites, apatite, eudialyte, secondary monazite, cheralite, and spent uranium solutions make up most of the remaining resources. Undiscovered resources are thought to be very large relative to expected demand.

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

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Data includes lanthanides and yttrium, but excludes most scandium. See also Scandium and Yttrium.
[2]As reported in Unocal Corp. annual reports and as estimated by the USGS commodity specialist.
[3]REO equivalent or contents of various materials were estimated. Data from U.S. Bureau of the Census.
[4]Monazite concentrate production was not included in the calculation of apparent domestic consumption and net import reliance. Net import reliance defined as imports - exports + adjustments for Government and industry stock changes.
[5]Price range from Elements - Rare Earths, Specialty Metals and Applied Technology, Trade Tech, Denver, CO.
[6]U.S. Department of Energy Ames Laboratory, 1999, Work begins on prototype magnetic-refrigeration unit: Ames, IA, Ames Laboratory news release, May 25, 1 p.
[7]See Appendix C for definitions.
[8]Number reported in China Rare Earth Information, Baotou, Inner Mongolia, China.
[9]As constituted before December 1991.

RHENIUM

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

Domestic Production and Use: During 1999, ores containing rhenium were mined by eight 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 jet engine components, representing about 35% and 55%, 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 1999 was $20 million.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production[1]	17,000	14,000	15,400	14,000	11,900
Imports for consumption	12,800	20,800	15,100	25,200	15,600
Exports	NA	NA	NA	NA	NA
Consumption: Estimated	16,200	24,100	17,900	28,600	19,900
Apparent	NA	NA	NA	NA	NA
Price, average value, dollars per kilogram:					
Metal powder, 99.99% pure	1,100	900	900	1,100	1,100
Ammonium perrhenate	700	500	300	400	750
Stocks, yearend, consumer, producer, dealer	NA	NA	NA	NA	NA
Employment, number			Small		
Net import reliance[2] as a percent of apparent consumption	NA	NA	NA	NA	NA

Recycling: Small amounts of molybdenum-rhenium and tungsten-rhenium scrap were processed during the past few years by several companies.

Import Sources (1995-98): Chile, 52%; Germany, 19%; Kazakhstan, 8%; Russia, 7%; and other, 14%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
Other inorganic acids, other—rhenium, etc.	2811.19.6050	4.2% ad val.
Salts of peroxometallic acids, other—ammonium perrhenate	2841.90.2000	3.1% ad val.
Rhenium, etc., (metals) waste and scrap	8112.91.0500	Free.
Rhenium, (metals) unwrought; powders	8112.91.5000	3% ad val.
Rhenium, etc., (metals) wrought; etc.	8112.99.0000	4% ad val.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: None.

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RHENIUM

Events, Trends, and Issues: During 1999, the average rhenium prices were $1,100 per kilogram for metal and $750 per kilogram for ammonium perrhenate. The supply decreased by 11,700 kilograms, while the consumption decreased by 8,700 kilograms, leaving a shortfall of 3,000 kilograms. The shortfall in supply was reflected by prices increasing about 100% over those of 1998. Imports of rhenium decreased by about 38% for 1999 compared with those of 1998. Chile and Germany supplied the majority of the rhenium imported. The United States relies on imports for much of its supply of rhenium. The decreased estimated consumption was in the areas of catalysts for petroleum refining and superalloys for jet engines.

It is estimated that U.S. consumption of rhenium in 2000 will be about 25,000 kilograms.

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

World Mine Production, Reserves, and Reserve Base:

	Mine production[e]		Reserves[3]	Reserve base[3]
	1998	1999		
United States	14,000	11,900	390,000	4,500,000
Armenia	1,000	700	95,000	120,000
Canada	2,200	1,300	—	1,500,000
Chile	13,600	13,000	1,300,000	2,500,000
Kazakhstan	2,400	2,400	190,000	250,000
Mexico	5,500	6,300	NA	NA
Peru	2,300	4,800	45,000	550,000
Russia	900	700	310,000	400,000
Uzbekistan	NA	NA	59,000	400,000
Other countries	3,200	3,300	91,000	360,000
World total (may be rounded)	45,100	44,400	2,500,000	11,000,000

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.

[1]Calculated rhenium contained in MoS_2 concentrates. Recovered quantities are considerably less and are withheld.

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

[3]See Appendix C for definitions.

RUBIDIUM

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

Domestic Production and Use: Although rubidium is not recovered from any domestically mined ores, at least one domestic company manufactured rubidium products from imported lepidolite ore. Small quantities of rubidium, usually in the form of chemical compounds, were used mainly in research and development. Rubidium also was used in electronic and medical applications.

Salient Statistics—United States: Salient statistics such as production, consumption, imports, and exports are not available. The domestic rubidium market is very small, with annual consumption probably amounting to only a few thousand kilograms. There is no active trading of the metal and, therefore, no market price. However, several companies publish prices for rubidium and rubidium compounds. These prices remain relatively stable for several years. The per-unit price for the metal or compounds purchased from these companies varies inversely with the quantity of material purchased. For example, in 1998, one company offered 1-gram ampoules of 99.8%-grade rubidium metal at $79.70. The price for 100 grams of the same material from this company was $998.00, or $9.98 per gram. At another company, the price for a 1-gram ampoule of 99.9%-pure rubidium was $187.40.

Recycling: None.

Import Sources (1995-98): 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 12/31/99
Alkali metals, other	2805.19.0000	5.5% ad val.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: None.

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RUBIDIUM

Events, Trends, and Issues: Rubidium and its compounds were largely the subject of laboratory study and were of little commercial significance. No major breakthroughs or developments were anticipated that would change the production or consumption patterns. Domestic rubidium production is entirely dependent on imported lepidolite ores. Because of the small scale of production of rubidium products, no significant environmental problems have been encountered.

World Mine Production, Reserves, and Reserve Base:[1] Rubidium forms no known minerals in which it is the predominant metallic element. Rather, it substitutes for potassium in a number of minerals, especially those that crystallize late in the formation of pegmatites. Lepidolite, a potassium lithium mica that may contain up to 3.15% rubidium, is the principal ore of rubidium. Pollucite, the cesium aluminosilicate mineral, may contain up to 1.35% rubidium. The rubidium-bearing minerals are mined as byproducts or coproducts with other pegmatite minerals.

World Resources: World resources of rubidium have not been estimated.

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]See Appendix C for definitions.

SALT

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Domestic production of salt increased slightly in 1999, with total value estimated at $965 million. Thirty-one companies operated 69 plants in 15 States. The estimated percentage of salt sold or used, by type, was salt in brine, 51%; rock salt, 32%; vacuum pan, 9%; and solar salt, 8%.

The chemical industry consumed about 50% of total salt sales, with salt brine representing about 89% of the type of salt used for feedstock. Chlorine and caustic soda manufacture was the main consuming sector within the chemical industry. Salt for highway deicing accounted for 21% of U.S. demand. The remaining markets for salt, in declining order, were distributors, 10%; industrial, 7%; agricultural and food, 4% each; other combined with exports, 3%; and primary water treatment, 1%.

Salient Statistics—United States:[1]	1995	1996	1997	1998	1999[e]
Production	42,100	42,200	41,400	41,200	41,400
Sold or used by producers	40,800	42,900	40,600	40,800	41,000
Imports for consumption	7,090	10,600	9,160	8,770	8,800
Exports	670	869	748	731	900
Consumption: Reported	46,500	52,800	49,500	44,200	48,900
Apparent	47,200	52,600	49,000	48,800	48,900
Price, average value of bulk, pellets and packaged salt, dollars per ton, f.o.b. mine and plant:					
Vacuum and open pan salt	118.63	120.54	119.61	114.93	110.00
Solar salt	30.82	39.97	38.81	37.56	40.00
Rock salt	21.80	22.14	20.50	21.90	19.00
Salt from brine	6.91	6.72	6.67	5.93	6.00
Stocks, producer, yearend[e 2]	1,300	1,400	800	400	400
Employment, mine and plant, number	4,150	4,150	4,150	4,150	4,100
Net import reliance[3] as a percent of apparent consumption	14	19	17	17	16

Recycling: None.

Import Sources (1995-98): Canada, 41%; Chile, 19%; Mexico, 18%; The Bahamas, 11%; and other, 11%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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 succession of mild winters reduced salt consumption in the United States for highway deicing. As a result, consumer and salt producer inventories of rock salt were higher than normal.

A rock salt mine in Detroit, MI, that was closed since the mid-1980's and reopened by a new salt company in 1998 continued to expand production operations in 1999. Output from this mine, and from the new Hampton Corners, NY, rock salt mine that came on-stream in late 1999, will help alleviate some of the shortage of the production capacity lost when the Retsof, NY, mine closed in 1995.

A large rock salt producer in Germany reduced its production capacity by one-third, or 900,000 tons per year, citing a weak demand for road salt caused by mild winters in Europe for the past couple of years. The company, which is the largest salt producer in Europe and the fourth largest in the world, announced plans to restructure its operations by upgrading its packaging facilities and reducing maintenance costs to offset reduced rock salt sales.

Consumption of salt in 2000 is expected to be similar to that of 1999. Many weather forecasters were forecasting below-normal temperatures and a more severe winter that should help alleviate the buildup of salt inventories for the past 2 years. The shutdown of two chlorine facilities in the Pacific Northwest will decrease imports of solar salt used as feedstock. Mexico had been a major source of imported salt for chloralkali manufacture.

World Production, Reserves, and Reserve Base:

	Production		Reserves and reserve base[4]
	1998	1999[e]	
United States[1]	41,200	41,400	Large. Economic and subeconomic deposits of salt are substantial in principal salt-producing countries. The oceans comprise an inexhaustible supply of salt.
Australia	8,880	8,800	
Brazil	5,500	5,700	
Canada	13,300	13,400	
China	30,800	31,000	
France	7,000	7,100	
Germany	15,700	15,200	
India	9,500	9,500	
Italy	3,600	3,600	
Mexico	8,400	8,400	
Poland	3,900	4,000	
Russia	2,000	2,100	
Spain	3,500	3,600	
Ukraine	2,500	2,400	
United Kingdom	6,600	6,600	
Other countries	23,600	37,200	
World total (may be rounded)	186,000	200,000	

World Resources: World resources of salt are practically unlimited. Domestic resources of rock salt and salt from brine are in the Northeast, Central Western, and southern Gulf Coast States. Saline lakes and solar evaporation salt facilities are near populated regions in the Western United States. Almost every country in the world has salt deposits or solar evaporation operations of various sizes.

Substitutes: There are no economic substitutes or alternates for salt. Calcium chloride and calcium magnesium acetate, hydrochloric acid, and potassium chloride can be substituted for salt in deicing, certain chemical processes, and food flavoring, but at a higher cost.

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

SAND AND GRAVEL (CONSTRUCTION)[1]

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

Domestic Production and Use: Construction sand and gravel valued at $5.1 billion was produced by an estimated 3,800 companies from 5,845 operations in 50 States. Leading States, in order of volume, were California, Texas, Michigan, Ohio, Arizona, Colorado, Minnesota, Washington, and Utah, which combined accounted for about 52% of the total output. It is estimated that about 51% of the 1.08 billion metric tons of construction sand and gravel produced in 1999 was for unspecified uses. Of the remaining total, about 42% was used as concrete aggregates; 25% for road base and coverings and road stabilization; 13% as asphaltic concrete aggregates and other bituminous mixtures; 12% as construction fill; 2% for concrete products such as blocks, bricks, pipes, etc.; 2% for plaster and gunite sands; and the remainder for snow and ice control, railroad ballast, roofing granules, filtration, and other miscellaneous uses.

The estimated output of construction sand and gravel in the 48 conterminous States shipped for consumption in the first 9 months of 1999 was about 816 million tons, which represents an increase of 2.8% compared with the same period of 1998. Additional production information by quarter for each State, geographic region, and the United States is published in the Quarterly Mineral Industry Surveys for Crushed Stone and Sand and Gravel.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production	907	[3]914	952	1,080	1,080
Imports for consumption	1	1	2	1	2
Exports	1	1	2	2	2
Consumption, apparent	907	914	952	1,080	1,080
Price, average value, dollars per ton	4.30	4.38	4.47	4.57	4.69
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e]	33,000	33,200	33,900	35,600	36,300
Net import reliance[4] as a percent of apparent consumption	—	—	—	—	—

Recycling: Asphalt road surfaces and cement concrete surfaces and structures were recycled on a limited, but increasing, basis.

Import Sources (1995-98): Canada, 72%; The Bahamas, 14%; Mexico, 3%; and other, 11%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Sand, construction	2505.90.0000	Free.
Gravel, construction	2517.10.0000	Free.

Depletion Allowance: Common varieties, 5% (Domestic and foreign).

Government Stockpile: None.

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SAND AND GRAVEL (CONSTRUCTION)

Events, Trends, and Issues: Construction sand and gravel output increased slightly in 1999. It is estimated that 2000 domestic production and U.S. apparent consumption will be about 1.13 billion tons each, a 4.4% increase. Aggregate consumption should see continued growth because of increased outlays for highway construction and maintenance provided by the Transportation Equity Act for the 21st Century (Public Law 105-178). The law guarantees that $165 billion will be obligated for highways and $35 billion for transit work through 2003.

The construction sand and gravel industry continued to be concerned with safety and health regulations and environmental restrictions. Shortages in urban and industrialized areas were expected to continue to increase because of local zoning regulations and land development. For these reasons, movement of sand and gravel operations away from highly populated centers is expected to continue.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	1998	1999[e]	
United States	1,080	1,080	The reserves and reserve base are controlled largely by land use and/or environmental constraints.
Other countries	NA	NA	
World total	NA	NA	

World Resources: Sand and gravel resources of the world are large. However, because of their geographic distribution, environmental restrictions, and quality requirements for some uses, their extraction is sometimes uneconomic. The most important commercial sources of sand and gravel have been river flood plains, river channels, and glacial deposits. Marine deposits are being used presently in the United States, mostly for beach erosion control, and as a source of construction aggregates in other countries.

Substitutes: Crushed stone remains the predominant choice for construction aggregate use.

[e]Estimated. NA Not available.
[1]See also Sand and Gravel (Industrial).
[2]See Appendix A for conversion to short tons.
[3]Excludes Hawaii.
[4]Defined as imports - exports + adjustments for Government and industry stock changes; changes in stocks not available and assumed to be zero.
[5]See Appendix C for definitions.

SAND AND GRAVEL (INDUSTRIAL)

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

Domestic Production and Use: Industrial sand and gravel valued at about $514 million was produced by 80 companies from 136 operations in 36 States. Leading States, in order of volume, were Illinois, Michigan, New Jersey, California, Wisconsin, and Texas. Combined production from these States represented 50% of the national total. About 39% of the national tonnage was used as glassmaking sand, 22% as foundry sand, 5% as abrasive sand, 4% as hydraulic fracturing sand, and the remaining 30% for other uses.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production	28,200	27,800	28,500	28,200	28,300
Imports for consumption	65	7	39	44	197
Exports	1,870	1,430	980	2,400	1,630
Consumption, apparent	26,400	26,400	27,600	26,200	26,900
Price, average value, dollars per ton	17.82	17.88	17.93	18.19	18.15
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e]	1,450	1,450	1,450	1,400	1,400
Net import reliance[2] as a percent of apparent consumption	E	E	E	E	E

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

Import Sources (1995-98): Australia, 60%; Mexico, 21%; Canada, 14%; Sweden, 3%; and other, 2%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
95% or more silica and not more than 0.6% iron oxide	2505.10.1000	Free.

Depletion Allowance: Industrial sand or pebbles, 15% (Domestic and foreign).

Government Stockpile: None.

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SAND AND GRAVEL (INDUSTRIAL)

Events, Trends, and Issues: Imports surged by nearly 4.5 times from those of 1998. Mexico and Canada were the leading sources of imports in 1999, accounting for more than 92% of imports. Import levels were the highest reported in at least the past 20 years. Imports of silica are generally of two types: small-quantity shipments of very-high-purity silica or a few large shipments of lower grade silica that is shipped only when special circumstances were achieved (e.g., very favorable freight rates).

The United States was the world's largest producer and consumer of industrial sand and gravel based on estimated world production figures. It was difficult to collect definitive numbers on silica sand and gravel production in most nations because of the wide range of terminologies and specifications for silica from country to country. Attempts to improve the accuracy of data on world industrial sand and gravel production are ongoing, and revisions should be expected.

The United States remained a major exporter of silica sand, shipping sand to almost every region of the world. This was attributed to the high quality and advanced processing techniques of a large variety of grades of silica, meeting virtually every specification for silica sand and gravel.

The quantities of industrial sand and gravel sold or used increased slightly in 1999 compared with that of 1998. It is estimated that 2000 domestic production and apparent consumption will be about 29 million tons and 27 million tons, respectively.

The industrial sand and gravel industry continued to be concerned with safety and health regulations and environmental restrictions in 1999. Local shortages were expected to continue to increase owing to local zoning regulations and land development alternatives. These situations are expected to continue to cause a movement of sand and gravel operations away from high-population centers.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e]		Reserves and reserve base[3]
	1998	1999	
United States	28,200	28,300	
Australia	2,500	2,500	Large. Silica is abundant in the Earth's crust. The reserves and reserve base are determined mainly by the location of population centers.
Austria	6,000	6,000	
Belgium	2,400	2,400	
Brazil	2,700	2,700	
Canada	1,700	1,750	
France	6,500	6,500	
Germany	6,000	6,200	
India	1,400	1,500	
Italy	3,000	3,000	
Japan	3,050	3,100	
Mexico	1,600	1,700	
Netherlands	5,000	5,000	
Paraguay	10,000	10,000	
South Africa	3,000	3,100	
Spain	5,800	5,800	
Sweden	500	600	
United Kingdom	4,800	4,900	
Other countries	15,900	16,000	
World total (rounded)	110,000	111,000	

World Resources: Sand and gravel resources of the world are sizable. However, because of their geographic distribution, environmental restrictions, and quality requirements for some uses, extraction of these resources is sometimes uneconomic. Quartz-rich sand and sandstones, the main source of industrial silica sand, occur throughout the world.

