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

Mineral Commodity Summaries 1998

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
Ilmenite
Indium
Iodine
Iron Ore
Iron and Steel
Kyanite
Lead
Lime
Lithium
Magnesium
Manganese
Manufactured Abrasives
Mercury
Mica
Molybdenum
Nickel
Nitrogen
Peat
Perlite
Phosphate Rock
Platinum
Potash
Pumice
Quartz Crystal
Rare Earths
Rhenium
Rubidium
Rutile
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

USGS
science for a changing world

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
MARK SCHAEFER, Interim Director

For sale by U.S. Government Printing Office
Washington, DC 20402

Published in the Eastern Region, Reston, VA
Manuscript approved for publication January 30, 1998

Library of Congress Cataloging in Publication Data
ISSN 0160-5151

This report is the earliest Government publication to furnish estimates covering 1997 nonfuel mineral industry data. Most of the estimates are based on at least 6 months of data. These reports contain information about the domestic industry structure, Government programs, tariffs, and 5-year salient statistics for over 90 individual minerals and materials. Most data are rounded to no more than three significant figures.

January 1998

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

CONTENTS

INSTANT INFORMATION

Information about the U.S. Geological Survey, its programs, staff, and products may be accessed via the Internet at http://www.usgs.gov. Aerial photography, digital data, geologic, and map products and information are available by contacting the Earth Science Information Center at 1-800-USA-MAPS. Water data and information may be obtained by contacting the Water Information Center at 1-800-426-9000.

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.er.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. 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 over 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 mineral activities.

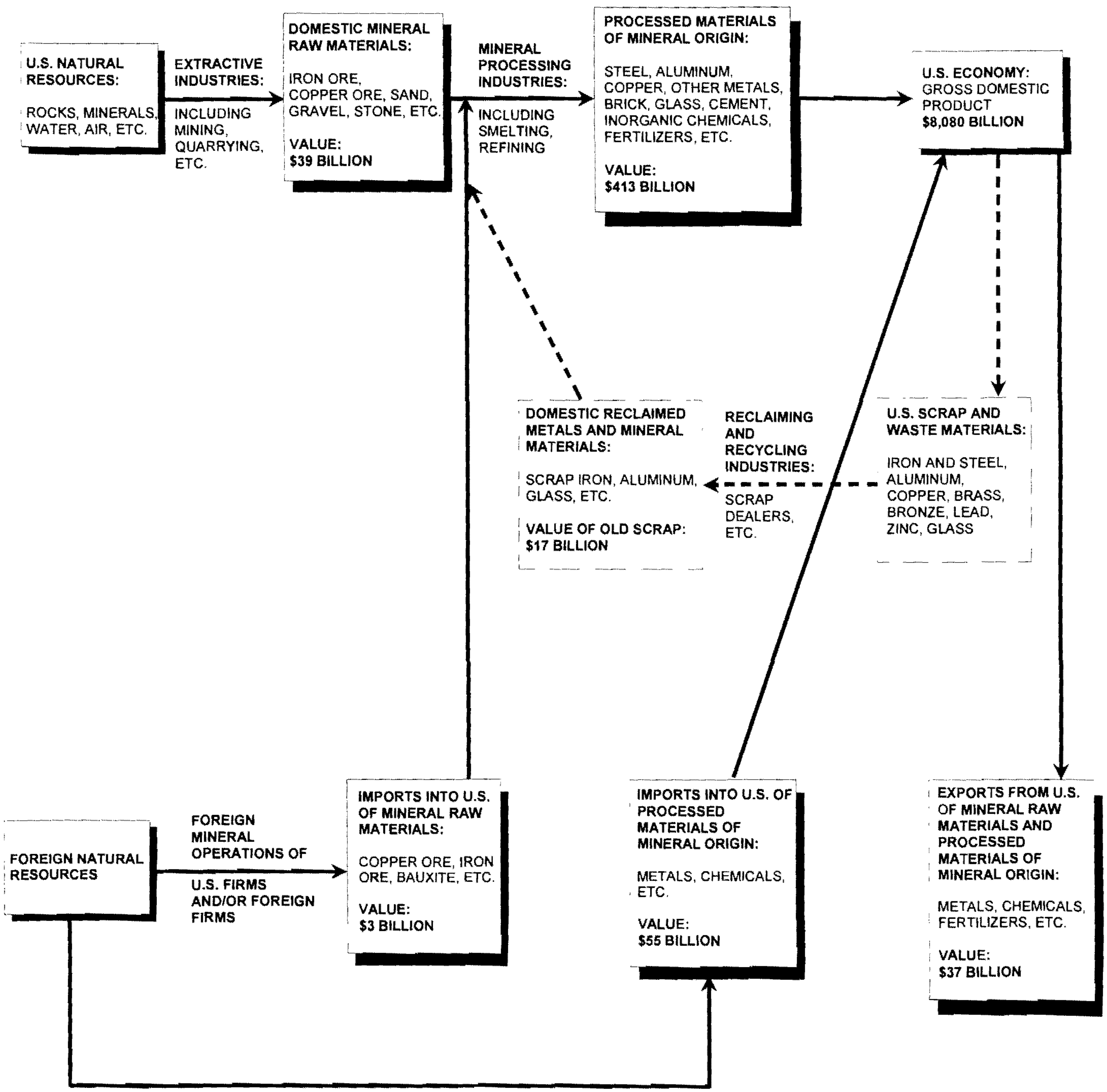
WHERE TO OBTAIN PUBLICATIONS

- *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) 892-4338 or writing NIOSH Printing Office, Pittsburgh Research Laboratory, P.O. Box 18070, Pittsburgh, PA 15236.

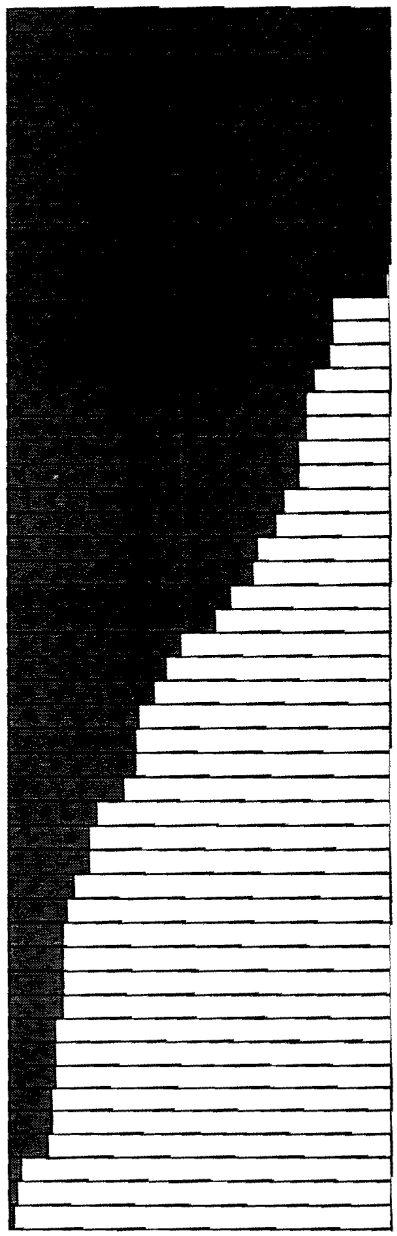
THE ROLE OF NONFUEL MINERALS IN THE U.S. ECONOMY

(ESTIMATED VALUES IN 1997)



1997 U.S. NET IMPORT RELIANCE FOR SELECTED NONFUEL MINERAL MATERIALS

COMMODITY	PERCENT	MAJOR SOURCES (1993-96)[1]
ARSENIC	100	China, Japan, Hong Kong, Germany
BAUXITE and ALUMINA	100	Australia, Guinea, Jamaica, Brazil
COLUMBIUM (niobium)	100	Brazil, Canada, Germany
FLUORSPAR	100	China, South Africa, Mexico
GRAPHITE (natural)	100	Mexico, China, Canada, Madagascar, Brazil
MANGANESE	100	South Africa, Gabon, Australia, France
MICA, sheet (natural)	100	India, Belgium, China, Brazil
STRONTIUM	100	Mexico, Germany
THALLIUM	100	Belgium, Mexico, Canada
THORIUM	100	France
YTTRIUM	100	China, Japan
GEMSTONES	99	Israel, Belgium, India
TIN	85	Brazil, Bolivia, Indonesia, China
TUNGSTEN	85	China, Russia, Germany, Bolivia
PLATINUM	84	South Africa, Russia, United Kingdom, Germany
TANTALUM	80	Australia, Thailand, Germany, Brazil
COBALT	78	Norway, Zambia, Finland, Canada, Russia
PALLADIUM	78	Russia, South Africa, United Kingdom, Belgium
CHROMIUM	76	South Africa, Turkey, Russia, Kazakstan, Zimbabwe
POTASH	76	Canada, Russia, Belarus, Israel
BARITE	72	China, India, Mexico, Morocco
ZINC	70	Canada, Mexico, Spain, Peru
IODINE	65	Japan, Chile, Canada
STONE (dimension)	64	Italy, India, Brazil, Canada
PEAT	58	Canada
NICKEL	54	Canada, Norway, Russia, Australia
DIAMOND (dust, grit, and powder)	45	Ireland, China, Germany
SELENIUM	41	Canada, Philippines, Belgium, Japan, United Kingdom
ASBESTOS	38	Canada
SILICON	34	Norway, Russia, Brazil, Canada
CADMIUM	33	Canada, Mexico, Belgium, Germany
MAGNESIUM COMPOUNDS	33	China, Canada, Austria, Greece
GYPSUM	30	Canada, Mexico, Spain
ALUMINUM	23	Canada, Russia, Venezuela, Mexico
IRON and STEEL	21	European Union, Canada, Japan, Brazil, Mexico
PUMICE	21	Greece, Turkey, Ecuador
SILVER	17	Canada, Mexico, Germany, Peru, Chile
IRON ORE	15	Canada, Brazil, Venezuela, Australia
CEMENT	14	Canada, Spain, Venezuela, Mexico
LEAD	14	Canada, Mexico, Peru, Australia
NITROGEN (fixed), AMMONIA	14	Trinidad and Tobago, Canada, Mexico
SALT	14	Canada, Mexico, Chile, The Bahamas
COPPER	12	Canada, Chile, Mexico
RARE EARTHS	12	Australia, France
SODIUM SULFATE	12	Canada, Mexico, Japan, Germany
PERLITE	11	Greece
SULFUR	11	Canada, Mexico, Germany
MAGNESIUM	10	Canada, Russia, China, Mexico, Ukraine
MICA, scrap and flake (natural)	3	Canada, India, Finland, Japan
IRON and STEEL SLAG	2	Canada, South Africa
LIME	1	Canada, Mexico



[1] In descending order of importance

Additional commodities for which there is some import dependency but data are withheld or are insufficient to determine import-reliance levels:

Antimony	China, Mexico, Bolivia, South Africa
Bismuth	Mexico, Belgium, China, United Kingdom, Canada
Gallium	France, Russia, Canada, Germany, Hungary
Germanium	Russia, United Kingdom, China, Belgium, Ukraine
Ilmenite	South Africa, Australia, Canada
Indium	Canada, Russia, France, Italy, China
Kyanite	South Africa
Mercury	Russia, Canada, Spain, Kyrgyzstan
Rhenium	Chile, Germany, Netherlands, United Kingdom, Russia
Rutile	Australia, South Africa, Sierra Leone
Titanium (sponge)	Russia, Japan, China, Kazakstan
Vanadium (ferrovanadium)	Russia, Canada, Belgium, Austria
Vermiculite	South Africa, China
Zirconium	Australia, South Africa

SIGNIFICANT EVENTS, TRENDS, AND ISSUES

The Mineral Sector of the U.S. Economy

The U.S. economy and, consequently, the demand for minerals grew at a moderate rate in 1997. A low inflation rate, stable interest rates, and increases in employment bolstered consumer confidence throughout the year. The increase in employment resulted in increased taxes paid at both the Federal and State levels, which decreased the Federal deficit and resulted in positive balances for 49 of 50 States. The decrease in the Federal deficit and low inflation were seen as positive indicators that the economy would continue to expand in the coming year. Demand for metals was relatively stable or increased compared with that of 1996. Demand for most industrial minerals, especially crushed stone and cement, increased compared with that of the previous 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 1997 was estimated to be $413 billion, an increase of nearly 7% compared with the 1996 value. The estimated value of U.S. raw nonfuel minerals production in 1997 was nearly $39.5 billion, an increase of about 2% compared with that of 1996. The nominal value of U.S. minerals production has increased in 31 of the last 37 years.