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

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

SCANDIUM

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

Domestic Production and Use: Demand for scandium increased in 1999. Although scandium was not mined domestically in 1999, quantities sufficient to meet demand were available from domestic concentrates and tailings. Principal sources were imports from Russia and the Ukraine. Companies that processed scandium ores, concentrates, and low-purity compounds to produce refined scandium products were located in Mead, CO; Urbana, IL; and Knoxville, TN. Capacity to produce ingot and distilled scandium metal was located in Phoenix, AZ; Urbana, IL; and Ames, IA. Scandium used in the United States was derived from both domestic and foreign sources. Principal uses for scandium in 1999 were aluminum alloys for sporting equipment, metallurgical research, high-intensity metal halide lamps, analytical standards, electronics, and laser research.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production, refinery	W	W	W	W	W
Imports for consumption	NA	NA	NA	NA	NA
Exports	NA	NA	NA	NA	NA
Consumption	W	W	W	W	W
Price, yearend, dollars:					
Per kilogram, oxide, 99.0% purity	1,500	1,400	1,400	1,100	900
Per kilogram, oxide, 99.9% purity	3,300	2,900	2,900	2,300	1,400
Per kilogram, oxide, 99.99% purity	5,100	4,400	4,400	3,400	2,100
Per kilogram, oxide, 99.999% purity	7,650	6,750	6,750	5,750	4,000
Per gram, powder, metal[1]	372.00	372.00	285.00	285.00	270.00
Per gram, sublimed, metal[2]	169.00	169.00	172.00	172.00	175.00
Per gram, scandium bromide, 99.99% purity[3]	80.00	80.00	90.00	90.00	91.80
Per gram, scandium chloride, 99.9% purity[3]	37.00	37.00	38.80	38.80	39.60
Per gram, scandium fluoride, 99.9% purity[3]	77.00	77.00	78.50	78.50	80.10
Per gram, scandium iodide, 99.999% purity[3]	78.00	78.00	148.00	148.00	151.00
Stocks	NA	NA	NA	NA	NA
Employment, processors, number	8	5	4	2	2
Net import reliance[4] as a percent of apparent consumption	NA	NA	NA	NA	NA

Recycling: Very minor, recovered from laser crystal rods.

Import Sources (1995-98): Not available.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Mineral substances not elsewhere specified or included: Including scandium ores	2530.90.0000	Free.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed including scandium	2805.30.0000	5.0% ad val.
Mixtures of rare-earth oxides except cerium oxide, including scandium oxide mixtures	2846.90.2010	Free.
Rare-earth compounds, including individual rare-earth oxides, hydroxides, nitrates, and other individual compounds, including scandium oxide	2846.90.8000	3.7% ad val.
Aluminum alloys, other: Including scandium-aluminum	7601.20.9090	Free.

Depletion Allowance: Percentage method, 15% (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 1999, the total market remained very small. Domestic increases in demand were primarily from

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SCANDIUM

recently developed applications in welding wire, scandium-aluminum baseball and softball bats, scandium-aluminum bicycle frames, and lacrosse sticks. Future demand is expected to be in fuel cells.

Scandium's use continued to increase in metal halide lighting. Scandium additions, as the metal or the iodide, mixed with other elements, were added to halide light bulbs to adjust the color to appear like natural sunlight. Demand also continued to increase for scandium-aluminum alloys. Future development is expected to occur in alloys for aerospace and specialty markets, including sports equipment. Market activity increased in 1998, primarily to meet demand for alloying. Scandium's availability from the Former Soviet Union (FSU) increased substantially back in 1992, after export controls were relaxed, and sales to the Western World, especially from the Ukraine, have been increasing. China also continued to supply a small quantity of goods to the U.S. market.

The price of scandium materials varies greatly based on purity and quantity. The weight-to-price ratio of scandium metals and compounds was generally much higher for gram quantities than for kilogram purchases. Kilogram prices for scandium metal ingot were typically double the cost of the starting scandium compound, while higher purity distilled or sublimed metal ranged from four to six times the cost of the starting material.

World Mine Production, Reserves, and Reserve Base: Scandium was produced as a byproduct material in China, Kazakhstan, Ukraine, and Russia. Foreign mine production data were not available. No scandium was mined in the United States in 1999. Scandium occurs in many ores in trace amounts but has not been found in sufficient quantities to be considered a reserve or reserve base.[5] As a result of its low concentration, scandium has been produced exclusively as a byproduct during processing of various ores or recovered from previously processed tailings or residues.

World Resources: Resources of scandium are abundant, especially when considered in relation to actual and potential demand. Scandium is rarely concentrated in nature due to its lack of affinity to combine with the common ore forming anions. It is widely dispersed in the lithosphere and forms solid solutions in over 100 minerals. In the Earth's crust, scandium is primarily a trace constituent of ferromagnesium minerals. Concentrations in these minerals (amphibole-hornblende, pyroxene, and biotite) typically range from 5 to 100 parts per million equivalent Sc_2O_3. Ferromagnesium minerals commonly occur in the igneous rocks, basalt and gabbro. Enrichment of scandium also occurs in rare-earth minerals, wolframite, columbite, cassiterite, beryl, garnet, muscovite, and the aluminum phosphate minerals. Recent domestic production has primarily been from the scandium-yttrium silicate mineral, thortveitite, and from byproduct leach solutions from uranium operations. Future production is expected from tantalum residues. One of the principal domestic scandium resources is the fluorite tailings from the Crystal Mountain deposit near Darby, MT. Tailings from the mined-out fluorite operations, which were generated from 1952 to 1971, contain the scandium mineral, thortveitite, and other associated scandium-enriched minerals. Resources are also contained in the tantalum residues previously processed at Muskogee, OK. Smaller resources are contained in tungsten, molybdenum, and titanium minerals from the Climax molybdenum deposit in Colorado, and in kolbeckite (sterrettite), varisite, and crandallite at Fairfield, UT. Other lower grade domestic resources are present in ores of aluminum, iron, molybdenum, nickel, phosphate, tantalum, tin, titanium, tungsten, zinc, and zirconium. Process residues from tungsten operations in the United States also contain significant amounts of scandium.

Foreign resources are known in China, Kazakhstan, Madagascar, Norway, and Russia. 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. 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, it is generally not subject to substitution. In metallurgical applications, titanium and aluminum high-strength alloys and carbon fiber may substitute in sporting goods, especially bicycle frames.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Less than 250 micron, 99.9% purity, 1995 through 1999 prices converted from 0.5-gram price, from Alfa Aesar, a Johnson Matthey company.
[2]Lump, sublimed dendritic 99.99% purity, from Alfa Aesar, a Johnson Matthey company.
[3]Bromide, chloride, and fluoride in crystalline or crystalline aggregate form and scandium iodide as ultradry powder from Alfa Aesar, a Johnson Matthey company.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix C for definitions.

SELENIUM

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

Domestic Production and Use: Primary selenium was recovered from anode slimes generated in the electrolytic refining of copper. 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, 14%; and other, including agriculture and metallurgy, 31%. In glass manufacturing, selenium was used to decolor container glass and other soda-lime silica glasses and to reduce solar heat transmission in architectural plate glass. Cadmium sulfoselenide red pigments, which have good heat stability, were used in ceramics and plastics. Chemical uses included rubber compounding chemicals, gun bluing, catalysts, human dietary supplements, and antidandruff shampoos. Dietary supplementation for livestock was the largest agricultural use. Combinations of bismuth and selenium were added to brasses to replace lead in plumbing applications. Selenium was added to copper, lead, and steel alloys to improve their machinability. In electronics, high-purity selenium was used primarily as a photoreceptor on the drums of plain paper copiers; but this application has reached the replacement-only stage as selenium has been supplanted by newer materials in currently manufactured copiers.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production, refinery	373	379	W	W	W
Imports for consumption, metal and dioxide	324	428	346	339	320
Exports, metal, waste and scrap	270	322	127	151	240
Consumption, apparent[1]	517	564	W	W	W
Price, dealers, average, dollars per pound, 100-pound lots, refined	4.89	4.00	2.94	2.49	2.55
Stocks, producer, refined, yearend	W	W	W	W	W
Employment, number	NA	NA	NA	NA	NA
Net import reliance[2] as a percent of apparent consumption	31	38	W	W	W

Recycling: There was no domestic production of secondary selenium. Scrap xerographic materials were exported for recovery of the contained selenium. An estimated 70 tons of selenium metal recovered from scrap was imported in 1999.

Import Sources (1995-98): Canada, 33%; Philippines, 30%; Belgium, 14%; Japan, 8%; and other, 15%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
Selenium metal	2804.90.0000	Free.
Selenium dioxide	2811.29.2000	Free.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: None.

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SELENIUM

Events, Trends, and Issues: Domestic selenium consumption was about the same as that in 1998. World selenium demand was steady, but production decreased so the oversupply situation was eased somewhat. The steady decline in the price of selenium that began in 1996 continued for the first third of 1999, but the price rose steadily thereafter.

The use of selenium in glass remained strong. The use in copiers continued to decline, while the use in metallurgical additives increased. The use of selenium as an additive to no-lead, free-machining brasses for plumbing applications continued to increase as more stringent regulations on lead in drinking water took effect (ordinary free-machining brass contains up to 7% lead). Alloys with bismuth/selenium additions are dominating this market. Selenium reduces the quantity of bismuth needed, without adverse effects on alloy properties.

Long-range research was continued to confirm the effectiveness of dietary selenium supplementation in cancer prevention. However, the dosage requirement for direct supplementation is likely to be small: 200 to 400 micrograms per day.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[3]	Reserve base[3]
	1998	1999[e]		
United States	W	W	10,000	19,000
Belgium	200	—	—	—
Canada	384	385	7,000	15,000
Chile	49	50	19,000	30,000
Finland	26	30	—	—
Germany	100	100	—	—
Japan	551	550	—	—
Peru	21	21	2,000	5,000
Philippines	40	40	2,000	3,000
Serbia and Montenegro	30	30	1,000	1,000
Sweden	20	20	—	—
Zambia	15	18	3,000	6,000
Other countries[4]	13	13	27,000	55,000
World total (rounded)	[5]1,450	[5]1,260	70,000	130,000

World Resources: In addition to the reserve base of selenium, which is contained in identified economic copper deposits, 2.5 times this quantity of selenium was estimated to exist in copper or other metal deposits that were undeveloped, of uneconomic grade, or as yet undiscovered. Coal contains an average of 1.5 parts per million of selenium, which is about 80 times the average for copper deposits, but recovery of selenium from coal appears unlikely in the foreseeable future.

Substitutes: High purity silicon has replaced selenium in high-voltage rectifiers and is the major substitute for selenium in low- and medium-voltage rectifiers. Other inorganic semiconductor materials, such as silicon, cadmium, tellurium, gallium, and arsenic, as well as organic photoconductors, substitute for selenium in photoelectric applications. Other substitutes include cerium oxide in glass manufacturing; tellurium in pigment and rubber compounding; bismuth, lead, and tellurium in free-machining alloys; and bismuth and tellurium in lead-free brasses.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Calculated using reported shipments, imports of selenium metal, and estimated exports of selenium metal, excluding scrap.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions.
[4]In addition to the countries listed, Australia, China, India, Kazakhstan, Russia, the United Kingdom, and Zimbabwe are known to produce refined selenium.
[5]Excludes 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 1999 was about $500 million. Ferrosilicon was produced by six companies in six plants, and silicon metal was produced by four companies in seven plants. Two of the eight companies in the industry produced both products. Most of the ferrosilicon and silicon metal plants were east of the Mississippi River or in the Pacific Northwest. Most ferrosilicon was consumed in the ferrous foundry and steel industries, predominantly in the eastern one-half of the United States. The main consumers of silicon metal were aluminum producers 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:	1995	1996	1997	1998	1999[e]
Production	396	412	430	429	425
Imports for consumption	250	227	256	241	252
Exports	47	44	50	47	67
Consumption, apparent	609	594	628	616	610
Price,[1] average, cents per pound Si:					
Ferrosilicon, 50% Si	57.9	64.0	54.8	52.1	49
Ferrosilicon, 75% Si	58.1	62.2	48.0	43.1	42
Silicon metal	69.5	89.7	81.4	70.5	57
Stocks, producer, yearend	35	35	44	50	50
Net import reliance[2] as a percent of apparent consumption	35	31	32	30	30

Recycling: Insignificant.

Import Sources (1995-98): Norway, 27%; Russia, 13%; Brazil, 11%; Canada, 10%; and other, 39%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Ferrosilicon, 55%-80% Si:		
More than 3% Ca	7202.21.1000	1.1% ad val.
Other	7202.21.5000	1.5% ad val.
Ferrosilicon, 80%-90% Si	7202.21.7500	1.9% ad val.
Ferrosilicon, more than 90% Si	7202.21.9000	5.8% ad val.
Ferrosilicon, other:		
More than 2% Mg	7202.29.0010	Free.
Other	7202.29.0050	Free.
Silicon, more than 99.99% Si	2804.61.0000	Free.
Silicon, 99.00%-99.99% Si	2804.69.1000	5.3% ad val.
Silicon, other	2804.69.5000	5.5% ad val.

Depletion Allowance: Quartzite, 15% (Domestic and foreign); gravel, 5% (Domestic and foreign).

Government Stockpile: Information on silicon carbide in the National Defense Stockpile is discussed in the “Manufactured Abrasives” chapter.

Events, Trends, and Issues: Domestic apparent consumption of silicon for 1999 is projected as just slightly less than that for 1998, or approximately the same as the average for 1995-98. Of the 1999 total, ferrosilicon is estimated to account for 57% and silicon metal 43%. The annual growth rate for ferrosilicon demand is expected to fall in the range of 1% to 2%, in line with long-term trends in steel production. Trends during the first half of 1999 suggested that domestic steel production could be as much as 5% less than that for 1998. The annual growth rate for silicon metal demand has been greater than that for ferrosilicon—about 3% for silicon demand by the aluminum industry and about 8% for silicon demand by the chemical industry. While demand by the chemical industry, principally for silicones, has been affected by the Asian economic crisis, indications were that silicon demand was picking up in the Western World through at least the first half of 1999.

In terms of contained silicon, domestic production is projected to be only slightly less than that for 1998, mostly because of a decline in ferrosilicon output. Cutbacks in silicon metal production were carried out by domestic as well as foreign producers.

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SILICON

Price trends for silicon materials in the U.S. market through the first three quarters of 1999 were mixed. The trend for the first three quarters indicated recovery in price for 75% ferrosilicon but, for the third consecutive year, declines in price for 50% ferrosilicon and especially silicon metal. Prices as of the end of September versus those at the beginning of the year were lower by 7% for 50% ferrosilicon and by 24% for silicon metal, and higher by 4% for 75% ferrosilicon. As of the end of September, the range in dealer import price, in cents per pound of contained silicon, was 46 to 50 for 50% ferrosilicon, 40.5 to 41.5 for 75% ferrosilicon, and 50 to 51 for silicon metal.

A unique action by the U.S. International Trade Commission may have had a bearing on prices, especially those for ferrosilicon. In August, after having replaced its changed circumstances review of imports of ferrosilicon with a reconsideration of its 1993-94 injury determinations, the Commission now found, in light of price-fixing by domestic producers, that the domestic industry had not been injured by imports. Consequently, antidumping and countervailing duties on imports of ferrosilicon from Brazil, China, Kazakhstan, Russia, Ukraine, and Venezuela no longer had a basis, and subsequently were removed by the International Trade Administration of the U.S. Department of Commerce. Legal challenges were expected.

World Production, Reserves, and Reserve Base:

	Production[e]		Reserves and reserve base[3]
	1998	**1999**	
United States	429	425	The reserves and reserve base in most major producing countries are ample in relation to demand. Quantitative estimates are not available.
Australia	29	29	
Brazil	254	236	
Canada	58	48	
China	715	780	
Egypt	26	26	
France	145	145	
Iceland	40	52	
India	58	58	
Kazakhstan	60	65	
Macedonia	37	37	
Norway	413	395	
Poland	50	47	
Russia	362	372	
Slovakia	20	20	
South Africa	98	99	
Spain	34	44	
Ukraine	195	195	
Venezuela	39	46	
Other countries	112	110	
World total (rounded)	3,200	3,200	

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 Brazil, China, Norway, Russia, Ukraine, and the United States, and for silicon metal Brazil, China, France, Norway, and the United States. China was by far the largest producer of ferrosilicon and may well have been the largest producer of silicon metal. China's production of silicon metal is not included in this tabulation because data are not available.

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

Substitutes: Various metals and alloys, such as aluminum and silicomanganese, can be substituted for ferrosilicon in some applications. Germanium and gallium arsenide are the principal substitutes for silicon in semiconductor and infrared applications.