Total U.S. trade in raw minerals and processed materials of mineral origin was valued at $95 billion in 1997. Imports of processed mineral materials were valued at an estimated $55 billion, while exports of these materials were valued at an estimated $37 billion. Imports of metal ores and concentrates and of raw industrial minerals increased almost 8% to $2.8 billion. Raw minerals exports increased slightly to $3.1 billion. Demand for metals and other mineral-based materials used extensively in motor vehicle manufacturing declined slightly in 1997 because of the estimated decline in automobile manufacture. 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 provided for modest growth in minerals demand. The construction sector is the largest consumer of brick clay, cement, sand and gravel, and stone. Road construction expenditures in 1997 maintained the high levels of the last few years as a result of the 6-year Federal highway and mass transit program reauthorized in 1991. Large quantities of asphalt, cement, crushed stone, and sand and gravel are used in road building. Apartment building construction and new home construction increased in 1997, which had a positive effect on the consumption of brick clay, cement, sand and gravel, steel, and stone.

Responding to domestic and world demand for fertilizer nutrients, the domestic mineral fertilizer manufacturing sector again operated at nearly full capacity, which resulted in a strong demand for fixed nitrogen, phosphate rock, and sulfur. Global fertilizer nutrient consumption increased substantially; U.S. demand at the farm level, where fertilizers are consumed, increased in response to higher domestic and world demand for coarse grains and other high volume agricultural products.

The Uruguay Round of the General Agreements on Tariffs and Trade (GATT) became effective January 1, 1995. GATT rules, such as those that address market access affected by tariff and nontariff market barriers, are significant to U.S. minerals producers. For example, Uruguay Round GATT agreements eliminate tariffs (during a 10-year period) on steel imposed by the United States and its trading partners, including the European Union and Japan.

Legislation to reform the Mining Law of 1872 has been considered by the Congress and the Administration for the past several years; however, no reform legislation was enacted in 1997. The Mining Law gives U.S. citizens and corporations the right to prospect for certain minerals on particular Federal lands and confers the right to file claims that permit the claimants to mine and sell minerals found. The Mining Law does not provide for a royalty payment to the Federal Government for minerals that are mined. Under the Mining Law, claimants also may apply for a patent that transfers ownership of minerals and mineral lands to the claimant.

In fiscal year 1997, the Defense Logistics Agency sold excess mineral materials valued at $513 million (see "Government Stockpile" in the commodity sections that follow). The Defense Production Act, which provides authority for priorities, allocations, and defense-related supply expansions, is expected to continue.

Outlook

The U.S. economy is expected to continue to grow at a moderate rate for the near term, providing a mild stimulus to the Nation's materials-consuming industries. Inflation is expected to remain low, thus permitting a continuance of low interest rates conducive to an expanding economy. Although motor vehicle sales have declined slightly from their 1994 peak, relatively strong sales are expected to continue because of moderate auto loan interest rates and advantageous monetary exchange rates. The Federal highway and mass transit program was expected to be reauthorized and continue to provide an impetus for consumption of stone, sand and gravel, and steel. The demand prospect for mineral fertilizer materials (i.e., fixed nitrogen, phosphate rock, potash, and sulfur) is expected

TABLE 1.—U.S. MINERAL INDUSTRY TRENDS

	1993	1994	1995	1996	1997[e]
Total mine production:[1]					
Metals	10,800	12,100	14,000	12,900	12,400
Industrial minerals	21,200	23,100	24,600	25,800	27,100
Coal	18,800	20,100	19,500	19,700	19,900
Employment:[2]					
Coal mining	86	90	84	79	75
Metal mining	40	39	41	42	42
Industrial minerals, except fuels	76	78	80	81	82
Chemicals and allied products	573	578	580	575	568
Stone, clay, and glass products	399	411	418	421	423
Primary metal industries	520	537	553	554	556
Average weekly earnings of production workers:[3]					
Coal mining	767	803	828	859	863
Metal mining	659	699	735	763	787
Industrial minerals, except fuels	585	610	624	648	679
Chemicals and allied products	639	654	675	699	717
Stone, clay, and glass products	506	526	534	555	568
Primary metal industries	611	641	643	662	682

[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.

to be strong in the coming year because low world stocks of grains and oilseeds should stimulate increased planting domestically and worldwide.

Significant International Events[1]

During 1997, the mining industries of most countries in both hemispheres were generally prosperous. By the end of the year, however, fundamental changes had overtaken global financial markets. Continued acceptance of foreign investment and privatization of formerly state-owned companies in much of the world had a salutary effect on production efficiencies, although the supply of investment capital appeared to be threatened as the year ended. Despite the long-anticipated investment upswing in Eurasia, particularly Kazakstan and Russia, overextension of credit during the period of growth in several East and Southeast Asian countries led to bank failures or insolvencies, withdrawal of foreign capital, and damaging runs in currency markets. The resulting currency devaluations amounted to large-scale destruction of capital and led to loss of confidence and contraction of the equity markets that provide investment capital. Market contractions engendered loss of confidence in other countries. Amidst plans for expansion of copper capacity, potential Asian demand for metals was seen to be threatened, with consequences for countries, such as Chile. The ripple effect spread to Mexico, Brazil, most of Latin America, and as far as London and South Africa. The United States and Japan, the world's two largest economies and major sources of capital for international mining ventures, were affected by market corrections that also diminished capital. By unfortunate coincidence, the price of gold steadily weakened throughout 1997. The central banks of several countries sold large shares of their gold holdings to meet common-currency criteria for the European Union (EU) or, as in Australia's case, simply to demonetize. Consequences, which have been serious, included closing or suspension of operations of many gold mines, as well as revision or cancellation of plans for gold exploration. The Bre-X Minerals Ltd. scandal in Indonesia added an additional burden on junior companies attempting to raise capital for gold exploration. The continuing commitment of many governments to privatize state-owned companies and acceptance of foreign investment for exploration and development may represent the essentially favorable news

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

	1993	1994	1995	1996	1997[e]
Gross domestic product (billion dollars)	6,560	6,950	7,270	7,640	8,080
Capital expenditures (billion dollars):					
All industries	490	550 [p]	594 [p]	603 [1]	NA
Manufacturing	134	153 [p]	172 [p]	185 [1]	NA
Mining and construction	31	36 [p]	36 [p]	34 [1]	NA
Industrial production (1992=100):					
Total index	104	109	115	118	124
Manufacturing	104	110	116	120	127
Stone, clay, and glass products	102	108	111	115	120
Primary metals	106	113	117	119	125
Iron and steel	107	114	118	118	123
Nonferrous metals	104	113	116	120	126
Chemicals and chemical products	101	105	107	110	115
Mining	100	103	102	104	106
Metals	99	100	102	103	107
Coal	95	104	104	107	109
Oil and gas extraction	101	102	100	102	103
Stone and earth minerals	102	109	113	116	119
Capacity utilization (percent):[2]					
Total industry	81	83	84	82	83
Mining	86	88	87	89	90
Metals	84	86	87	88	90
Stone and earth minerals	83	86	87	86	85
Housing starts (thousands)	1,290	1,460	1,350	1,480	1,490
Automobile production (thousands)	5,980	6,610	6,350	6,080	6,030
Highway construction, all public, expenditures (billion dollars)	31	34	34 [p]	36 [e]	37

[e]Estimated. [p]Preliminary. NA Not available.

[1]Planned expenditures.

[2]1997 estimates based on seasonally adjusted figures.

Sources: U.S. Department of Commerce, Federal Reserve Board, American Automobile Manufacturers' Association, and U.S. Department of Transportation.

in the midst of the current uncertainties of the capital markets.

Africa

In 1997, Africa witnessed a significant revival of mineral exploration and development following the end of sanctions against South Africa; the end of longstanding civil wars in Angola and Mozambique; privatization trends in Zambia and Congo (Kinshasa), formerly Zaire, and the liberalization of mining and foreign investment laws in many countries. According to the Metal Economics Group of Halifax, Nova Scotia, $662.6 million, or more than 16% of the combined exploration budgets of 279 companies, was expended in Africa This was the largest growth in exploration expenditure of any region in the world. In addition, plans for more than $18 billion in potential new mineral developments in the region were announced.

Much of the interest in exploration and development was centered in southern Africa. In Angola, the developments in the petroleum and diamond sectors were major. Two offshore petroleum discoveries, the Girassol and the Dahlia I blocks, were each estimated to contain more than 2 billion barrels. With the return of foreign investment, two new diamond projects, Luo and Catoca, came into production. Total diamond production was expected to increase from 4 million to 5 million carats per year within 2 to 4 years. In Congo (Kinshasa), 10 companies had entered joint ventures with the state-owned mining companies to revitalize the copper-cobalt, zinc, gold, and manganese industries. Potential investment, subject to a return to political stability, could exceed $2 billion. In Mozambique, planned new investment includes an aluminum smelter, a direct reduced iron plant, two new titanium mining and processing operations, and development of the Pande natural gas field and pipeline.

In South Africa, $2.4 billion in planned new investment will be used to expand the Richards Bay coal export terminal and the Namakwa Sands titanium project, to modernize the aging steel plant at Vanderbijlpark and the Bayside aluminum smelter at Richards Bay, and to construct a major 1.25-million-metric-ton-per-year steel plant at Saldhana Bay and a new titanium mine and plant near Richards Bay. The six dominant mining houses continued their "unbundling" of assets, devolving more into holding companies than into operators. In October, two of the major mining houses merged their gold mining operations into a new company that will become the second largest gold producer in the world with a production capacity of 200 tons per year of gold. At about 490 tons, gold production was the lowest in 41 years.

In Namibia, diamond dredging in the offshore Koichab area was begun, major capital investment was secured for the Rossing open-pit uranium mine, and decisions were made to proceed with development of the $600 million Haib copper and the $164 million Scorpion zinc deposits. In Zambia, privatization of state-owned coal and copper operations was expected to be completed by yearend. The Zambian Privatization Agency divided the state copper company into nine entities and sold them separately. A consortium of U.S., Canadian, and South African mining companies was negotiating to acquire the Nkana and the Nchanga Divisions, representing more than 50% of national production, for a several-hundred-million-dollar buy-in and a commitment to invest an additional $1 billion to expand operations.

In west Africa, gold exploration continued in Burkina Faso, the Central African Republic, Côte d'Ivoire, Ghana, Guinea, Mali, Niger, and Senegal. In Ghana, the Damang and the Obotan Mines were brought into production during 1997; the Wassa, the Bibiani, and the Tarkwa Mines are scheduled to start-up in 1998. Petroleum activity continued with exploration offshore of Benin, Côte d'Ivoire, Equatorial Guinea, Ghana, Nigeria, and Senegal. Although exploration activity declined in Nigeria, natural gas production, which will reduce the enormous volume of gas burned off, began.

Gold also was the target of exploration efforts in the east African countries of Eritrea, Ethiopia, Uganda, and Tanzania. In Tanzania, four newly discovered deposits each contain from 1 million to 5 million troy ounces of gold; two of these are undergoing engineering feasibility studies. Also in Tanzania, a Canadian-Australian joint venture is studying the feasibility of bringing the Kabanga nickel deposit into production by 2001.