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

SILVER

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

Domestic Production and Use: In 1999, U.S. silver production was about 1,860 tons with an estimated value of $320 million. Nevada was the largest producer, with more than 490 tons. Precious metal ores accounted for approximately one-half of domestic silver production; the other one-half was recovered as a byproduct from processing of copper, lead, and zinc ores. There were 22 principal refiners of commercial-grade silver with an estimated output of approximately 4,000 tons. About 30 fabricators accounted for more than 90% of the silver consumed in arts and industry. The remainder was consumed mostly by small companies and artisans. Aesthetic uses of silver for decorative articles, jewelry, tableware, and coinage were overshadowed by industrial and technical uses. Industrial and technical uses include photographic materials, electrical products, catalysts, brazing alloys, dental amalgam, and bearings.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production: Mine	1,560	1,570	2,180	2,060	1,860
Refinery: Primary	NA	NA	2,200	2,300	2,300
Secondary	NA	NA	1,360	1,700	1,700
Imports for consumption[2]	3,250	3,010	2,540	3,330	2,800
Exports[2]	2,890	2,950	3,080	2,250	2,000
Shipments from Government stockpile excesses	220	232	109	—	—
Consumption, apparent	NA	NA	4,980	4,300	4,500
Price, dollars per troy ounce[3]	5.15	5.19	4.89	5.54	5.20
Stocks, yearend: Treasury Department[4]	520	402	484	582	500
COMEX, CBT[5]	6,290	4,550	3,430	2,360	2,390
Department of Defense	13	10	—	—	—
Employment, mine and mill,[6] number	1,200	1,400	1,550	1,550	1,600
Net import reliance[7] as a percent of apparent consumption	NA	NA	E	14	14

Recycling: About 1,700 tons of silver was recovered from old and new scrap in 1999.

Import Sources[2] (1995-98): Mexico, 30%; Canada, 26%; Peru, 8; Chile, 3%; and other, 33%.

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

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: The Government continued to dispose of the silver held in the National Defense Stockpile, using it primarily for the production of commemorative coins and the Eagle silver bullion coins. During the past 17 years, from 1982 through September 30, 1999, the Government has reduced the quantity of silver held in the Stockpile from 4,300 tons to about 815 tons.

Stockpile Status—9-30-99[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Silver	815	—	815	311	277

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SILVER

Events, Trends, and Issues: Representatives of the Silver Users Association (SUA), the Silver Institute, and the International Precious Metals Institute met with officials of the Office of Occupational Safety and Health Administration (OSHA) to discuss an SUA initiative seeking revision to the Permissible Exposure Limit (PEL) for airborne silver in workroom air. In 1998, SUA submitted its study, "The Effect of Exposure to Silver, a Survey of the Literature," to accompany its request to OSHA for revising the PEL for silver in workroom air. The study agreed with the European view that soluble silver should be regulated differently from insoluble silver. After a detailed review of the survey, which resulted from SUA interviews in Europe and an exchange of information from Europe and Japan, OSHA requested that the association clarify further some of the findings by the overseas researchers who have studied the exposure of individuals working with silver.

Photographic applications account for about 28% of total silver demand, and digital imaging is considered to be a potential threat to this sector of the market. In contrast to the use of silver halide film in conventional photography, digital technology converts images directly into electronic form, thereby avoiding the need for silver. Silver halide pictures may also be scanned into electronic form, which necessitates the use of silver in taking and printing the picture but eliminates the need for silver halide technology in further processing. The major advantage of using digital cameras is the ability to immediately capture a digital picture that can be manipulated on a personal computer using readily available software. The major disadvantage is that digital cameras are expensive and produce poorer picture quality compared to conventional cameras.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[9]	Reserve base[9]
	1998	1999[e]		
United States	2,060	1,860	33,000	72,000
Australia	1,469	1,500	29,000	33,000
Canada	1,179	1,100	37,000	47,000
Mexico	2,680	2,700	37,000	40,000
Peru	1,934	1,900	25,000	37,000
Other countries	7,070	6,700	120,000	190,000
World total (rounded)	16,400	15,900	280,000	420,000

World Resources: Approximately two-thirds of world silver resources are associated with copper, lead, and zinc deposits, often at great depths. The remaining one-third is in vein deposits in which gold is the most valuable metallic component. Although most recent discoveries have been primarily gold and silver deposits, significant future reserves and resources are expected from major base metal discoveries that contain byproduct silver. Even though the price of silver and improved technology may appear to increase sharply the quantity of minable reserves, the extraction of silver from these resources will depend on the salability of the primary base metals.

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

[e]Estimated. E Net exporter. NA Not available.
[1]One metric ton (1,000 kilograms) = 32,150.7 troy ounces.
[2]Refined bullion, plus silver content of ores, concentrates, precipitates, and doré; excludes coinage, waste, and scrap material.
[3]Handy & Harman quotations.
[4]Balance in U.S. Mint only.
[5]COMEX: Commodity Exchange Inc., New York. CBT: Chicago Board of Trade.
[6]Source: Mine Safety and Health Administration.
[7]Defined as imports - exports + adjustments for Government and industry stock changes.
[8]See Appendix B for definitions.
[9]Includes silver recoverable from base metal ores. See Appendix C for definitions.

SODA ASH

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Four companies in Wyoming operating five plants and one company in California with one plant composed the U.S. soda ash (sodium carbonate) industry, which was the largest in the world. The five producers, with a combined annual nameplate capacity of 13 million tons, operated at 78% of nameplate capacity. 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. The total estimated value of domestic soda ash produced in 1999 was $800 million.[1]

Based on final 1998 data, the estimated 1999 reported distribution of soda ash by end use was glass, 49%; chemicals, 27%; soap and detergents, 11%; distributors, 5%; flue gas desulfurization, 3%; pulp and paper and water treatment, 2% each; and other, 1%.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production[2]	10,100	10,200	10,700	10,100	10,100
Imports for consumption	83	107	101	83	85
Exports	3,570	3,840	4,190	3,660	3,550
Consumption: Reported	6,500	6,390	6,480	6,550	6,610
Apparent	6,510	6,470	6,620	6,560	6,610
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	74.50	82.60	77.25	75.30	72.00
Stocks, producer, yearend	306	271	259	273	300
Employment, mine and plant, number	2,800	2,800	2,800	2,700	2,600
Net import reliance[3] as a percent 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 (1995-98): Canada, 99%; and other, 1%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Disodium carbonate	2836.20.0000	1.2% ad val.

Depletion Allowance: 15% (Domestic and foreign); for natural only.

Government Stockpile: None.

Events, Trends, and Issues: The economic problems in Asia that began in 1997 and continued in 1999 reduced U.S. soda ash exports; however, China increased its soda ash exports to local Asian consumers. A buildup of excess soda ash supplies in China prompted producers to reduce inventories by exporting the surplus at reduced prices. Also, China began preliminary discussions about forming an export association that would manage the handling and distribution of soda ash shipment by the majority of the Chinese soda ash industry. In November, the Chinese hosted an international synthetic soda ash conference to promote the activities of its industry. The synthetic soda ash producer in England, which had previously purchased its rival soda ash plant in the Netherlands, was itself acquired by a group of U.S. investors, including a major bank.

A U.S. soda ash producer in Wyoming was sold at midyear to the largest domestic soda ash producer that also had a plant in Wyoming. The acquisition was done to strengthen the competitive position of the latter and gain access to the former's trona resources adjacent to their mine.

A new glass container was introduced that could affect consumption of soda ash in glass manufacture. The largest glass container manufacturer in North America developed a new lightweight glass bottle known as the Duraglass XL™ bottle, that reduces the amount of glass required to make a typical bottle, resulting in faster and more cost effective

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SODA ASH

production of containers, reduced energy consumption, and lower transportation costs. Furthermore, raw material requirements reportedly are reduced 10% to 20%, which will further reduce soda ash sales to this sector. The company dedicated two production lines for this new container at its Streator, IL, plant but plans to install the process at some of its other locations as the new container gains acceptance. A major brewery was listed as one of first customers to use this new glass bottle at its Milwaukee, WI, plant. The new bottles are 100% recyclable.

World soda ash consumption is forecast to remain favorable into the next century because of growing demand for soda ash in developing nations, especially in the Far East and in South America. Exports will continue to be the most important market for increased U.S. soda ash sales. Consolidation within the U.S. soda ash industry will reduce the number of suppliers but should strengthen soda ash sales and prices. Soda ash consumption in glass containers will probably continue to decline as lightweight bottles and plastic containers displace the quantity of new raw materials for glass manufacture.

Notwithstanding the economic problems in certain regions, the overall world demand for soda ash is expected to grow 1.5% to 2% annually in the early part of the next century. Domestic demand should be slightly higher in 2000.

World Production, Reserves, and Reserve Base:

	Production		Reserves[4 5]	Reserve base[5]
Natural:	1998	1999[e]		
United States	10,100	10,100	[6]23,000,000	[6]39,000,000
Botswana	200	190	400,000	NA
Kenya	200	200	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)	10,500	10,500	24,000,000	40,000,000
World total, synthetic (rounded)	21,200	21,300	—	—
World total (rounded)	31,700	31,800	—	—

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. Commercial mining of nahcolite is presently being done by one producer in Colorado, and two other companies are trying to obtain financing for development of competing nahcolite projects. None of the ventures are associated with oil shale mining or with dawsonite recovery.

Substitutes: Caustic soda can be substituted for soda ash in certain uses, particularly in the pulp and paper, water treatment, and certain chemical sectors. Soda ash, soda liquors, or trona can be used as feedstock to manufacture chemical caustic soda, which is an alternative to electrolytic caustic soda.

[e]Estimated. E Net exporter. NA Not available.
[1]Does not include values for soda liquors and mine waters.
[2]Natural only.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]The reported quantities are sodium carbonate only. About 1.8 tons of trona yields 1 ton of sodium carbonate.
[5]See Appendix C for definitions.
[6]From trona, nahcolite, and dawsonite sources.

SODIUM SULFATE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: The domestic natural sodium sulfate industry consisted of two producers operating a total of two plants in California and Texas. Total production of natural and synthetic sodium sulfate increased an estimated 10% compared with that of 1998. Approximately one-half of total production was as byproduct from facilities that manufacture rayon and various chemicals. The total value of natural and synthetic sodium sulfate sold was an estimated $60 million.

Estimates of U.S. sodium sulfate consumption by end use were soap and detergents, 45%; textiles, 18%; pulp and paper, 13%; glass, 10%; and miscellaneous, 14%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production: Natural	327	306	318	W	W
Synthetic[1]	318	296	262	NA	NA
Total[1]	645	602	580	535	590
Imports for consumption	206	177	150	110	80
Exports	66	86	86	90	140
Consumption, apparent (natural and synthetic)	803	690	636	555	530
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
Average sales value (natural source), f.o.b. mine or plant, dollars per metric ton	84.55	88.90	109.13	W	W
Stocks, producer, yearend, natural	16	19	26	W	W
Employment, well and plant, number	240	240	240	W	W
Net import reliance[2] as a percent of apparent consumption	17	13	10	4	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 (1995-98): Canada, 95%; Mexico, 4%; and other, 1%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
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: 15% (Domestic and foreign); for natural only.

Government Stockpile: None.

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SODIUM SULFATE

Events, Trends, and Issues: Data reporting from the natural sodium sulfate company that has an operation in Texas was terminated in mid-1998 at the company's request, resulting in the suspension of the U.S. Geological Survey's natural sodium sulfate canvass for this industry. Collection of data from the California operation continues but cannot be disclosed and must be withheld. Total sodium sulfate production statistics continue to be collected and published by the U.S. Bureau of the Census.

Byproduct production from rayon and battery recycling facilities declined in 1999. The demand for rayon decreased because of imports of less expensive textiles, and the availability of recycled leaded automotive batteries was lower than normal because of the mild winters for the past couple of years and better battery manufacturing. Severe winter weather causes a strain on battery life resulting in more batteries being discarded and recycled.

Consumption of sodium sulfate by the detergent industry remained strong in 1999 as powdered laundry detergent manufacturers increased sales, especially to developing nations. Liquid detergents, which do not use very much sodium sulfate in their formulations, remain popular in North America. Sodium sulfate use by the pulp and paper sector remained stagnant and was expected to remain so in the future.

The outlook for sodium sulfate in 2000 is forecast to be slightly lower than that for 1999, with detergents remaining the largest sodium sulfate-consuming sector. World production and consumption of sodium sulfate are expected to grow in the next few years, especially in Asia and South America.

World Production, Reserves, and Reserve Base: Data on mine production for natural sodium sulfate are not available; however, total world production of natural sodium sulfate is about 4 million tons. Total world production of byproduct sodium sulfate is estimated between 1.5 million tons and 2.0 million tons.

	Reserves[3]	Reserve base[3]
Natural:		
United States	860,000	1,400,000
Canada	84,000	270,000
Mexico	170,000	230,000
Spain	180,000	270,000
Turkey	100,000	NA
Other countries	100,000	200,000
World total, natural (rounded)	3,300,000	4,600,000

World Resources: Sodium sulfate resources are sufficient to last hundreds of years at the present rate of world consumption. In addition to the countries listed in World Production, 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 metric tons of sodium sulfate resource, representing about 35% of the lake brine. In Utah, about 12% of the dissolved salts in the Great Salt Lake is sodium sulfate, representing about 400 million tons of resource. An irregular, 21-meter-thick mirabilite deposit is associated with clay beds 4.5 to 9.1 meters below the lake bottom near Promontory Point, UT. Several playa lakes in west Texas contain underground sodium sulfate-bearing brines and crystalline material. Other economic and subeconomic deposits of sodium sulfate are near Rhodes Marsh, NV; Grenora, ND; Okanogan County, WA; and Bull Lake, WY. Sodium sulfate can also be obtained as a byproduct from the production of ascorbic acid, boric acid, cellulose, chromium chemicals, lithium carbonate, rayon, resorcinol, and silica pigments. The quantity and availability of byproduct sodium sulfate are dependent on the production capabilities of the primary industries and the sulfate recovery rates.

Substitutes: In pulp and paper, emulsified sulfur and caustic soda (sodium hydroxide) can replace sodium sulfate. In detergents, a variety of products can substitute for sodium sulfate. In glassmaking, soda ash and calcium sulfate have been substituted for sodium sulfate with less-than-perfect results.

[e]Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Source: Bureau of the Census. Synthetic production data are revised in accordance with recent updated Census statistics.
[2]Defined as imports - exports + adjustments for Government and industry stock changes (if available).
[3]See Appendix C for definitions.

STONE (CRUSHED)[1]

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

Domestic Production and Use: Crushed stone valued at $8.6 billion was produced by 1,500 companies operating 3,800 active quarries in 49 States. Leading States, in order of production, were Texas, Pennsylvania, Florida, Georgia, Illinois, Missouri, Ohio, North Carolina, Virginia, and Tennessee, together accounting for about 51.3% of the total output. It is estimated that, of the 1.56 billion tons of crushed stone produced in 1999, about 42.4% was for unspecified uses with only 13.6% estimated for nonrespondents. Of the remaining 870 million tons, about 82.4% was used as construction aggregates mostly for highway and road construction and maintenance; 14.7% for chemical and metallurgical uses, including cement and lime manufacture; 1.6% for agricultural uses; and 1.2% 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 Minerals Yearbook, are not included in the above percentages. Of the total crushed stone produced in 1998, about 70% was limestone and dolomite; 16%, granite; 7%, traprock; and the remaining 7%, was shared, in descending order of quantity, by sandstone and quartzite, miscellaneous stone, marble, slate, calcareous marl, 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 1999 was 1.14 billion tons, which represents an increase of 3.3% compared with the same period of 1998. Additional production information by quarters for each State, geographic division, and the United States is published in the Quarterly Mineral Industry Surveys for Crushed Stone and Sand and Gravel.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production	1,260	1,330	1,410	1,510	1,560
Imports for consumption	11	11	12	14	14
Exports	6	3	4	4	4
Consumption, apparent	1,265	1,338	1,418	1,520	1,570
Price, average value, dollars per metric ton	5.36	5.40	5.64	5.39	5.53
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e 3]	75,900	76,000	77,600	78,500	79,000
Net import reliance[4] as a percent of apparent consumption	—	—	—	—	—

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

Import Sources (1995-98): Canada, 53%; Mexico, 30%; The Bahamas, 9%; and other, 8%.

Tariff: Item	**Number**	**Normal Trade Relations 12/31/99**
Crushed stone	2517.10.00	Free.

Depletion Allowance: (Domestic) 15% 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 increased 3.3% in 1999. It is estimated that in 2000, domestic production and apparent consumption will be about 1.63 billion tons each, a 4.5% increase. The Transportation Equity Act for the 21st Century (Public Law 105-178) appropriated $205 billion through year 2003, a 44% increase compared to the previous Intermodal Surface Transportation Efficiency Act (ISTEA) 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 Environmental Protection Agency's new air quality standards for particulate matter, also known as PM 2.5.

The crushed stone industry continued to be concerned with safety regulations and environmental restrictions. Shortages in some urban and industrialized areas were expected to continue to increase owing to local zoning regulations and land development alternatives. These 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[6]
	1998	1999[e]	
United States	1,510	1,560	Adequate except where special
Other countries	NA	NA	types are needed or where
World total	NA	NA	local shortages exist.

World Resources: Stone resources of the world are very large. High-purity limestone and dolomite suitable for specialty uses are limited in many geographic areas. The largest resources of high-purity limestone and dolomite in the United States are in the central and eastern parts of the country.

Substitutes: Crushed stone substitutes for roadbuilding include sand and gravel and slag. Substitutes for construction aggregates include sand and gravel, slag, sintered or expanded clay or shale, and perlite or vermiculite.

[e]Estimated. NA Not available.
[1]See also Stone (Dimension).
[2]See Appendix A for conversion to short tons.
[3]Including office staff.
[4]Defined as imports - exports + adjustments for Government and industry stock changes. Changes in stocks were assumed to be zero in the net import reliance and apparent consumption calculations because data on stocks were not available.
[5]See Appendix C for definitions.

STONE (DIMENSION)[1]

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Approximately 1.04 million tons of dimension stone, valued at $230 million, was sold or used in 1999. Dimension stone was produced by 137 companies, operating 227 quarries, in 33 States and Puerto Rico. Indiana was the leading producing State, followed by Vermont, Georgia, and Wisconsin. These four States accounted for 44% of the tonnage output and 35% of the value. Approximately 37%, by tonnage, of dimension stone sold or used was granite, followed by limestone (33%), sandstone (16%), quartzite (4%), marble (3%), slate (3%), and miscellaneous stone (4%). By value, the largest sales or use were for granite (49%), followed by limestone (27%), sandstone (10%), slate (6%), marble (4%), and miscellaneous stone (4%). Rough block represented 55% of the tonnage and 41% of the value of all the dimension stone sold or used by domestic producers, excluding exports. The largest uses of rough block, by tonnage, were in construction (51%) and monuments (20%). Dressed stone was sold for flagging (26%), curbing (22%), and ashlars and partially squared pieces (19%), by tonnage.

Salient Statistics—United States:[2]	1995	1996	1997	1998	1999[e]
Production: Tonnage	1,160	1,150	1,180	1,130	1,040
Value, million dollars	233	234	225	224	230
Imports for consumption, value, million dollars	478	462	548	698	805
Exports, value, million dollars	52	50	55	60	45
Consumption, apparent, value, million dollars	659	646	718	862	990
Price	Variable, depending on type of product				
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[3]	3,000	3,000	3,000	3,000	3,000
Net import reliance[4] as a percent of apparent consumption (based on value)	65	64	69	74	77
Granite only:					
Production	495	501	444	414	420
Imports for consumption	NA	NA	NA	NA	NA
Exports (rough and finished)	158	137	166	145	131
Consumption, apparent	NA	NA	NA	NA	NA
Price	Variable, depending on type of product				
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[3]	1,500	1,500	1,500	1,500	1,500
Net import reliance[4] as a percent of apparent consumption (based on tonnage)	NA	NA	NA	NA	NA

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

Import Sources (1995-98 by value): Dimension stone: Italy, 42%; India, 12%; Canada, 12%; Spain, 10%; and other, 24%. Granite only: Italy, 43%; Canada, 15%; India, 15%; Brazil, 14%; and other, 13%.

Tariff: Dimension stone tariffs ranged from free to 4.9% ad valorem for countries with normal trade relations in 1999, according to type, degree of preparation, shape, and size. Most crude or rough trimmed stone is imported for 3.0% ad valorem or less.

Depletion Allowance: 15% (Domestic and foreign); 5% if used for rubble and other nonbuilding purposes.

Government Stockpile: None.

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STONE (DIMENSION)

Events, Trends, and Issues: Domestic production declined by 8% to 1.04 million tons valued at $230 million in 1999. Imports increased by 15% in value to $805 million, making 1999 the third consecutive year of double-digit increases in imports. Exports, on the other hand, declined 25% in value to $45 million. With the continued growth in the U.S. economy, markets for dimension stone have increased. Apparent consumption, by value, was $990 million, an increase of 15% from that of 1998. Dimension stone is being used more commonly in residential markets. Additionally, improved quarrying, finishing, and handling technology; and a greater variety of stone, as well as rising costs of alternative construction materials, are among the factors that indicate an increased demand for dimension stone during the next 5 to 10 years.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	1998	1999[e]	
United States	1,130	1,040	Adequate except for certain special types and local shortages.
Other countries	NA	NA	
World total	NA	NA	

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

Substitutes: In some applications, substitutes for dimension stone include concrete, steel, aluminum, resin-agglomerated stone, plastics, and glass.

[e]Estimated. NA Not available.
[1]See also Stone (Crushed).
[2]Includes Puerto Rico.
[3]Excluding office staff.
[4]Defined as imports - exports + adjustments for Government and industry stock changes. Changes in stocks were assumed to be zero in the net import reliance and apparent consumption calculations because data on stocks were not available.
[5]See Appendix C for definitions.

STRONTIUM

(Data in metric tons of contained strontium,[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, 76%; ferrite ceramic magnets, 10%; pyrotechnics and signals, 5%; and other applications, 9%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production, strontium minerals	—	—	—	—	—
Imports for consumption:					
Strontium minerals	12,700	11,600	12,500	10,600	13,200
Strontium compounds	20,800	20,500	26,000	25,000	26,800
Exports, compounds	1,160	712	599	875	473
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent, celestite and compounds	32,300	31,400	37,900	34,700	39,500
Price, average value of mineral imports at port of exportation, dollars per ton	71	67	72	60	77
Net import reliance[2] as a percent of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1995-98): Strontium minerals: Mexico, 100%. Strontium compounds: Mexico, 90%; Germany, 9%; and other, 1%. Total imports: Mexico, 94%; and Germany, 6%.

Tariff: Item	Number	Normal Trade Relations 12/31/99	Mexico 12/31/99
Celestite	2530.90.0010	Free	Free.
Strontium metal	2805.22.1000	3.7% ad val.	Free.
Compounds:			
Strontium carbonate	2836.92.0000	4.2% ad val.	Free.
Strontium nitrate	2834.29.2000	4.2% ad val.	Free.
Strontium oxide, hydroxide, peroxide	2816.20.0000	4.2% ad val.	Free.

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

Government Stockpile:

Stockpile Status—9-30-99[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Celestite	5,100	—	5,100	—	—

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STRONTIUM

<u>Events, Trends, and Issues</u>: Although there is celestite in the National Defense Stockpile, none of it is stockpile grade; its total value is listed as zero. The stockpile goal was reduced to zero in 1969, and at that time the stockpile contained both 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 2000 Annual Materials Plan, announced at the end of September 1999 by the Defense National Stockpile Center, did not list any quantity of celestite to be offered for disposal. Because the remaining material does not meet the quality specifications of celestite purchasers, it will be difficult to dispose of the material into the traditional markets. It might be attractive as a low-cost replacement for barite in drilling mud applications.

<u>World Mine Production, Reserves, and Reserve Base</u>:[4]

	Mine production		Reserves[5]	Reserve base[5]
	1998	1999[e]		
United States	—	—	—	1,400,000
Algeria	5,400	5,400		
Argentina	2,000	4,000		
China	35,000	35,000		
Iran	20,000	20,000		
Mexico	118,000	120,000	Other:	Other:
Pakistan	670	700	6,800,000	11,000,000
Spain	100,000	100,000		
Tajikistan	NA	NA		
Turkey	30,000	30,000		
World total (may be rounded)	[6]311,000	[6]315,000	6,800,000	12,000,000

<u>World Resources</u>: Resources in the United States are several times the reserve base. World resources, although not thoroughly evaluated, are thought to exceed 1 billion tons.

<u>Substitutes</u>: Although it is possible to substitute for strontium in some of its applications, such a change would adversely affect product performance and/or cost. For example, barium could replace strontium in color television picture tube glass only after extensive circuit redesign to reduce operating voltages that produce harmful secondary X-rays. Barium replacement of strontium in ferrite ceramic magnets would decrease the maximum energy and temperature characteristics of the magnets. Substituting for strontium in pyrotechnics would be impractical because the desired brilliance and visibility are imparted only by strontium and its compounds.

[e]Estimated. NA Not available.
[1]The strontium content of celestite is 43.88%; this amount was used to convert units of celestite.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.
[4]Metric tons of strontium minerals.
[5]See Appendix C for definitions.
[6]Excludes Tajikistan.

SULFUR

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

Domestic Production and Use: In 1999, elemental sulfur and byproduct sulfuric acid were produced at 149 operations in 30 States, Puerto Rico, and the U.S. Virgin Islands. Total shipments were valued at about $320 million. Elemental sulfur production was 9.8 million metric tons; Texas and Louisiana accounted for about 50% of domestic production. Elemental sulfur was recovered at petroleum refineries, natural gas processing plants, and coking plants by 52 companies at 121 plants in 26 States and the U.S. Virgin Islands. Elemental sulfur was produced by one company at two mines in two States, using the Frasch method of mining. One of the mines closed during the year. Byproduct sulfuric acid, representing 12% of sulfur in all forms, was recovered at 14 nonferrous smelters in 8 States by 10 companies. Three smelters closed. Domestic elemental sulfur provided 67% of domestic consumption and byproduct acid accounted for 9%. The remaining 24% of sulfur consumed was provided by imported sulfur and sulfuric acid. About 90% of sulfur was consumed in the form of sulfuric acid. Agricultural chemicals (primarily fertilizers) comprised 69% of reported sulfur demand; petroleum refining, 16%; metal mining, 7%; and chemicals, organic and inorganic, 4%. Other uses, accounting for 4% of demand, were widespread because a multitude of industrial products require sulfur in one form or another during some stage of their manufacture.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production: Frasch[e]	3,150	2,900	2,820	1,800	1,800
Recovered elemental	7,250	7,480	7,650	8,220	8,000
Other forms	1,400	1,430	1,550	1,610	1,300
Total[e] (may be rounded)	11,800	11,800	12,000	11,600	11,100
Shipments, all forms	12,100	11,800	11,900	12,100	10,900
Imports for consumption:					
Recovered, elemental	2,510	1,960	2,060	2,270	2,700
Sulfuric acid, sulfur content	628	678	659	668	430
Exports:					
Frasch and recovered elemental	906	855	703	889	640
Sulfuric acid, sulfur content	56	38	39	51	49
Consumption, apparent, all forms	14,300	13,600	13,900	14,100	13,300
Price, reported average value, dollars per ton of elemental sulfur, f.o.b., mine and/or plant	44.46	34.11	36.06	29.14	30.00
Stocks, producer, yearend	583	646	761	283	500
Employment, mine and/or plant, number	3,100	3,100	3,100	3,100	3,100
Net import reliance[1] as a percent of apparent consumption	21	13	13	18	17

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

Import Sources (1995-98): Elemental: Canada, 70%; Mexico, 24%; Venezuela, 5%; and other, 1%. Sulfuric acid: Canada, 80%; Mexico, 6%; Japan, 5%; Germany, 4%; and other, 5%. Total sulfur imports: Canada, 72%; Mexico, 19%; Venezuela, 4%; and other, 5%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
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: 23% (Domestic and foreign).

Government Stockpile: None.

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SULFUR

Events, Trends, and Issues: Frasch production continued to be plagued by technical production problems early in 1999. As production wells that had been lost to a late-1998 hurricane in the Gulf of Mexico were replaced, the west Texas mine was closed, leaving the off-shore Frasch operation as the single remaining sulfur mine in the United States and the Western Hemisphere. Although sulfur production at petroleum refineries increased, production for sulfur in all forms decreased for the second consecutive year. The decreased total production was attributed to reduced sulfur recovery at natural gas operations and lower byproduct sulfuric acid production from copper smelters. Three of seven copper smelters in the United States closed in 1999, reducing byproduct acid production by almost 20%. Further reductions in smelter acid production were expected for 2000.

Reduced production in the phosphate fertilizer industry caused by low demand for exported fertilizer contributed to significantly lower domestic sulfur consumption. Because production did not decrease as much as demand, producer stocks of sulfur increased and prices decreased. Increased demand for sulfur in other parts of the world and restricted availability of export material, especially from Canada, caused price increases for most of the rest of the world. Canadian sulfur producers, particularly natural gas operations in Alberta continued to stockpile sulfur in an effort to increase prices for their overseas exports.

Domestic Frasch sulfur production is not expected to surpass 2 million tons in the future and may not reach that level on a regular basis, depending on the demand situation. Production of recovered elemental sulfur from petroleum refineries will continue its steady growth, supported by new facilities being installed that are intended to increase the capability of current operations to handle higher-sulfur crudes from Mexico and Venezuela. Recovered sulfur from natural gas processing has decreased in recent years, and that trend may persist. The amount of byproduct sulfuric acid produced is closely tied to copper smelting; and no significant recovery in domestic copper smelting is expected for the next few years. Apparent consumption of sulfur in all forms is projected to remain steady at about at 13.3 million tons in 2000 unless phosphate fertilizer demand increases.

World Production, Reserves, and Reserve Base:

	Production—All forms		Reserves[2]	Reserve base[2]
	1998	1999[e]		
United States	11,600	11,100	140,000	230,000
Canada	9,250	9,500	160,000	330,000
China	6,150	6,000	100,000	250,000
France	1,050	1,000	10,000	20,000
Germany	1,180	1,200	NA	NA
Iran	900	900	NA	NA
Iraq	450	450	130,000	500,000
Japan	3,400	3,400	5,000	15,000
Kazakhstan	1,150	1,200	NA	NA
Mexico	1,390	1,400	75,000	120,000
Poland	1,570	1,300	130,000	300,000
Russia	4,480	4,500	NA	NA
Saudi Arabia	2,000	2,000	100,000	130,000
South Africa	532	500	NA	NA
Spain	993	950	50,000	300,000
Other countries	11,700	10,500	500,000	1,300,000
World total (may be rounded)	57,800	55,900	1,400,000	3,500,000

World Resources: Resources of elemental sulfur in evaporite and volcanic deposits and sulfur associated with natural gas, petroleum, tar sands, and metal sulfides amount to about 5 billion tons. The sulfur in gypsum and anhydrite is almost limitless, and some 600 billion tons are contained in coal, oil shale, and shale rich in organic matter, but low-cost methods have not been developed to recover sulfur from these sources. The domestic resource is about one-fifth of the world total. Elemental sulfur deposits have become marginal reserves unless the deposits are already developed. Sulfur from petroleum and metal sulfides may be recovered where they are refined, which may be in the country of origin or in an importing nation. The rate of sulfur recovery from refineries is dependent on the environmental regulations where refining is accomplished.

Substitutes: There are no adequate substitutes for sulfur at present or anticipated price levels; some acids, in certain applications, may be substituted for sulfuric acid.

[e]Estimated. NA Not available.

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

[2]See Appendix C for definitions.

TALC AND PYROPHYLLITE

(Data in thousand metric tons, unless noted)

Domestic Production and Use: The total estimated crude ore value of 1999 domestic talc production was $30 million. There were 15 talc-producing mines in 7 States in 1999. Companies in Montana, New York, Texas, and Vermont accounted for most of the domestic production. Ground talc was consumed in ceramics, 30%; paper, 21%; paint, 18%; roofing, 8%; plastics, 7%; cosmetics, 3%; and other, 13%. Two firms in North Carolina accounted for all of the domestic pyrophyllite production, which increased from that of 1998. Consumption was, in decreasing order, in ceramics, refractories, and paint.

Salient Statistics—United States:[1]	1995	1996	1997	1998	1999[e]
Production, mine	1,060	994	1,050	971	954
Sold by producers	901	909	942	870	879
Imports for consumption	146	187	123	165	213
Exports	183	192	179	146	150
Shipments from Government stockpile excesses	—	—	—	—	([2])
Consumption, apparent	1,020	989	992	990	1,020
Price, average, processed dollars per ton	111	111	118	126	105
Stocks, producer, yearend	80	NA	NA	NA	NA
Employment, mine and mill	750	750	750	700	700
Net import reliance[3] as a percent of apparent consumption	E	E	E	2	6

Recycling: Insignificant.

Import Sources (1995-98): China, 42%; Canada, 17%; Japan, 14%; and other, 27%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Crude, not ground	2526.10.0000	Free.
Ground, washed, powdered	2526.20.0000	Free.
Cut or sawed	6815.99.2000	Free.

Depletion Allowance: Block steatite talc: 23% (Domestic), 15% (Foreign). Other: 15% (Domestic and foreign).

Government Stockpile:

Stockpile Status—9-30-99[4]
(Metric tons)

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Talc, block and lump	907	2	907	907	2
Talc, ground	988	—	988	—	—

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TALC AND PYROPHYLLITE

Events, Trends, and Issues: Production decreased 2% and sales increased slightly from those of 1998. Apparent consumption increased 3%. Exports increased by 3% compared with those of 1998. Canada was the major importer of U.S. talc. U.S. imports of talc increased by 29% compared with those of 1998. Canada, China, and Japan supplied approximately 82% of the imported talc.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	1998	1999[e]		
United States[1]	971	954	140,000	540,000
Brazil	452	450	14,000	54,000
China	2,300	2,300	Large	Large
India	543	550	4,000	9,000
Japan	965	950	130,000	200,000
Korea, Republic of	822	830	14,000	18,000
Other countries	2,000	2,170	Large	Large
World total (rounded)	8,050	8,200	Large	Large

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

Substitutes: The major substitutes for talc are clays and pyrophyllite in ceramics; kaolin and mica in paint; kaolin in paper; clays and mica in plastics; and kaolin and mica in rubber.

[e]Estimated. E Net exporter. NA Not available
[1]Excludes pyrophyllite.
[2]Less than ½ unit.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B.
[5]See Appendix C for definitions.

TANTALUM

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

Domestic Production and Use: There has been no significant domestic tantalum-mining industry 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, approximately 60% of use, mainly in tantalum capacitors. The value of tantalum consumed in 1999 was estimated at around $180 million.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production, mine	—	—	—	—	—
Imports for consumption, concentrate, tin slags, and other[1]	NA	NA	NA	NA	NA
Exports, concentrate, metal, alloys, waste, and scrap[e]	220	290	340	440	430
Government stockpile releases[e 2]	—	(70)	20	220	NA
Consumption: Reported, raw material	NA	NA	NA	NA	NA
Apparent	515	490	550	525	550
Price, tantalite, dollars per pound[3]	26.98	27.75	28.76	33.80	34.00
Stocks, industry, processor, yearend	NA	NA	NA	NA	NA
Employment	NA	NA	NA	NA	NA
Net import reliance[4] as a percent of apparent consumption	80	80	80	80	80

Recycling: Combined prompt industrial and obsolete scrap consumed represented about 20% of apparent consumption.

Import Sources (1995-98): Australia, 34%; Thailand, 15%; China, 10%; Germany, 7%; and other, 34%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Synthetic tantalum-columbium concentrates	2615.90.3000	Free.
Tantalum ores and concentrates	2615.90.6060	Free.
Tantalum oxide	2825.90.9000	3.7% ad val.
Potassium fluotantalate	2826.90.0000	3.1% ad val.
Tantalum, unwrought:		
Waste and scrap	8103.10.3000	Free.
Powders	8103.10.6030	2.5% ad val.
Alloys and metal	8103.10.6090	2.5% ad val.
Tantalum, wrought	8103.90.0000	4.4% ad val.