Middle East

The Governments of most Middle Eastern nations continued to encourage foreign and private interests in mineral development. Petroleum and petrochemicals remain the most important mineral commodities for the majority of countries in the region.

In accordance with the United Nations, Iraq resumed limited oil exports in August with the larger share of the oil transiting through Turkey. In Saudi Arabia and Syria, the discovery and development of domestic petroleum reservoirs with light, low-sulfur, crude oils provided higher priced export crudes. Both countries are endorsing the increased usage of natural gas to relieve more liquid fuels for export. Iran opened the long-awaited Bandar Abbas oil refinery during the year, with full capacity of 232,000 barrels per day expected to be reached in 1998.

The region's petrochemical industry is growing rapidly. In Kuwait, a $2 billion petrochemical complex at Shuayba opened in September with Government equity at 45%. A number of Saudi Arabian petrochemical complexes, under new construction or expansion, will come on-stream between 1997 and 2000, increasing the country's petrochemical production to 28 million tons per year.

Asia and the Pacific

Australia continued to attract mineral investment in 1997. In September, a major Australian iron ore mining company announced that it would begin development of its sixth iron ore mine in Western Australia's Pilbara region. Initial output, scheduled for mid-1999, was expected to be 5 million tons per year of high-grade pisolitic fines. In the same month, a major Australian minerals company overcame the last obstacle in its acquisition and development of a lead-zinc-silver mine in Queensland. The mine is expected to cost about $90 million and to produce 780,000 tons per year of concentrates for use in the company's 205,000-ton-per-year smelter in the Netherlands. A Japanese consortium started renovations of a newly acquired 120,000-ton-per-year copper smelter and refinery complex at Port Kembla, New South Wales, Australia.

At its 15th National Congress in September, the Communist Party of China announced plans to accelerate the reform of state-owned enterprises that was implemented in the early 1990's. The Chinese Government plans to convert large- and medium-sized state-owned enterprises into independent corporations. The Government will share equity in the new corporations but will bear limited responsibility for their debts. The enterprises will be responsible for their own profits and

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1997 p 1

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$805,000	18	2.04	Cement (portland), stone (crushed), lime, sand and gravel (construction), cement (masonry).
Alaska	827,000	17	2.10	Zinc, lead, gold, sand and gravel (construction), silver.
Arizona	3,520,000	1	8.91	Copper, sand and gravel (construction), cement (portland), molybdenum, lime.
Arkansas	535,000	24	1.36	Bromine, stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial).
California	2,810,000	3	7.13	Cement (portland), sand and gravel (construction), boron, stone (crushed), gold.
Colorado	521,000	26	1.32	Sand and gravel (construction), cement (portland), molybdenum, stone (crushed), gold.
Connecticut[2]	64,800	46	.16	Stone (crushed), sand and gravel (construction), stone (dimension), clays (common), gemstones.
Delaware[2]	6,490	50	.02	Magnesium compounds, sand and gravel (construction), gemstones.
Florida	1,740,000	6	4.42	Phosphate rock, stone (crushed), cement (portland), sand and gravel (construction), titanium (ilmenite).
Georgia	1,770,000	4	4.49	Clays (kaolin), stone (crushed), cement (portland), clays (fuller's earth), sand and gravel (construction).
Hawaii[2]	99,900	43	.25	Stone (crushed), cement (portland), cement (masonry), gemstones.
Idaho	442,000	31	1.12	Phosphate rock, gold, sand and gravel (construction), molybdenum, silver.
Illinois	880,000	16	2.23	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), lime.
Indiana	669,000	21	1.70	Stone (crushed), cement (portland), sand and gravel (construction), lime, cement (masonry).
Iowa	493,000	29	1.25	Stone (crushed), cement (portland), sand and gravel (construction), gypsum (crude), lime.
Kansas	547,000	23	1.39	Cement (portland), salt, stone (crushed), helium (Grade-A), sand and gravel (construction).
Kentucky	476,000	30	1.21	Stone (crushed), lime, cement (portland), sand and gravel (construction), clays (ball).
Louisiana	379,000	35	.96	Salt, sulfur (Frasch), sand and gravel (construction), stone (crushed), sand and gravel (industrial).
Maine	88,200	44	.22	Sand and gravel (construction), cement (portland), stone (crushed), peat, cement (masonry).
Maryland	401,000	33	1.02	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry), stone (dimension).
Massachusetts	213,000	39	.54	Stone (crushed), sand and gravel (construction), stone (dimension), lime, clays (common).
Michigan	1,560,000	9	3.96	Cement (portland), iron ore (usable), sand and gravel (construction), magnesium compounds, stone (crushed).