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

Government Stockpile: For fiscal year (FY) 1999, ending September 30, 1999, the Defense National Stockpile Center (DNSC) sold about 2 tons of tantalum contained in tantalum carbide powder valued at about $260,000, about 11 tons of tantalum capacitor-grade metal powder valued at about $1.9 million, about 12 tons of tantalum vacuum-grade metal ingots valued at about $2.2 million, about 87 tons of tantalum contained in tantalum minerals valued at about $11 million, and about 9 tons of tantalum contained in tantalum oxide valued at about $1.23 million from the National Defense Stockpile (NDS). From April 1997 through September 1999, the DNSC sold a total of about 4 tons of tantalum contained in tantalum carbide powder valued at about $524,000, about 11 tons of tantalum capacitor-grade metal powder valued at about $1.9 million, about 12 tons of tantalum vacuum-grade metal ingots valued at about $2.2 million, about 132 tons of tantalum contained in tantalum minerals valued at about $17.2 million, and about 37 tons of tantalum contained in tantalum oxide valued at about $4.9 million from the NDS. The DNSC also proposed maximum disposal limits in FY 2000 of about 2 tons of tantalum contained in tantalum carbide powder, about 23 tons of tantalum capacitor-grade metal powder, about 18 tons of tantalum vacuum-grade metal ingots, about 91 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 453 tons of tantalum contained in nonstockpile-grade minerals.

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TANTALUM

Stockpile Status—9-30-99[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Tantalum:					
Carbide powder	9	—	9	2	2
Metal:					
Capacitor-grade powder	62	2	45	11	11
Ingots	100	4	45	11	12
Minerals	1,000	42	1,000	91	87
Oxide	46	—	46	9	9

Events, Trends, and Issues: Total consumption of tantalum in 1999 increased, owing to continued strong demand for tantalum capacitors in products such as portable telephones, pagers, personal computers, and automotive electronics. U.S. sales of tantalum capacitors for the first one-half year increased by more than 15% compared with that of the similar period in 1998. For the same period, tantalum imports increased. Imports for consumption of tantalum mineral concentrates rose slightly, with Australia supplying about 60% of quantity and value. Exports increased, with Hong Kong, China, Brazil, and Israel the major recipients of the tantalum materials. In early November, spot prices for tantalum ore (per pound of contained tantalum pentoxide), in three published sources, were $33 to $35, $28 to $31.50, and $45. The most recent industry source (August 1999) on tantalum prices indicated that the average selling prices for some tantalum products (per pound of contained tantalum) were as follows: capacitor-grade powder, $135 to $260; capacitor wire, $180 to $270; vacuum-grade metal for superalloys, $75 to $100; and sheet, $100 to $150. It is estimated that in 2000 domestic mine production will be zero, and U.S. apparent consumption will be less than 600 tons.

World Mine Production, Reserves, and Reserve Base:

	Mine production[6] 1998	Mine production[6] 1999[e]	Reserves[7]	Reserve base[7]
United States	—	—	—	Negligible
Australia	330	350	7,000	16,000
Brazil	60	60	NA	3,000
Canada	61	60	3,000	5,000
Congo (Kinshasa)[8]	—	—	1,800	4,500
Nigeria	3	3	NA	7,000
Other countries[9]	—	—	NA	NA
World total (may be rounded)	454	473	12,000	36,000

World Resources: Most of the world's resources of tantalum occur outside the United States. On a worldwide basis, identified resources of tantalum are considered adequate to meet projected needs. These resources are largely in Australia, Brazil, Canada, Congo (Kinshasa), and Nigeria. The United States has about 1,500 tons of tantalum resources in identified deposits, all of which were considered uneconomic at 1999 prices.

Substitutes: The following materials can be substituted for tantalum, but usually with less effectiveness: columbium in superalloys and carbides; aluminum and ceramics in electronic capacitors; columbium, glass, platinum, titanium, and zirconium in corrosion-resistant equipment; and columbium, hafnium, iridium, molybdenum, rhenium, and tungsten in high-temperature applications.

[e]Estimated. NA Not available.
[1]Metal, alloys, and synthetic concentrates; exclusive of waste and scrap.
[2]Net quantity including effect of upgrading program. Data in parentheses denote increases in inventory.
[3]Average value, contained tantalum pentoxides, 60% basis.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix B for definitions.
[6]Excludes production of tantalum contained in tin slags.
[7]See Appendix C for definitions.
[8]Formerly Zaire.
[9]Bolivia, China, Russia, and Zambia also produce, or are believed to produce tantalum, but available information is inadequate to make reliable estimates of output levels.

TELLURIUM

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

Domestic Production and Use: Tellurium and tellurium dioxide of commercial grades were recovered in the United States at one copper refinery, principally from anode slimes, but also from lead refinery skimmings. High-purity tellurium, tellurium master alloys, and tellurium compounds were produced by primary and intermediate processors from commercial-grade metal and tellurium dioxide. Tellurium was used mainly in the production of free-machining steels. It was used as a minor additive in copper and lead alloys and malleable cast iron, as an accelerator in rubber compounding, in thermoelectric applications, and as a semiconductor in thermal-imaging and photoelectric applications. Tellurium was added to selenium-base photoreceptor alloys to increase the photo speed. In 1999, 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 uses, 7%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production, refinery	W	W	W	W	W
Imports for consumption:					
Unwrought, waste and scrap[1]	46	74	64	89	40
Exports	NA	NA	NA	NA	NA
Consumption, apparent	NA	NA	NA	NA	NA
Price, dollars per pound, 99.7% minimum[2]	23	21	19	18	14
Stocks, producer, refined, yearend	W	W	W	W	W
Employment, number	NA	NA	NA	NA	NA
Net import reliance[3] as a percent of apparent consumption	NA	NA	NA	NA	NA

Recycling: There was no domestic secondary production of tellurium. However, some tellurium may have been recovered abroad from selenium-base photoreceptor scrap exported for recycling.

Import Sources (1995-98): United Kingdom, 29%; Philippines, 25%; Belgium, 16%; Canada, 14%; and other, 16%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Metal	2804.50.0000	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 in 1999. World production also decreased, but there was little change in the oversupply. 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 in remote area power supplies, mainly in developing countries, where the largest percentage increases in power consumption will occur early in this century.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[4]	Reserve base[4]
	1998	1999[e]		
United States	W	W	3,000	6,000
Canada	57	55	700	1,500
Japan	33	30	—	—
Peru	25	25	500	1,600
Other countries[5]	NA	NA	16,000	29,000
World total (rounded)	[6]115	[6]110	20,000	38,000

World Resources: The figures shown for reserves and reserve base include only tellurium contained in economic copper deposits. In addition, significant quantities of tellurium are contained in economic gold and lead deposits, but currently none is recovered. Deposits of coal, copper, and other metals that are of subeconomic grade contain several times the amount of tellurium contained in identified economic copper deposits. However, it is unlikely that tellurium contained in these deposits can be recovered economically.

Substitutes: The chief substitutes for tellurium are selenium, bismuth, and lead in metallurgical applications; selenium and sulfur in rubber compound applications; and selenium, germanium, and organic compounds in electronic applications.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Imports of boron and tellurium are grouped together under the Harmonized Tariff Schedule; however, imports of boron are thought to be small relative to tellurium.
[2]Yearend prices quoted by the sole producer.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions. Estimates include tellurium contained in copper resources only.
[5]In addition to the countries listed, Australia, Belgium, China, France, Germany, Kazakhstan, the Philippines, Russia, and the United Kingdom produce refined tellurium, but output is not reported and available information is inadequate for formulation of reliable production estimates.
[6]Excludes refinery production from the United States and "Other countries."

THALLIUM

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

Domestic Production and Use: Thallium is a byproduct metal recovered in some countries from flue dusts and residues collected in the smelting of copper, zinc, and lead ores. Although thallium was contained in ores mined or processed in the United States, it was not recovered domestically in 1999. Consumption of thallium metal and its compounds continued in most of the established end uses. These included a semiconductor material for selenium rectifiers, an activator in gamma radiation detection equipment, an electrical resistance component in infrared radiation detection and transmission equipment, and a crystalline filter for light diffraction in acousto-optical measuring devices. Other uses included an alloying component with mercury for low-temperature measurements, an additive in glass to increase its refractive index and density, a catalyst or intermediate in the synthesis of organic compounds, and a high-density liquid for sink-float separation of minerals. Also, the use of radioactive thallium compounds for medical purposes in cardiovascular imaging was continued in 1999.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Imports for consumption[1]	1,180	166	168	104	380
Exports	NA	NA	NA	NA	NA
Consumption[e]	700	300	300	100	380
Price, metal, dollars per kilogram[2]	1,100	1,200	1,280	1,280	1,295
Net import reliance[3] as a percent of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1995-98): Belgium, 46%; Mexico, 43%; Germany, 10%; and United Kingdom, 1%.

Tariff: Item	**Number**	**Normal Trade Relations[4] 12/31/99**
Unwrought; waste and scrap; powders	8112.91.6000	4.0% ad val.

Depletion Allowance: 15% (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 1999 to improve and expand the use of thallium. These activities focused principally on the development of high-temperature superconducting materials for such applications as magnetic resonance imaging, storage of magnetic energy, magnetic propulsion, and electric power generation and transmission, and on the further use of radioactive thallium in clinical diagnostic applications, including cardiovascular and oncological imaging.

Thallium metal and its compounds are highly toxic materials and are strictly controlled to prevent a threat to humans and the environment. Thallium and its compounds can be absorbed into the human body by skin contact, ingestion, or inhalation of dust or fumes. With regard to these toxicity concerns, the U.S. Environmental Protection Agency (EPA) issued a proposed rule and a notice during the year that addressed further the control of thallium levels in the environment. The proposed rule offered an efficient approach to the management of certain furnace dusts containing high levels of thallium. The notice requested information from interested and informed parties concerning transfrontier movement of wastes, including thallium wastes and residues, to recycling operations within the member countries of the Organization for Economic Cooperation and Development (OECD). The information will be used by the EPA and other Federal agencies in developing U.S. positions, with respect to potential harmonization of OECD Council decisions on the transfrontier movement issue with those of the Basel Convention.

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

	Mine production		Reserves[6]	Reserve base[6]
	1998	1999		
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 the world's coal resources. The average thallium content of the Earth's crust has been estimated at 0.7 part per million.

Substitutes: While other light-sensitive materials can substitute for thallium and its compounds in specific electronic applications, ample supplies of thallium discourage development of substitute materials.

[e]Estimated. NA Not available.
[1]Unwrought; waste and scrap; powders, including thallium contained in compounds.
[2]Estimated price of 99.999%-pure granules in 100-gram lots.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]By the North American Free Trade Agreement, there is no tariff for Canada or Mexico.
[5]Estimates, based on thallium content of zinc ores.
[6]See Appendix C for definitions.
[7]Thallium contained in mined base-metal ores, estimated at 450 to 500 kilograms per year, is separated from the base metals but not extracted for commercial use.

THORIUM

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

Domestic Production and Use: The primary source of the world's thorium is the rare-earth and thorium phosphate mineral, monazite. Monazite was not recovered as a salable product during processing of heavy mineral sands in 1999. Past production had been as a byproduct during processing for titanium and zirconium minerals, and monazite was recovered for its rare-earth content. Essentially all thorium compounds and alloys consumed by the domestic industry were derived from imports, stocks of previously imported materials, or materials shipped from U.S. Government stockpiles. About eight companies processed or fabricated various forms of thorium for nonenergy uses, such as high-temperature ceramics, catalysts, and welding electrodes. The value of thorium metal, alloys, and compounds used by the domestic industry was estimated to be about $400,000.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production, refinery[1]	—	—	—	—	—
Imports for consumption:					
Thorium ore and concentrates (monazite), gross weight	40	101	20	—	—
Thorium ore and concentrates (monazite), ThO_2 content	2.80	7.07	1.40	—	—
Thorium compounds (oxide, nitrate, etc.), gross weight	20.51	26.30	13.50	7.45	6.77
Thorium compounds (oxide, nitrate, etc.), ThO_2 content	15.16	19.45	10.00	5.51	5.00
Exports:					
Thorium ore and concentrates (monazite), gross weight	—	2	—	—	—
Thorium ore and concentrates (monazite), ThO_2 content	—	.14	—	—	—
Thorium compounds (oxide, nitrate, etc.), gross weight	.08	.06	.24	1.13	1.07
Thorium compounds (oxide, nitrate, etc.), ThO_2 content	.06	.04	.18	.84	.79
Shipments from Government stockpile excesses ($ThNO_3$)	—	—	.82	—	—
Consumption: Reported, (ThO_2 content[e])	5.4	4.9	13.0	7.0	NA
Apparent	NA	NA	33.6	6.9	4.1
Price, yearend, dollars per kilogram:					
Nitrate, welding-grade[2]	5.46	5.46	5.46	5.46	5.46
Nitrate, mantle-grade[3]	23.30	14.32	27.00	27.00	27.00
Oxide, yearend: 99.9% purity[4]	88.50	88.50	82.50	82.50	82.50
99.99% purity[4]	107.25	107.25	107.25	107.25	107.25
Stocks, industrial, yearend	NA	35.2	12.8	NA	NA
Net import reliance[5] as a percent of apparent consumption	NA	NA	100	100	100

Recycling: None.

Import Sources (1995-98): Monazite: Australia, 75%; and France, 25%. Thorium compounds: France, 99.7%; and other, 0.3%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Thorium compounds	2844.30.1000	5.5% ad val.

Depletion Allowance: Percentage method: Monazite, 23% on thorium content, 15% on rare-earth and yttrium content (Domestic); 14% (Foreign).

Government Stockpile:

Stockpile Status—9-30-99[6]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 1999**	**Disposals FY 1999**
Thorium nitrate (gross weight)	3,217	—	2,945	454	—

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 1999. Domestic demand for thorium ores, compounds, metals, and alloys has exhibited a long-term declining trend. Thorium consumption in the United States decreased in 1998 to 7.0 tons, however, most material was consumed in a nonrecurring application. Thorium consumption in 1999 is estimated to decrease. Based on data through July 1999, the average value of imported thorium compounds increased to $53.15 per kilogram from the 1998 average of $23.00 per kilogram (gross weight).

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THORIUM

A team of researchers from a university in Massachusetts, a U.S. Government research laboratory, a university in Israel, a nuclear research facility in Moscow, Russia, and a nuclear fuel manufacturer in Russia, have joined with a U.S. company in Washington, DC, to study the commercialization of nonproliferative thorium energy.[7] The researchers in Massachusetts will assess the application of "seed-blanket" thorium fuel to Light Water Reactors with regard to neutronics and fission control. A study of the toxicity of various nuclear fuels determined that after 100 to 200 years, thorium produces only one sixth of the actinide toxicity produced by other nuclear fuels, such as uranium.[8] The toxicity, measured in conjunction with the uranium used in the Th/U fuel cycle, still was reduced by a factor of 3 compared to the other actinides.

The use of thorium in the United States has decreased significantly since the 1980's, when consumption averaged 45 tons per year. Increased costs to monitor and dispose of thorium have caused the domestic processors to switch to thorium-free materials. Real and potential costs related to compliance with State and Federal regulations, proper disposal, and monitoring of thorium's radioactivity have limited its commercial value. It is forecast that thorium's use will continue to decline unless a low-cost disposal process is developed or new technology creates renewed demand.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[9]	Reserve base[9]
	1998	1999		
United States	—	—	160,000	300,000
Australia	—	—	300,000	340,000
Brazil	NA	NA	16,000	18,000
Canada	NA	NA	100,000	100,000
India	NA	NA	290,000	300,000
Malaysia	—	—	4,500	4,500
Norway	—	—	170,000	180,000
South Africa	NA	NA	35,000	39,000
Other countries	NA	NA	90,000	100,000
World total (rounded)	NA	NA	1,200,000	1,400,000

Reserves and reserve base are contained primarily in 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 provinces similar to those of reserves. The largest share are contained in placer deposits. Resources of more than 500,000 tons are contained in placer, vein, and carbonatite deposits. Disseminated deposits in various other alkaline igneous rocks contain additional resources of more than 2 million tons. Large thorium resources are found in Australia, Brazil, Canada, Greenland, India, South Africa, and the United States.

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

[e]Estimated. NA Not available.
[1]All domestically consumed thorium was derived from imported materials.
[2]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 Rare Earths, 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]Radkowsky Thorium Power Corporation news release, 1999, MIT joins Radkowsky thorium fuel team—findings to be presented at Global 99 International Conference on Future Nuclear Systems: RTPC news, Washington, D.C., July 8, 2 p.
[8]Radkowsky Thorium Power Corporation news release, 1999, Environmental advantages achieved in reduced toxicity of new thorium fuel: RTPC news, Washington, D.C., August 2, 2 p.
[9]See Appendix C for definitions.

TIN

(Data in metric tons of contained tin, unless otherwise noted)

Domestic Production and Use: In 1999, there was no domestic tin mine production. Production of tin at the only U.S. tin smelter, at Texas City, TX, stopped in 1989. Twenty-five firms consumed about 97% of the primary tin. The major uses were as follows: cans and containers, 30%; electrical, 20%; construction, 10%; transportation, 10%; and other, 30%. Based on the New York composite price, the estimated values of some critical items were as follows: primary metal consumed, $277 million; imports for consumption, refined tin, $326 million; old scrap, $65 million.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999**[e]
Production: Mine	—	—	—	—	—
Secondary (old scrap)	7,800	7,710	7,830	8,390	9,000
Secondary (new scrap)	3,800	3,930	4,540	7,710	8,800
Imports for consumption, refined tin	33,200	30,200	40,600	44,000	45,000
Exports, refined tin	2,790	3,670	4,660	5,020	6,000
Shipments from Government stockpile excesses	11,500	11,800	11,700	12,200	12,000
Consumption, reported: Primary	35,200	36,500	36,200	37,100	38,200
Secondary	10,800	8,180	8,250	8,620	9,000
Consumption, apparent	47,000	48,400	55,300	60,620	59,700
Price, average, cents per pound:					
New York market	295	288	265	264	249
New York composite	416	412	384	381	329
London	282	279	257	256	219
Kuala Lumpur	278	275	254	252	236
Stocks, consumer and dealer, yearend	11,700	10,900	11,200	10,700	11,100
Employment, mine and primary smelter, number[e]	—	—	—	—	—
Net import reliance[1] as a percent of apparent consumption	84	83	86	85	85

Recycling: About 17,800 tons of tin from old and new scrap was recycled in 1999. Of this, about 7,710 tons was recovered from old scrap at 5 detinning plants and 46 secondary nonferrous metal processing plants.

Import Sources (1995-98): Brazil, 21%; Indonesia, 20%; Bolivia, 17%; China, 16%; and other, 26%.

Tariff: Most major imports of tin, including unwrought metal, waste and scrap, and unwrought tin alloys, enter duty free.

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

Government Stockpile: The Defense Logistics Agency (DLA) tin sales program emphasized its long-term activity and had only a modest spot sales effort. DLA allocated 2,000 tons of tin to sell on the spot market at monthly sales. Two long-term sales were again conducted, one in the spring, another in the fall. DLA announced that its Annual Materials Plan for fiscal year 1999 called for sales of up to 12,000 tons of stockpile tin. Stockpile tin is warehoused at six depots, with the largest holdings at Hammond, IN, and Baton Rouge, LA. The Stockton, CA, depot was closed.

Stockpile Status—9-30-99[2]

Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 1999**	**Disposals FY 1999**
Pig tin	71,674	8,077	71,674	12,000	12,000

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TIN

Events, Trends, and Issues: The Steel Recycling Institute (SRI), Pittsburgh, PA, announced that the domestic steel can recycling rate was 56% in 1998, compared with a 61% rate in 1997. SRI continued to emphasize the importance of aerosol can recycling. It noted that 200 million Americans had access to steel can recycling programs.

The world tin industry's major research and development laboratory, based in the United Kingdom, was in its fifth full year under its new structure. It is now privatized, with funding supplied by numerous major tin producing and consuming firms rather than by the Association of Tin Producing Countries. The organization reported progress in several areas of research to develop new tin uses; among these were a tin foil capsule to replace lead foil capsules on wine bottles, and a new noncyanide-based electrolyte called "Stanzec" that yields a coating of tin and zinc, which could replace cadmium as an environmentally acceptable anticorrosion coating on steel.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	1998	1999[e]		
United States	—	—	20,000	40,000
Australia	10,000	9,000	210,000	600,000
Bolivia	11,000	12,000	450,000	900,000
Brazil	18,000	17,000	1,200,000	2,500,000
China	79,000	80,000	2,100,000	3,400,000
Indonesia	40,000	42,000	750,000	820,000
Malaysia	6,000	7,000	1,200,000	1,400,000
Peru	26,000	27,000	300,000	400,000
Portugal	4,000	4,000	70,000	80,000
Russia	5,000	5,000	300,000	350,000
Thailand	1,000	1,000	940,000	1,000,000
Other countries	6,000	6,000	180,000	200,000
World total (may be rounded)	206,000	210,000	7,700,000	12,000,000

World Resources: U.S. resources of tin, primarily in Alaska, were insignificant compared with those of the rest of the world. Sufficient world resources, principally in western Africa, southeastern Asia, Australia, Bolivia, Brazil, China, and Russia were available to sustain current production rates well into the next century.

Substitutes: Aluminum, glass, paper, plastic, or tin-free steel substitute for tin in cans and containers. Other materials that substitute for tin are epoxy resins for solder; aluminum alloys, copper-base alloys, and plastics for bronze; plastics for bearing metals that contain tin; and compounds of lead and sodium for some tin chemicals.

[e]Estimated.
[1]Defined as imports - exports + adjustments for Government and industry stock changes.
[2]See Appendix B.
[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 heavy-mineral sands operations in Florida and Virginia, and one firm produced ilmenite in California as a byproduct of sand and gravel production. Domestic production data were withheld to avoid revealing company proprietary data. Based on average prices, the value of titanium mineral concentrates consumed in the United States in 1999 was about $522 million. The major coproduct of mining from ilmenite and rutile deposits is zircon. About 95% of titanium mineral concentrates were consumed by five titanium pigment producers. The remainder was used in welding rod coatings and for manufacturing metal, carbides, and chemicals.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Imports for consumption					
Ilmenite and slag	586	641	651	732	750
Rutile, natural and synthetic	295	305	311	365	305
Exports,[e] all forms	21	10	15	38	6
Consumption					
Ilmenite and slag	1,010	1,010	1,060	[2]980	[2]985
Rutile, natural and synthetic	439	365	383	392	380
Price, dollars per metric ton:					
Ilmenite, bulk, 54% TiO_2, f.o.b. Australian ports	83	87	83	77	91
Rutile, yearend, bulk, f.o.b. Australian ports	600	563	530	500	485
Slag:[e]					
80% TiO_2, f.o.b. Sorel, Quebec, Canada	244	292	294	338	377
85% TiO_2, f.o.b. Richards Bay, South Africa	349	353	390	385	393
Stocks, mine, distributor and consumer, yearend[2]					
Ilmenite	137	267	234	248	250
Rutile	52	77	80	70	70
Employment, mine and mill, number[e]	400	400	400	450	450
Net import reliance[3] as a percent of reported consumption	70	57	68	76	77

Recycling: None.

Import Sources (1995-98): Ilmenite: South Africa, 53%; Australia, 29%; Canada, 6%; India, 6%; and other, 6%. Rutile: Australia, 54%; South Africa, 39%; and other, 7%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
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: 23% (Domestic), 15% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: Global production of total ilmenite and slag in 1999 was estimated to be nearly unchanged compared with that of 1998. Similarly, domestic consumption of ilmenite and titanium slag concentrates in 1999 was estimated to be unchanged compared with that of 1998. In 1999, the United States continued its reliance on imported feedstocks with 61% of imports derived from beneficiated ilmenite products.

In the United States, development efforts were proceeding the minerals sands deposits near Camden, TN; a feasibility study was being conducted that included construction of a pilot plant separation facility and the development of a detailed mine plan.

In 1999, two of the largest producers of titanium mineral concentrates merged to form a new company. The merger was estimated to represent 32% of the current supply of titanium feedstock. In Australia, a major new source of ilmenite production was closed after insurmountable operational difficulties. Several companies in Australia were conducting feasibility studies in the Murray Basin. Feasibility studies also continued at the Kwale deposit in Kenya.

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TITANIUM MINERAL CONCENTRATES

World Mine Production, Reserves, and Reserve Base:

	Mine production 1998	Mine production 1999[e]	Reserves[4]	Reserve base[4]
United States:				
Ilmenite	W	W	13,000	59,000
Rutile	W	W	700	1,800
Australia:				
Ilmenite	1,355	1,140	[5]81,000	[5]120,000
Rutile	225	180	[5]17,000	[5]51,000
Canada, ilmenite[6]	760	770	31,000	36,000
India:				
Ilmenite	162	162	30,000	38,000
Rutile	13	13	6,600	7,700
Norway, ilmenite[6]	266	270	40,000	40,000
South Africa:				
Ilmenite[6]	935	932	63,000	63,000
Rutile	112	112	8,300	8,300
Ukraine:				
Ilmenite	133	133	5,900	13,000
Rutile	48	48	2,500	2,500
Other countries:				
Ilmenite	248	248	63,000	98,000
Rutile	8	8	7,900	100,000
World total (ilmenite, rounded)	[7]3,860	[7]3,650	330,000	460,000
World total (rutile, rounded)	[7]406	[7]361	43,000	170,000
World total (rounded)	[7]4,260	[7]4,010	370,000	640,000

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, rutile, and leucoxene are used for producing titanium dioxide pigment, titanium metal, and welding rod coatings. In the future, commercial processes may be developed to use anatase and perovskite mineral concentrates.

Fewer environmental pollution problems are encountered when pigment is produced from rutile rather than ilmenite. The chloride process, using a rutile feed, generates about 0.2 ton of waste per ton of TiO_2 product; the sulfate process, using ilmenite, generates about 3.5 tons of waste per ton of product. Producing synthetic rutile from ilmenite results in about 0.7 ton of waste, mainly iron oxide, per ton of product. Direct chlorination of ilmenite generates about 1.2 tons of waste, mainly ferric chloride, per ton of TiO_2.

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]See also Titanium and Titanium Dioxide.
[2]Excludes ilmenite used to produce synthetic rutile.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix C for definitions.
[5]Based on data published by the Australian Bureau of Resource Sciences.
[6]Ilmenite is used primarily to produce titaniferous slag. Reserves and reserve base are ilmenite.
[7]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 firms with operations in Nevada and Oregon. Ingot was made by the two sponge producers and by nine other firms in seven States. About 30 firms consume ingot to produce forged components, mill products, and castings. In 1999, an estimated 60% of the titanium metal used was in aerospace applications. The remaining 40% was used in the armor, chemical processing, power generation, marine, medical, sporting goods, and other nonaerospace applications. The value of sponge metal consumed was about $264 million, assuming an average selling price of $9.37 per kilogram ($4.25 per pound).

In 1999, titanium dioxide (TiO_2) pigment, valued at about $3 billion, was produced by five companies at eight facilities in seven States. TiO_2 was used in paint, varnishes, and lacquers, 51%; plastics, 20%; paper, 18%; and other, 11%. Other uses of TiO_2 included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Titanium sponge metal:					
Production	W	W	W	W	W
Imports for consumption	7,560	10,100	16,100	10,900	6,100
Exports	225	528	976	348	681
Shipments from Government stockpile excesses	—	—	227	1,384	453
Consumption, reported	21,500	28,400	32,000	28,200	17,500
Price, dollars per pound, yearend	4.40	4.40	4.40	4.40	4.25
Stocks, industry yearend[e]	5,270	4,390	5,470	10,600	8,700
Employment, number[e]	300	300	300	300	300
Net import reliance[2] as a percent of reported consumption	36	37	47	39	44
Titanium dioxide:					
Production	1,250,000	1,230,000	1,340,000	1,330,000	1,350,000
Imports for consumption	183,000	167,000	194,000	192,000	220,000
Exports	342,000	332,000	405,000	398,000	382,000
Consumption, apparent	1,080,000	1,080,000	1,130,000	1,130,000	1,160,000
Price, rutile, list, dollars per pound, yearend	1.01	1.09	1.05	.98	1.00
Stocks, producer, yearend	120,000	107,000	108,000	103,000	130,000
Employment, number[e]	4,600	4,600	4,600	4,600	4,600
Net import reliance[2] as a percent of apparent consumption	E	E	E	E	E

Recycling: New scrap metal recycled by the titanium industry was about 19,000 tons in 1999. In addition, estimated use of titanium as scrap and in the form of ferrotitanium made from scrap by the steel industry was about 5,200 tons; by the superalloy industry, 1,000 tons; and in other industries, 500 tons. Old scrap reclaimed was about 400 tons.

Import Sources (1995-98): Sponge metal: Russia, 54%; Japan, 33%; Kazakhstan, 6%; China, 4%; and other, 3%. Titanium dioxide pigment: Canada, 43%; Germany, 15%; France, 11%; Spain, 6%; and other, 25%.

Tariff:

Item	**Number**	**Normal Trade Relations 12/31/99**
Waste and scrap metal	8108.10.1000	Free.
Unwrought metal	8108.10.5000	15.0% ad val.
Wrought metal	8108.90.6000	15.0% ad val.
Titanium dioxide pigments	3206.11.0000	6.0% ad val.
Titanium oxides	2823.00.0000	5.5% ad val.

Depletion Allowance: Not applicable.

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TITANIUM AND TITANIUM DIOXIDE

Government Stockpile: The Defense National Stockpile Center continued to solicit offers for the sale of titanium sponge held in the Government stockpile. For fiscal year 2000, 4,540 tons of titanium sponge was being offered for sale.

Stockpile Status—9-30-99[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Titanium sponge	31,300	—	31,300	4,540	393

Events, Trends, and Issues: In 1999, domestic production of titanium pigment reached 1.35 million tons, a slight increase compared with 1998. Imports of pigment were estimated to have increased 13% compared with 1998, while exports decreased 6%. Apparent consumption of titanium pigment increased 3% and published prices of rutile-grade pigment increased slightly. Owing to reduced demand from commercial aircraft manufacturers, consumption of titanium sponge metal decreased 38% compared with that of 1998. Domestic production of titanium ingot and mill products were estimated to have decreased 20% and 28%, respectively.

Significant trends in the titanium pigment industry include: a consolidation of ownership; expansions by the chloride route in lieu of the sulfate-route; and increased demand for higher TiO_2 content mineral feedstocks (synthetic rutile and slag). In 1999, the world's top seven producers accounted for an estimated 85% of pigment capacity.

In the titanium metal industry, the cancellation of aircraft orders and a reduction of inventories held by consumers indicated a slowing in demand for titanium metal products.

World Sponge Metal Production and Sponge and Pigment Capacity:

	Sponge production		Capacity 1999[4]	
	1998	1999[e]	Sponge	Pigment
United States	W	W	21,600	1,486,000
Australia	—	—	—	189,000
Belgium	—	—	—	70,000
Canada	—	—	—	75,000
China[e]	2,500	2,500	7,000	45,000
Finland	—	—	—	100,000
France	—	—	—	238,000
Germany	—	—	—	360,000
Italy	—	—	—	80,000
Japan	24,200	19,200	25,800	336,000
Kazakhstan[e]	10,000	10,000	22,000	1,000
Mexico	—	—	—	120,000
Russia[e]	22,000	16,000	26,000	20,000
Spain	—	—	—	65,000
Ukraine[e]	1,200	2,500	6,000	120,000
United Kingdom[e]	—	—	—	304,000
Other countries	—	—	—	632,000
World total (rounded)	[5]60,000	[5]50,000	110,000	4,200,000

World Resources:[6] Resources and reserves of titanium minerals (ilmenite and rutile) are discussed in the section on titanium mineral concentrates. Most titanium for domestic sponge production was obtained from rutile or rutile substitutes. The feedstock sources for pigment production were ilmenite, slag, synthetic rutile, and rutile.

Substitutes: There are few substitutes for titanium in aircraft and space use without some sacrifice of performance. For industrial uses, high-nickel steel, zirconium, and, to a limited extent, the superalloy metals may be substituted. In certain applications, ground calcium carbonate, precipitated calcium carbonate, kaolin, and talc compete with titanium dioxide as a white pigment.

[e]Estimated. E Net exporter. W Withheld to avoid disclosing company proprietary data.
[1]See also Titanium Mineral Concentrates.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B for definitions.
[4]Operating capacity.
[5]Excludes 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 recorded production of tungsten concentrates in the United States was in 1994. Approximately 10 companies in the United States processed tungsten concentrates, ammonium paratungstate, tungsten oxide, and/or scrap to make tungsten powder, tungsten carbide powder, and/or tungsten chemicals. Nearly 75 industrial consumers were surveyed on a monthly or annual basis. Based on data reported by these consumers, approximately 73% of the tungsten consumed in the United States went into making cemented carbide parts to be used as cutting and wear-resistant materials primarily in the metalworking, oil and gas drilling, mining, and construction industries. The remaining tungsten was consumed in making lamp filaments, electrodes, and other components for the electrical and electronics industries, 14%; steels, superalloys, and wear-resistant alloys, 12%; and chemicals for catalysts and pigments, 1%. The total estimated value of primary tungsten materials consumed in 1999 was $250 million.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production, mine	—	—	—	—	—
Imports for consumption, concentrate	4,660	4,190	4,850	4,750	3,300
Exports, concentrate	20	72	40	49	200
Government stockpile shipments: Concentrate	—	—	—	—	1,300
Other forms	—	—	—	—	240
Consumption: Reported, concentrate	5,890	5,260	6,590	[1]3,210	W
Apparent, all forms	10,000	10,800	12,100	12,300	12,000
Price, concentrate, dollars per mtu WO_3,[2] average:					
U.S. spot market, Platt's Metals Week	62	66	64	52	47
European market, Metal Bulletin	64	53	47	44	40
Stocks, consumer, yearend concentrate	627	569	658	514	500
Employment, mine and mill, number	—	—	—	—	—
Net import reliance[3] as a percent of apparent consumption	90	89	84	77	81

Recycling: During 1999, the tungsten content of scrap consumed by processors and end users was estimated at 3,000 tons. This represented approximately 25% of apparent consumption of tungsten in all forms.

Import Sources (1995-98): Tungsten content of ores and concentrates, intermediate and primary products, wrought and unwrought tungsten, and waste and scrap: China, 35%; Russia, 23%; Bolivia, 5%; Germany, 5%; and other, 32%.

Tariff: Item	Number	Normal Trade Relations[4] 12/31/99
Ore	2611.00.3000	Free.
Concentrate	2611.00.6000	37.5¢/kg W cont.
Ferrotungsten	7202.80.0000	5.6% ad val.
Tungsten powders	8101.10.0000	7.0% ad val.
Ammonium tungstate	2841.80.0010	5.5% ad val.
Tungsten carbide	2849.90.3000	8.0% ad val.
Tungsten oxide	2825.90.3000	5.5% ad val.