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1997 p 1—Continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Minnesota	$1,600,000	8	4.06	Iron ore (usable), sand and gravel (construction), stone (crushed), sand and gravel (industrial), stone (dimension).
Mississippi	137,000	42	.35	Sand and gravel (construction), cement (portland), clays (fuller's earth), stone (crushed), clays (bentonite).
Missouri	1,320,000	10	3.34	Stone (crushed), lead, cement (portland), lime, zinc.
Montana	498,000	28	1.26	Copper, gold, cement (portland), palladium metal, molybdenum.
Nebraska	161,000	41	.41	Cement (portland), sand and gravel (construction), stone (crushed), cement (masonry), clays (common).
Nevada	3,030,000	2	7.69	Gold, copper, silver, sand and gravel (construction), diatomite.
New Hampshire [2]	60,200	47	.15	Sand and gravel (construction), stone (crushed), stone (dimension), gemstones.
New Jersey	296,000	37	.75	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), greensand marl, peat.
New Mexico	994,000	13	2.52	Copper, potash, sand and gravel (construction), cement (portland), perlite (crude).
New York	904,000	15	2.29	Stone (crushed), cement (portland), salt, sand and gravel (construction), zinc.
North Carolina	758,000	20	1.92	Stone (crushed), phosphate rock, sand and gravel (construction), sand and gravel (industrial), clays (common).
North Dakota	31,600	48	.08	Sand and gravel (construction), lime, clays (common), sand and gravel (industrial), gemstones.
Ohio	984,000	14	2.49	Stone (crushed), sand and gravel (construction), salt, lime, cement (portland).
Oklahoma	411,000	32	1.04	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial), iodine (crude).
Oregon	272,000	38	.69	Sand and gravel (construction), stone (crushed), cement (portland), diatomite, lime.
Pennsylvania [2]	1,240,000	11	3.13	Stone (crushed), cement (portland), lime, sand and gravel (construction), cement (masonry).
Rhode Island [2]	22,600	49	.06	Sand and gravel (construction), stone (crushed), sand and gravel (industrial), gemstones.
South Carolina	507,000	27	1.28	Cement (portland), stone (crushed), gold, sand and gravel (construction), cement (masonry).
South Dakota	340,000	36	.86	Gold, cement (portland), stone (crushed), sand and gravel (construction), lime.
Tennessee	786,000	19	1.99	Stone (crushed), zinc, cement (portland), sand and gravel (construction), clays (ball).
Texas	1,700,000	7	4.31	Cement (portland), stone (crushed), sand and gravel (construction), magnesium metal, salt.
Utah	1,760,000	5	4.46	Copper, gold, molybdenum, magnesium metal, sand and gravel (construction).

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1997 p 1—Continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Vermont [2]	$68,200	45	0.17	Stone (dimension), stone (crushed), sand and gravel (construction), talc and pyrophyllite, gemstones.
Virginia	600,000	22	1.52	Stone (crushed), sand and gravel (construction), cement (portland), lime, kyanite.
Washington	522,000	25	1.32	Sand and gravel (construction), magnesium metal, stone (crushed), cement (portland), gold.
West Virginia	190,000	40	.48	Stone (crushed), cement (portland), sand and gravel (industrial), lime, salt.
Wisconsin	389,000	34	.98	Stone (crushed), sand and gravel (construction), copper, sand and gravel (industrial), lime.
Wyoming	996,000	12	2.52	Soda ash, clays (bentonite), helium (Grade-A), cement (portland), stone (crushed).
Undistributed	29,800	XX	.08	
Total	39,500,000	XX	100.00	

pPreliminary. XX Not applicable.

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

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

losses. The Government will encourage enterprises to merge, to declare bankruptcy if necessary, and to increase efficiency by downsizing staff.

In the wake of the Busang gold scandal, the Indonesian Government unveiled proposed revisions to the new mining Contracts-of-Work. Following widespread expressions of concern that these revisions would act as a major deterrent to future mining investment in the country, however, the Government subsequently canceled plans to revise the mining regulations. A U.S. oil company discovered a massive natural gas field with a proven reserve of 178 billion cubic meters in the onshore Wiriagar and the offshore Berau blocks in Irian Jaya. The Natuna fields in the South China Sea, one of the world's largest gasfields with in-place reserves of 6.28 trillion cubic meters, is expected to supply liquefied natural gas to Asian markets by 2003.

To meet the growing demand for copper, nickel, and zinc in Asian markets, Japan plans to undertake several expansion programs within the next 2 years. By 1999, Japan's refining capacities will be 1.34 million tons per year of copper, 36,000 tons per year of nickel, and 669,200 tons per year of zinc.

To encourage foreign investors to participate in exploration and development of Mongolian mineral resources, the Government revised its 1994 Mineral Resources Law and related Foreign Investment and Tax Laws in June 1997. The major provisions under the revised laws are as follows: expansion of areas open to exploration, establishment of a cadastral office to issue exploration licences and mining permits, reduction of the royalty rate for all minerals to 2.5%, reduction of corporate income tax to 30%, tax allowances for capital expenditure on infrastructure and accelerated depreciation of fixed assets, exemption of import duty on plant and equipment, and simplification of foreign investment procedures.

On New Caledonia, a report by an independent engineering consultancy concluded that establishment of a second nickel smelter in the north of the island of La Grand Terre would be feasible. The smelter would be a joint-venture project between a company predominantly owned by the local Kanaks, New Caledonia's indigenous people, and a major Canadian nickel company.

In Papua New Guinea, the world-class gold mine on Lihir Island in New Ireland Province came on-stream 3 months ahead of schedule and under budget, pouring its first gold from the treatment of oxide ore in May; the first gold from the higher-grade sulfide ore was poured in September. The operator of the Ok Tedi Mine signed two agreements dealing with the compensation of communities and landowners affected by severe environmental changes caused by the mine's operations. Under the Lower Ok Tedi agreement, about $28.6 million will be paid to affected river communities along the lower reaches of the Ok Tedi River basin during the remaining life of the mine.

In the Philippines, a junior Australian mining company announced plans to reopen the Nonoc nickel mine-smelter-refinery complex on Nonoc Island. The nickel complex was foreclosed in 1986 by the Philippine Government. Work was expected to begin in late 1997 and to take 18 months to complete at a cost of about $550 million. Capacity after refurbishment is expected to be about 35,000 metric tons per year of nickel and about 1,800 metric tons per year of cobalt.

Europe and Central Eurasia

In most of the 15 countries of the EU, the rates of economic growth increased and tight monetary policies eased. Continued liberalization of investment laws allowed greater foreign participation in mineral projects. Mineral exploration was encouraged by deregulation and tax relief. These improved conditions encouraged increased consumption of minerals. In addition, various EU member countries continued to privatize state-owned mineral enterprises. Following the privatization of the last 2 to 3 years, more than 90% of the European steel industry is now in private hands.

The trend in metallic minerals exploration in Western Europe continued to be for copper, gold, lead, and zinc. Exploration for copper was mainly in France and Portugal, and exploration for lead and zinc was mainly in Ireland and Spain. A major gold deposit was being developed in northern Spain. Continued discoveries of gold mineralization encouraged further exploration efforts, particularly in Finland, Greenland, east-central Portugal, Sardinia, Scotland, and northern Spain.