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

Government Stockpile: In July, the U.S. Government began sales of tungsten ores and concentrates from the National Defense Stockpile for the first time since 1989. In September, sales of ferrotungsten, tungsten carbide powder, and tungsten metal powder were initiated. In addition to the data shown below, as of September 30, 1999, the stockpile contained 95 tons (tungsten content) of committed nonstockpile-grade ferrotungsten and the following quantities of uncommitted nonstockpile-grade tungsten materials (tons of tungsten content): ores and concentrates, 7,010; ferrotungsten, 437; metal powder, 151; and carbide powder, 51. During fiscal year 1999, 91 tons (tungsten content) of nonstockpile-grade ferrotungsten were disposed.

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TUNGSTEN

Stockpile Status—9-30-99[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Carbide powder	760	111	760	454	111
Ferrotungsten	385	—	385	136	—
Metal powder	674	36	674	68	36
Ores and concentrates	26,300	1,320	26,300	1,360	1,350

Events, Trends, and Issues: World tungsten supply continued to be dominated by Chinese production and exports. In an effort to control its output, the Chinese Government stopped issuing new permits for tungsten mines and reduced the number of export licenses for tungsten materials. To bring the prices of tungsten materials closer to the costs of production, the China Tungsten Industry Association established minimum prices for ammonium paratungstate, tungsten concentrates, and tungsten oxide. Following these actions, Metal Bulletin prices for ammonium paratungstate and tungsten concentrates steadily increased during the second half of 1999.

In July, the U.S. Government began selling tungsten materials from the National Defense Stockpile. In August, the U.S. Department of Commerce and U.S. International Trade Commission reviewed the antidumping duty order on tungsten ore concentrates from China, which had been in effect since 1991. As a result of the review, the order was revoked effective January 1, 2000.

World Mine Production, Reserves, and Reserve Base:

	Mine production 1998	Mine production 1999[e]	Reserves[6]	Reserve base[6]
United States	—	—	140,000	200,000
Australia	—	—	1,000	63,000
Austria	1,400	1,400	10,000	15,000
Bolivia	497	250	53,000	100,000
Brazil	50	50	20,000	20,000
Burma	200	280	15,000	34,000
Canada	—	—	260,000	490,000
China	24,700	24,700	850,000	1,200,000
France	—	—	20,000	20,000
Kazakhstan	—	—	NA	38,000
Korea, North	900	900	NA	35,000
Korea, Republic of	—	—	58,000	77,000
Portugal	831	450	25,000	25,000
Russia	3,000	3,000	250,000	420,000
Tajikistan	—	—	NA	23,000
Thailand	20	20	30,000	30,000
Turkmenistan	—	—	NA	10,000
Uzbekistan	200	150	NA	20,000
Other countries	355	109	280,000	360,000
World total (rounded)	32,200	31,300	2,000,000	3,200,000

World Resources: More than 90% of the world's estimated tungsten resources is outside the United States. Nearly 40% of these resources is in China, 15% is in Canada, and 13% is in Russia.

Substitutes: Cemented tungsten carbide remained a primary cutting-tool insert material because of its versatility in meeting technical requirements in many turning and milling operations. However, ceramics, ceramic-metallic composites, and other materials continued to be developed and utilized as substitutes to meet the changing needs of the world market. Increased quantities of carbide cutting-tool inserts were coated with nitrides, oxides, and carbides to extend the life of the inserts. Tungsten remained the preferred and essentially unsubstitutable material for filaments, electrodes, and contacts in lamp and lighting applications. However, an electrodeless, nontungsten lamp is available for commercial and industrial use.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Excludes 6 months of withheld data.
[2]A metric ton unit (mtu) of tungsten trioxide (WO_3) contains 7.93 kilograms of tungsten.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]Special tariff rates apply for Canada and Mexico.
[5]See Appendix B for definitions.
[6]See Appendix C for definitions.

VANADIUM

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

Domestic Production and Use: Eight firms make up the U.S. vanadium industry. These firms process material such as ferrophosphorus slag, petroleum residues, spent catalysts, utility ash, and vanadium-bearing iron slag to produce ferrovanadium, vanadium pentoxide, vanadium metal, and vanadium-bearing chemicals or specialty alloys. The ferrophosphorus slag was produced at a mine in Idaho. Metallurgical use, primarily as an alloying agent for iron and steel, accounts for more than 95% of the vanadium consumed domestically. Of the other uses for vanadium, the major nonmetallurgical use was in catalysts for the production of maleic anhydride and sulfuric acid. With regard to total domestic consumption, major end-use distribution was as follows: carbon steel 29%; high-strength low-alloy steel, 25%; full alloy steel, 24%; tool steel, 9%; and other, 13%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production:					
Mine, mill	W	W	W	W	W
Petroleum residues, recovered basis	1,990	3,730	[e]2,000	[e]2,000	NA
Imports for consumption:					
Ash, ore, residues, slag	2,530	2,270	2,950	2,400	2,200
Vanadium pentoxide, anhydride	547	485	711	847	600
Oxides and hydroxides, other	36	11	126	33	10
Aluminum-vanadium master alloys (gross weight)	36	2	11	298	300
Ferrovanadium	1,950	1,880	1,840	1,620	1,600
Exports:					
Vanadium pentoxide, anhydride	229	241	614	681	700
Oxides and hydroxides, other	1,010	2,670	385	232	100
Aluminum-vanadium master alloys (gross weight)	660	310	974	856	500
Ferrovanadium	340	479	446	579	400
Shipments from Government stockpile	416	201	260	—	—
Consumption: Reported	4,650	4,630	4,730	4,390	4,000
Price, average, dollars per pound V_2O_5	2.80	3.19	3.90	5.47	2.00
Stocks, consumer, yearend	310	286	308	314	300
Employment, mine and mill, number	390	390	400	400	400
Net import reliance[1] as a percent of reported consumption	84	31	94	78	80

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 (1995-98): Ferrovanadium: Canada, 47%; China, 15%; Czech Republic, 12%; South Africa, 11%; and other, 15%. Vanadium pentoxide: South Africa, 94%; China, 5%; and other, 1%.

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

Item	Number	Normal Trade Relations 12/31/99
Vanadium pentoxide anhydride	2825.30.0010	10.8% ad val.
Vanadium oxides and hydroxides, other	2825.30.0050	10.8% ad val.
Vanadates	2841.90.1000	8.4% ad val.
Ferrovanadium	7202.92.0000	4.2% ad val.
Aluminum-vanadium master alloys	7601.20.9030	Free.

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

Government Stockpile: Disposal of the vanadium pentoxide held in the National Defense Stockpile was completed in 1997.

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VANADIUM

Events, Trends, and Issues: Vanadium consumption in the United States in 1999 declined slightly from that in 1998. Preliminary data indicated the following changes among the major uses for vanadium during the first 6 months of 1999: carbon steel decreased 30%; tool steel increased 26%; full alloy steel increased 5%; and high-strength low-alloy steel increased 5%.

Both ferrovanadium and vanadium pentoxide prices declined during 1999. Articles in various industry-related publications attributed the falling prices to a decline in vanadium consumption, combined with an increased supply of material.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[2]	Reserve base[2]
	1998	1999[e]		
United States	W	W	45,000	4,000,000
China	14,700	14,000	2,000,000	3,000,000
Russia	9,000	9,000	5,000,000	7,000,000
South Africa	17,000	16,000	3,000,000	12,000,000
Other countries	1,100	1,000	—	1,000,000
World total (may be rounded)	[3]41,800	[3]40,000	10,000,000	27,000,000

World Resources: World resources of vanadium exceed 63 million tons. Vanadium occurs in deposits of titaniferous magnetite, phosphate rock, and uraniferous sandstone and siltstone, in which it constitutes less than 2% of the host rock. Significant amounts are also present in bauxite and carboniferous materials, such as crude oil, coal, oil shale, and tar sands. Because vanadium is usually recovered as a byproduct or coproduct, demonstrated world resources of the element are not fully indicative of available supplies. While domestic resources are adequate to supply current domestic needs, a substantial part of U.S. demand is currently met by foreign material because of price advantages.

Substitutes: Steels containing various combinations of other alloying elements can be substituted for steels containing vanadium. Metals such as columbium, manganese, molybdenum, titanium, and tungsten are to some degree interchangeable with vanadium as alloying elements in steel. Platinum and nickel can replace vanadium compounds as catalysts in some chemical processes. There is currently no acceptable substitute for vanadium in aerospace titanium alloys.

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

VERMICULITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Two companies, with mining and processing facilities, produced vermiculite concentrate. One company had its operation in South Carolina, and the other company had an operation in Virginia and an operation in South Carolina run by its subsidiary company. Most of the vermiculite concentrate was shipped to 20 exfoliating plants in 11 States. The end uses for exfoliated vermiculite were estimated to be agriculture and insulation, 78%; lightweight concrete aggregates (including concrete, plaster, and cement premixes), 18%; and other, 4%.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production[1]	171	W	W	W	W
Imports for consumption[e]	30	48	67	68	70
Exports[e]	6	8	8	11	10
Consumption, apparent, concentrate	195	W	W	W	W
Consumption, exfoliated	130	135	[e]155	[e]170	170
Price, average value, concentrate, dollars per ton, f.o.b. mine	W	W	W	W	W
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number[e]	230	230	230	230	230
Net import reliance[2] as a percent of apparent consumption	12	W	W	W	W

Recycling: Insignificant.

Import Sources (1995-98): South Africa, 76%; China, 21%; and other, 3%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Vermicullite, perlite and chlorites, unexpanded	2530.10.0000	Free.
Exfoliated vermiculite, expanded clays, foamed slag and similar expanded materials	6806.20.0000	Free.

Depletion Allowance: 15% (Domestic and foreign).

Government Stockpile: None.

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VERMICULITE

Events, Trends, and Issues: A U.S. natural resource holding company reportedly was planning to complete its current exploration program at yearend on two vermiculite properties in Nevada and Montana. Its jointly held affiliate company was planning to test vermiculite ore amenability to the milling process used at the company's mill at Dillon, MT. The holding company had entered negotiations in September to acquire a vermiculite exfoliation plant in California. In recent years, the only domestic mining of vermiculite has been in the eastern United States.

In Brazil, four companies had an estimated output of 23,000 tons, Japan had an estimated 15,000 tons, and output in Zimbabwe was about 15,000 tons and came from two companies. Recent information from a nongovernment source, which is not included in the world mine production data below, gave production of vermiculite in Australia of around 11,000 tons in 1998, with an increase anticipated in 1999; production in China was an estimated 40,000 tons.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[3]	Reserve base[3]
	1998	1999[e]		
United States	W	W	25,000	100,000
Russia	25	25	NA	NA
South Africa	210	210	20,000	80,000
Other countries[4]	57	60	5,000	20,000
World total	[5]292	[5]295	50,000	200,000

World Resources: Marginal reserves of vermiculite, occurring in Colorado, Nevada, North Carolina, Texas, and Wyoming, are estimated to be 2 to 3 million tons. Resources in other countries may include material that does not exfoliate as well as U.S. and South African vermiculite.

Substitutes: Expanded perlite is a substitute for vermiculite in lightweight concrete and plaster. Other more dense but less costly material substitutes in these applications are expanded clay, shale, slate, and slag. Alternate materials for loosefill fireproofing insulation include fiberglass, perlite, and slag wool. In agriculture, substitutes include peat, perlite, sawdust, bark and other plant materials, and synthetic soil conditioners.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Concentrate sold and used by producers.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions.
[4]Excludes countries for which information is not available.
[5]Excludes the United States.

YTTRIUM[1]

(Data in metric tons of yttrium oxide (Y_2O_3) content, unless otherwise noted)

Domestic Production and Use: The rare-earth element, yttrium, was mined as a constituent of the mineral bastnasite, but was not recovered as a separate element during processing. Bastnasite, a rare-earth fluocarbonate mineral, was mined as a primary product at Mountain Pass, CA. Bastnasite's yttrium content is very small, and represents a potential minor source of the element. Yttrium used by the domestic industry was imported primarily as compounds.

Yttrium was used in many applications. Principal uses were in phosphors used in color televisions and computer monitors, trichromatic fluorescent lights, temperature sensors, and X-ray-intensifying screens. As a stabilizer in zirconia, yttrium was used in abrasives, wear-resistant and corrosion-resistant cutting tools, seals and bearings, high-temperature refractories for continuous-casting nozzles, jet engine coatings, oxygen sensors in automobile engines, and simulant gemstones. In electronics, yttrium-iron-garnets were components in microwave radar to control high frequency signals. Yttrium was an important component in yttrium-aluminum garnet laser crystals used in industrial cutting and welding, medical and dental surgical procedures, temperature and distance sensing, photoluminescence, photochemistry, digital communications, and nonlinear optics. Yttrium was also used in heating-element alloys, superalloys, and high-temperature superconductors. The approximate distribution in 1998 by end use was as follows: lamp and cathode ray tube phosphors, 68%; oxygen sensors, laser crystals, miscellaneous, 19%; and ceramics and abrasives, 13%.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999[e]**
Production, mine	—	—	—	—	—
Imports for consumption:					
In monazite (yttrium oxide content[e])	0.44	1.11	0.22	—	—
Yttrium compounds, greater than 19% to less than 85% oxide equivalent (gross weight)	NA	42.2	48.4	107	166
Exports, in ore and concentrate	NA	NA	NA	NA	NA
Consumption, estimated[2]	365	207	292	516	400
Price, dollars:					
Monazite concentrate, per metric ton[3]	222-259	244-285	400-400	400-400	400-400
Yttrium oxide, per kilogram, 99.0% to 99.99% purity[4]	17-110	17-85	17-85	22-85	22-85
Yttrium metal, per kilogram, 99.0% to 99.9% purity[4]	150-200	95-200	80-100	80-100	80-100
Stocks, processor, yearend	NA	NA	NA	NA	NA
Net import reliance[e 5] as a percent of apparent consumption	100	100	100	100	100

Recycling: Small quantities, primarily from laser crystals and synthetic garnets.

Import Sources (1998):[e] Yttrium compounds: China, 65%; France, 18%; United Kingdom, 7%; Japan, 5%; and other, 5%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**
Thorium ores and concentrates (monazite)	2612.20.0000	Free.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed	2805.30.0000	5.0% ad val.
Yttrium bearing materials and compounds containing by weight >19% but <85% Y_2O_3	2846.90.4000	Free.
Rare-earth compounds, including yttrium oxide, yttrium nitrate, and other individual compounds	2846.90.8000	3.7% ad val.

Depletion Allowance: Percentage method: Monazite: 23% on thorium content and 15% on yttrium and rare-earth content (Domestic), 15% (Foreign). Xenotime: 15% (Domestic and foreign).

Government Stockpile: None.

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YTTRIUM

Events, Trends, and Issues: Yttrium demand in the United States increased in 1998 and declined slightly in 1999 as prices remained stable. International yttrium markets continued to be competitive, although China was the source of most of the world's supply. The increase in domestic yttrium demand is primarily the result of U.S. dollar strength and the recessionary Asian economies minimizing inflation and undercutting commodity prices. Yttrium was consumed primarily in the form of high-purity compounds, especially the oxide and nitrate. Demand for yttrium metal increased in 1999 compared with that of 1998.

World Mine Production, Reserves, and Reserve Base:

	Mine production[6]		Reserves[7]	Reserve base[7]
	1998[e]	1999[e]		
United States	—	—	120,000	130,000
Australia	—	—	100,000	110,000
Brazil	15	15	400	1,500
Canada	—	—	3,300	4,000
China	2,200	2,200	220,000	240,000
Congo (Kinshasa)[8]	—	—	570	630
India	55	55	36,000	38,000
Malaysia	7	7	13,000	21,000
South Africa	—	—	4,400	5,000
Sri Lanka	2	2	240	260
Thailand	—	—	600	600
Former Soviet Union[9]	125	125	9,000	10,000
World total (rounded)	2,400	2,400	510,000	560,000

World Resources: Large resources of yttrium in monazite and xenotime are available worldwide in ancient and recent placer deposits (monazite and xenotime), weathered clay deposits (ion-adsorption ore), carbonatites, and uranium ores. Additional large subeconomic resources of yttrium occur in other monazite-bearing deposits, apatite-magnetite rocks, sedimentary phosphate deposits, deposits of columbium-tantalum minerals, and certain uranium ores, especially those of the Blind River District in Canada. It is probable that the world's resources are very large relative to expected demand.

Substitutes: Substitutes for yttrium are available for some applications, but generally are much less effective. In most uses, especially in phosphors, electronics, and lasers, yttrium is not subject to substitution by other elements. As a stabilizer in zirconia ceramics, yttria (yttrium oxide) may be substituted with calcia (calcium oxide) or magnesia (magnesium oxide), but is generally not as resilient.

[e]Estimated. NA Not available.
[1]See also Rare Earths and Scandium.
[2]Essentially all yttrium consumed domestically was imported or refined from imported ores and concentrates.
[3]Monazite concentrate prices derived from Metal Bulletin (1995-96) and U.S. Bureau of the Census data (1997-99).
[4]Yttrium oxide and metal prices from Elements—Rare Earths, Specialty Metals and Applied Technology (a TradeTech publication), Denver, CO, and/or Rhodia Rare Earths, Inc., Shelton, CT.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]Includes yttrium contained in rare-earth ores.
[7]See Appendix C for definitions.
[8]Formerly Zaire.
[9]As constituted before December 1991.

ZINC

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

Domestic Production and Use: The value of zinc mined in 1999, based on contained zinc recoverable from concentrate, was about $860 million. It was produced in 6 States by 17 mines operated by 7 mining companies. Alaska, Tennessee, New York, and Missouri accounted for 97% of domestic mine output; Alaska alone accounted for nearly 70%. Three primary and eight secondary smelters refined zinc metal of commercial grade in 1999. 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 56% was used in galvanizing, 19% in zinc-base alloys, 13% in brass and bronze, and 12% 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 decreasing order, were lead, sulfur, cadmium, silver, gold, and germanium.

Salient Statistics—United States:	**1995**	**1996**	**1997**	**1998**	**1999**[e]
Production: Mine, recoverable[1]	614	600	605	722	775
Primary slab zinc	232	226	226	234	235
Secondary slab zinc	131	140	140	134	135
Imports for consumption:					
Ore and concentrate	10	15	50	46	50
Refined zinc	856	827	876	879	965
Exports: Ore and concentrate	424	425	461	552	600
Refined zinc	3	2	4	2	1
Shipments from Government stockpile	14	15	32	26	21
Consumption: Apparent, refined zinc	1,230	1,210	1,240	1,280	1,355
Apparent, all forms	1,460	1,450	1,480	1,580	1,630
Price, average, cents per pound:					
Domestic producers[2]	55.8	51.1	64.6	51.4	51.0
London Metal Exchange, cash	46.8	46.5	59.7	46.5	45.0
Stocks, slab zinc, yearend	78	76	104	92	92
Employment: Mine and mill, number[e]	2,700	2,700	2,500	2,400	2,500
Smelter primary, number[e]	1,000	1,000	1,000	1,000	1,000
Net import reliance[3] as a percent of apparent consumption:					
Refined zinc	71	70	71	70	73
All forms of zinc	35	33	35	35	30

Recycling: In 1999, an estimated 430,000 tons of zinc was recovered from waste and scrap; about one-third was recovered in the form of slab zinc and the remainder in alloys, oxide, and chemicals. Of the total amount of scrap recycled, 340,000 tons was derived from new scrap and 90,000 tons was derived from old scrap. About 28,000 tons of scrap was exported, mainly to Taiwan, and 24,000 tons imported, mainly from Canada.

Import Sources (1995-98): Ore and concentrate: Peru, 45%; Mexico, 25%; Australia, 20%; and other, 10%. Metal: Canada, 57%; Mexico, 10%; Peru, 7%; and other, 26%. Combined total: Canada, 52%; Mexico, 11%; Peru, 9%; and other, 28%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12/31/99**	**Canada and Mexico 12/31/99**
Ore and concentrate	2608.00.0030	Free	Free.
Unwrought metal	7901.11.0000	1.5% ad val.	Free.
Alloys, casting-grade	7901.12.1000	3% ad val.	Free.
Alloys	7901.20.0000	3% ad val.	Free.
Waste and scrap	7902.00.0000	Free	Free.
Hard zinc spelter	2620.11.0000	Free	Free.
Zinc oxide	2817.00.0000	Free	Free.

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

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ZINC

Government Stockpile:

Stockpile Status—9-30-99[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Zinc	179	3	179	45	14

Events, Trends, and Issues: In spite of the closure of the Clinch Valley Mine in Tennessee and the Leadville Mine in Colorado, domestic mine production increased in 1999, mainly because of increased output at the Red Dog Mine in Alaska, the leading producer in the United States. Because most of the production from the Red Dog Mine is processed in Canada, exports of zinc concentrate increased in correspondence with increased production. The United States is the world's largest exporter of zinc concentrates; it is also the largest importer of zinc metal. The planned tripling of refinery capacity at the Clarksville, TN, smelter was suspended by Pasminco Ltd. of Australia, after hostile takeover of Savage Resources Ltd., the previous owners of the Clarksville smelter.[5] The small increase of refining capacity, to 345,000 tons, was the result of improved efficiencies at all three primary smelters.

Domestic consumption of zinc metal continued to increase in 1999, mainly because of increased use of galvanized steel. The United States is the largest consumer of zinc and zinc products, but domestic metal production capacity, both primary and secondary, accounts for less than one-third of the quantity consumed. Canada and Mexico are the leading sources of zinc to 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.

After a high of more than 79 cents per pound in the summer of 1997, the domestic producers' price declined to a low of about 47 cents per pound in January 1999.

World Mine Production, Reserves, and Reserve Base:

	Mine production[6]		Reserves[7]	Reserve base[7]
	1998	1999[e]		
United States	755	810	25,000	80,000
Australia	1,059	1,100	34,000	85,000
Canada	1,057	1,100	11,000	31,000
China	1,100	1,050	33,000	80,000
Mexico	395	390	6,000	8,000
Peru	869	870	7,000	12,000
Other countries	2,310	2,320	72,000	130,000
World total (may be rounded)	7,550	7,640	190,000	430,000

World Resources: Identified zinc resources of the world are about 1.9 billion tons.

Substitutes: Aluminum, steel, and plastics substitute for galvanized sheet. Aluminum, plastics, and magnesium are major competitors as die-casting 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.
[2]Platt's Metals Week price for North American Special High Grade zinc.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B for definitions.
[5]Platt's Metals Week, 1999, Pasminco wins battle for Savage Resources: Platt's Metals Week, v. 70, no. 6, February 8, p. 1.
[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 one mine in Virginia. Zirconium and hafnium metal were produced from zircon sand by two domestic producers, one each in Oregon and Utah. Both metals are present in the ore typically in a Zr to Hf ratio of 50:1. Primary zirconium chemicals were produced by the Oregon metal producer and at a plant in New Jersey. Secondary zirconium chemicals were produced by 10 other companies as well. Zirconia (ZrO_2) was produced from zircon sand at plants in Alabama, New Hampshire, New York, Ohio, and 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 an addition in superalloys.

Salient Statistics—United States:	1995	1996	1997	1998	1999[e]
Production: Zircon (ZrO_2 content)[1]	W	W	W	W	W
Imports:					
Zirconium, ores and concentrates (ZrO_2 content)	60,800	60,100	40,600	58,200	38,600
Zirconium, alloys, waste and scrap (ZrO_2 content)	884	836	929	1,210	1,400
Zirconium oxide (ZrO_2 content)[2]	4,370	5,240	4,220	3,900	3,100
Hafnium, unwrought, waste and scrap	5	9	8	12	11
Exports:					
Zirconium ores and concentrates (ZrO_2 content)	26,200	22,780	28,800	26,600	44,900
Zirconium, alloys, waste and scrap (ZrO_2 content)	221	184	188	216	166
Zirconium oxide (ZrO_2 content)[2]	1,680	1,480	1,970	1,540	1,610
Consumption, zirconium ores and concentrates, apparent (ZrO_2 content)	W	W	W	W	W
Prices:					
Zircon, dollars per metric ton (gross weight):					
Domestic[3]	352	462	419	320	300
Imported, f.o.b.[4]	325	400	400	355	313
Zirconium sponge, dollars per kilogram[5]	20-26	20-26	20-26	20-26	20-26
Hafnium sponge, dollars per kilogram[5]	165-209	165-209	165-209	165-209	165-209
Net import reliance[6] as a percent of apparent consumption:					
Zirconium	W	W	W	W	W
Hafnium	NA	NA	NA	NA	NA

Recycling: Zirconium metal was recycled by four companies, one each in California, Michigan, New York, and Texas. The majority of the zirconium recycled came from scrap generated during metal production and fabrication. Zircon foundry mold cores and spent or rejected zirconia refractories are often recycled. Recycling of hafnium metal was insignificant.

Import Sources (1995-98): Zirconium ores and concentrates: South Africa, 53%; Australia, 45%; and other, 2%. Zirconium, wrought, unwrought, waste and scrap: France, 48%; Germany, 22%; Canada, 7%; Japan, 7%; and other, 16%. Hafnium, unwrought, waste and scrap: France, 71%; Australia, 17%; Germany, 8%; and United Kingdom, 4%.

Tariff: Item	Number	Normal Trade Relations 12/31/99
Zirconium ores and concentrates	2615.10.0000	Free.
Germanium oxides and ZrO_2	2825.60.0000	3.7% ad val.
Ferrozirconium	7202.99.1000	4.2% ad val.
Zirconium, waste and scrap	8109.10.3000	Free.
Zirconium, other unwrought, powders	8109.10.6000	4.2% ad val.
Zirconium, other wrought, alloys	8109.90.0000	3.7% ad val.
Unwrought hafnium, waste and scrap	8112.91.2000	Free.

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

Government Stockpile: In addition to 15,769 tons of baddeleyite ore (gross weight) held in the National Defense Stockpile, the U.S. Department of Energy (DOE) held over 500 tons of zirconium in various forms. DOE also maintained a supply of approximately 35 tons of hafnium.

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ZIRCONIUM AND HAFNIUM

Stockpile Status—9-30-99[7]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1999	Disposals FY 1999
Baddeleyite	15,769	—	15,769	—	—

Events, Trends, and Issues: The global supply and demand of zirconium mineral concentrates was largely in balance in 1999. This trend is expected to continue over the next few years. However, long-term supply shortages may occur unless new production sources of zirconium concentrates are developed. U.S. imports of zirconium concentrates were estimated to have decreased 57%, while exports increased 69% compared with those of 1998. A new mining operation at Stony Creek, VA, began production of zircon and other heavy minerals in 1998. Initial capacity was expected to include up to 30,000 tons per year of zircon. Availability of hafnium continued to exceed supply. Surpluses were stockpiled in the form of hafnium oxide. The demand for nuclear-grade zirconium metal, the production of which necessitates hafnium's removal, produces more hafnium than can be consumed by the metal's uses.

World Refinery Production, Reserves, and Reserve Base: World primary hafnium production statistics are not available. Hafnium occurs with zirconium in the minerals zircon and baddeleyite.

	Zirconium				Hafnium	
	Mine production (thousand metric tons)		Reserves[8] (million metric tons, ZrO_2)	Reserve base[8] (million metric tons, ZrO_2)	Reserves[8] (thousand metric tons, HfO_2)	Reserve base[8] (thousand metric tons, HfO_2)
	1998	1999[e]				
United States	W	W	3.4	5.3	68	97
Australia	404	400	9.1	29.8	182	596
Brazil	16	16	.4	.4	7	7
China[e]	15	15	.5	1.0	NA	NA
India	19	19	3.4	3.8	42	46
South Africa	270	270	14.3	14.3	259	259
Ukraine[e]	65	65	4.0	6.0	NA	NA
Other countries	25	30	.9	4.1	NA	NA
World total (may be rounded)	[9]814	[9]815	36	65	560	1,000

World Resources: Resources of zircon in the United States included about 14 million tons associated with titanium resources in heavy-mineral sand deposits. Phosphate and sand and gravel deposits have the potential to yield substantial amounts of zircon as a future byproduct. Eudialyte and gittinsite are zirconium silicate minerals that have a potential for zirconia production. Identified world resources of zircon exceed 60 million tons.

Resources of hafnium in the United States are estimated to be about 130,000 tons, available in the 14-million ton domestic resources of zircon. World resources of hafnium are associated with those of zircon and baddeleyite and exceed 1 million tons.

Substitutes: Chromite and olivine can be used instead of zircon for some foundry applications. Dolomite and spinel refractories can also substitute for zircon in certain high-temperature applications. Columbium (niobium), stainless steel, and tantalum provide limited substitution in nuclear applications, while titanium and synthetic materials may substitute in some chemical plant uses.

Silver-cadmium-indium control rods are used in lieu of hafnium at numerous nuclear powerplants. Zirconium can be used interchangeably with hafnium in certain superalloys; in others, only hafnium produces the desired or required grain boundary refinement.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]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]Bureau of the Census trade data.
[5]American Metal Market, daily, Miscellaneous Prices. Converted from pounds.
[6]Defined as imports - exports.
[7]See Appendix B for definitions.
[8]See Appendix C for definitions.
[9]Excludes the United States.

APPENDIX A

Abbreviations and Units of Measure

1 carat (metric) (diamond)	= 200 milligrams
1 flask (fl)	= 76 pounds, avoirdupois
1 karat (gold)	= one twenty-fourth part
1 kilogram (kg)	= 2.2046 pounds, avoirdupois
1 long ton (lt)	= 2,240 pounds, avoirdupois
1 long ton unit (ltu)	= 1% of 1 long ton or 22.4 pounds avoirdupois
long calcined ton (lct)	= excludes water of hydration
long dry ton (ldt)	= excludes excess free moisture
Mcf	= 1,000 cubic feet
1 metric ton (t)	= 2,204.6 pounds, avoirdupois or 1,000 kilograms
1 metric ton (t)	= 1.1023 short ton
1 pound (lb)	= 453.6 grams
1 short ton (st)	= 2,000 pounds, avoirdupois
1 short ton unit (stu)	= 1% of 1 short ton or 20 pounds, avoirdupois
1 short dry ton (sdt)	= 2,000 pounds, avoirdupois, excluding moisture content
1 troy ounce (tr oz)	= 1.09714 avoirdupois ounces
1 troy pound	= 12 troy ounces

APPENDIX B

Terms Used for Materials in the National Defense Stockpile

Uncommitted inventory, as used by the Department of Defense, refers simply to material currently in the stockpile, whether stockpile-grade or nonstockpile-grade. In the tables for this report, only the stockpile-grade material is listed; nonstockpile-grade material, if any, is cited in the text.

Committed inventory refers to both stockpile-grade materials and nonstockpile-grade materials that have been sold or traded from the stockpile, either in the current fiscal year or in prior years, but not yet removed from stockpile facilities.

Authorized for disposal refers to quantities that are in excess of the stockpile goal for a material, and for which Congress has authorized disposal over the long term at rates designed to maximize revenue but avoid undue disruption of the usual markets and loss to the United States.

Disposal plan FY 1999 refers the Defense Logistics Agency's Annual Materials Plan for the fiscal year. Fiscal year 1999 is the period 10/1/98 through 9/30/99.

Disposals FY 1999 refers to material sold or traded from the stockpile in fiscal year 1999; it may or may not have been removed by the buyers.

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 (marginal reserves), and some of those that are currently subeconomic (subeconomic resources).

[1]Based on U.S. Geological Survey Circular 831, 1980.

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*

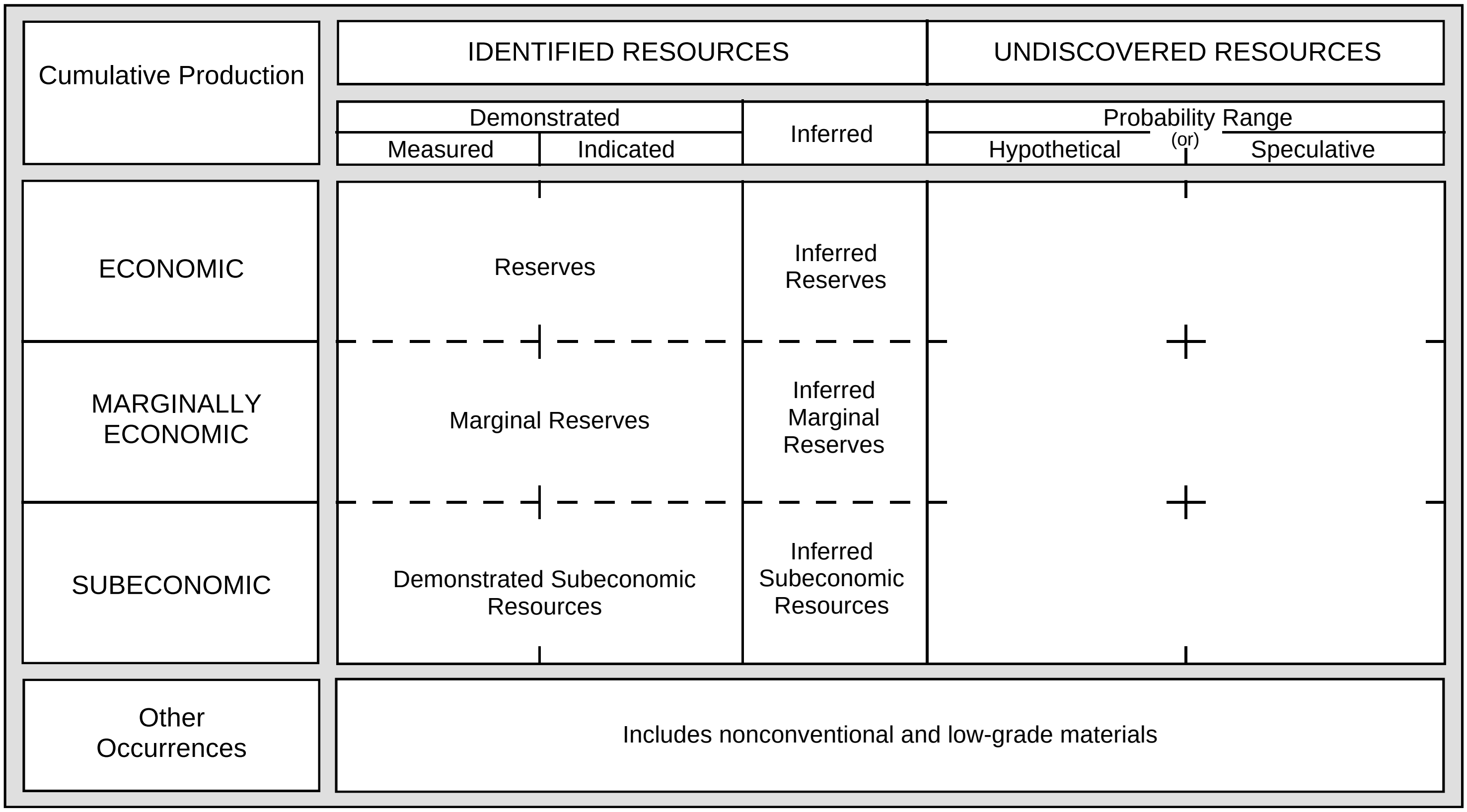

FIGURE 2.--*Reserve Base* and *Inferred Reserve Base* Classification Categories