The trend in the denationalization of state-owned and state-operated industrial enterprises in Central and Eastern Europe continued in 1997. This was underscored when Poland's giant copper producer, KGHM, floated its stock on the Warsaw Exchange. Foreign investment in the region remained focused on gold exploration and mine development, as well as on the acquisition of industrial mineral properties to produce such commodities as clays, dimension stone, limestone, perlite, and silica sand. Major foreign investments also were made in facilities producing cement, chemicals, and float glass.

Central Europe (the Czech Republic, Hungary, Poland, and Slovakia) appears to be ready for large investments for highway expansion, as well as attendant services, such as gas stations, repair facilities, warehouses, etc. This will result in increased consumption of cement, structural steel, and other construction materials.

Mineral production in the countries of the Former Soviet Union (FSU) was marked more by the transformation of the mineral industries into market oriented, profit-seeking enterprises than by any major changes in the level of production or the pattern of exports. The changes that occurred in production levels and export patterns were geared to this transformation as mineral-producing enterprises tried to adjust their production profiles to meet market demand. These enterprises moved further towards exporting to world markets or to selling their products for convertible currency within the FSU.

Enterprises in all mineral sectors in the FSU were engaged in various methods of transformation to become profitable producers, including joint ventures, downsizing, conglomeration, renovation, changing production profiles, issuing stocks, contracting for foreign management, and selling companies to foreign and domestic investors. Following the breakup of the Soviet Union, investment in mineral-producing enterprises outside the oil and gold sectors sparked little interest. Now, however, investors are looking to invest in quality enterprises that produce a wide variety of mineral products. Enterprises that have high-quality deposits and processing facilities are now passing into the hands of a new group of domestic and foreign investors, who appear to be prepared to invest in these enterprises and to reorganize their production to make them more competitive in the global market. The fate of those enterprises that have poorer quality assets or are in sectors for which the world market is in a downturn remains uncertain. One major factor impeding the survival of many mineral-producing enterprises is the almost total drop in demand for their output within the FSU, with the prospects for a revival of demand still in the too-distant future in terms of the survival of these enterprises. A trend to create a reformed mineral-production industry controlled, for the most part, by private investors, however, is now emerging in the FSU.

Latin America and Canada

Investment monies continued to flow into Latin America. This movement was stimulated by continuing clarification and refinement of mining laws, as well as ongoing privatization of government-owned companies. Concomitantly, changes to general investment laws to accommodate foreign and private interests attracted worldwide attention. Although exploration focused primarily on gold, copper was sought not only in Chile, but in Central America, Mexico, and Peru. Latin America continued to be an important source of mineral commodities as trade in minerals generally increased throughout the region. Canada, Mexico, and Venezuela supplied much of the petroleum requirement of the United States. Regional consumption of minerals may also be increasing; South American demand for steel had been projected to grow by 12%.

In the midst of a long recovery from the financial crisis and peso devaluation of early 1995, Mexico's mineral industry started 1997 in robust condition. Production of metals continues to increase, and that of industrial minerals improved after being slowed in 1995. Capital flowed into the Mexican economy as the result of increased mineral exports and investment in mineral projects. As a result of its long-established program of privatization, Mexico now has 372 international mining companies conducting exploration and production projects.

An agreement to develop the Cupey nickel mine and processing plant in Cuba and to construct a nickel refinery in Canada was announced in July. The Cupey property, located in the Moa Bay area, 22 million tons of proven and 85 million tons probable reserves at a grade of 1.32% nickel and 0.115% cobalt at a cut-off grade of 1% nickel. The project is designed to produce 30,000 tons per year of nickel and 1,400 tons per year of cobalt for 25 years and would bring Cuba's nickel production capacity to about 100,000 metric tons. In April, construction of the Phase I gold-leaching operation began in the Mantua project in Pinar del Río Province. Phase I was designed to recover 800,000 ounces of gold in 2 years from the gossan cap, which has reserves of 2 million metric tons with 1.44 grams of gold per ton and 11 grams of silver per ton.

Argentina's Bajo de La Alumbrera copper-gold project is on schedule to begin shipping concentrates in October. The project is designed to produce an average of 180,000 tons per year of copper and 640,000 ounces per year of gold for the next 20 years.

New amendments to Brazil's 1988 Constitution allow private firms to participate in the mineral sector. Now, 100% equity ownership is allowed, profits can be expatriated, and the private sector may participate in public utilities previously reserved for the Government. The 40-year Government monopoly of the petroleum industries has ended, allowing Petrobras, the state-owned petroleum company, to enter into joint ventures with foreign investors. The steel industry is being privatized, and the petrochemicals and the mining industries also are moving in that direction.

The Government of Bolivia peacefully ended the siege of the Huanuni tin mine by negotiating an agreement with the cooperative miners, who have been traditionally against any form of private ownership particularly that involving foreign participation in ownership. Capitalization of the Vinto works, the state-owned antimony and tin smelter, was, however, postponed again; this is the process by which private investors obtain ownership of a state-owned entity by subscribing new equity into the entity. This process also was used to transfer Yacimientos Petrolíferos Fiscales Bolivianos (YPFB), the state-owned petroleum company, to the private sector. The resulting consortium, Transredes, will operate a network of 22 existing oil and gas pipelines and the long-awaited Bolivia-to-Brazil gas transmission line. Construction of the $500 million Bolivian stretch began in October with the first deliveries expected in late 1998.

In Chile, Codelco, the state-owned copper-mining corporation, began production at its $700 million Rodomiro Tomic Mine. This is the first mine to be developed solely by Codelco, whose previous projects have been limited to expansions of existing operations. Annual output during the 22-year life of the mine will increase from 150,000 to 225,000 tons per year. A proposal by Chilean officials to raise taxes paid by the country's booming mining sector caused a reaction among multinational companies that are investing billions of dollars there. The mining industry argued that imposition of new taxes would impair Chile's ability to attract new mining investment.

The Colombian Government proceeded with efforts to privatize its mining sector and, early in the year, sold its remaining interest in Colombia's only nickel producer, Cerro Matoso, to its South African owner. In August, an international consortium was awarded a 30-year contract to develop the Cerrejón Zona Sur coal deposit in the Guajira Department. The same consortium combined two other important adjacent coal properties, the Cerrejón Zona Centro and the Oreganal, that together produced about 3.3 million tons of coal in 1996. Expansion plans for the combined property call for 16 million tons per year of coal to be produced.

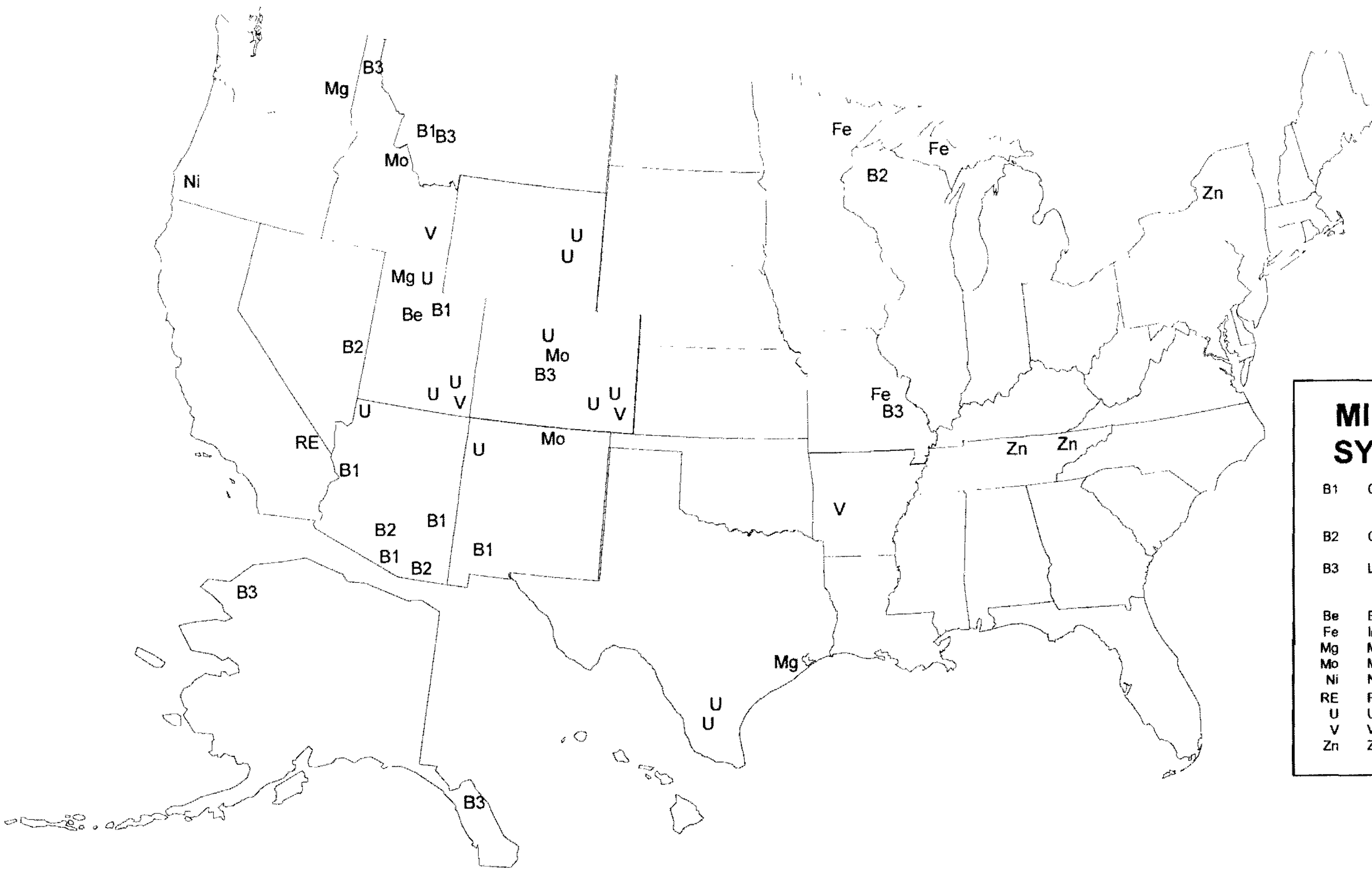
Peru's success in controlling terrorism and restoring political stability, along with changes in laws governing mining and investment, and a program to privatize state-owned companies have attracted many foreign investors. As a result of revisions to the General Mining Law of 1992, mining contracts and ventures are guaranteed immunity from unilateral changes by any Governmental authority without appropriate legal or administrative remedy in the Civil Code. This allowed $3 billion to be invested in mineral exploration, and $3.1 billion in mine development, expansion, and modernization. Of this, commitments in privatized mining projects amounted to almost $1 billion. A further $5 billion is expected to be invested in new mine projects, such as Antimina, La Granja, and Quelleveco for base-metals and Pierina for gold.

In spite of the migration of many Canadian companies' operations to the United States and, especially, Latin America, mining in Canada remained strong in 1997 after reaching new highs in 1996. Output of mineral commodities grew by 14% over that of the previous year. Monies committed to exploration in Canada increased by 50% in 1996, reaching almost $700 million. After spreading to almost every part of Canada, exploration for diamond continued, but with less public interest than during the wild claim-staking rush of 2 or 3 years before. A major newsmaker in the Canadian mining industry continued to be the huge nickel-copper-cobalt discovery at Voisey's Bay on the coast of Labrador, where exploration drilling expanded the limits of the ore body. Following the Bre-X scandal, Canadian mining circles called for more stringent due-diligence requirements for companies trading on Canadian exchanges.

---

[1]The regimes of some countries in this volume may not be recognized by the U.S. Government. The information contained herein is technical and statistical and is not to be construed as conflicting with or contradictory to U.S. foreign policy.

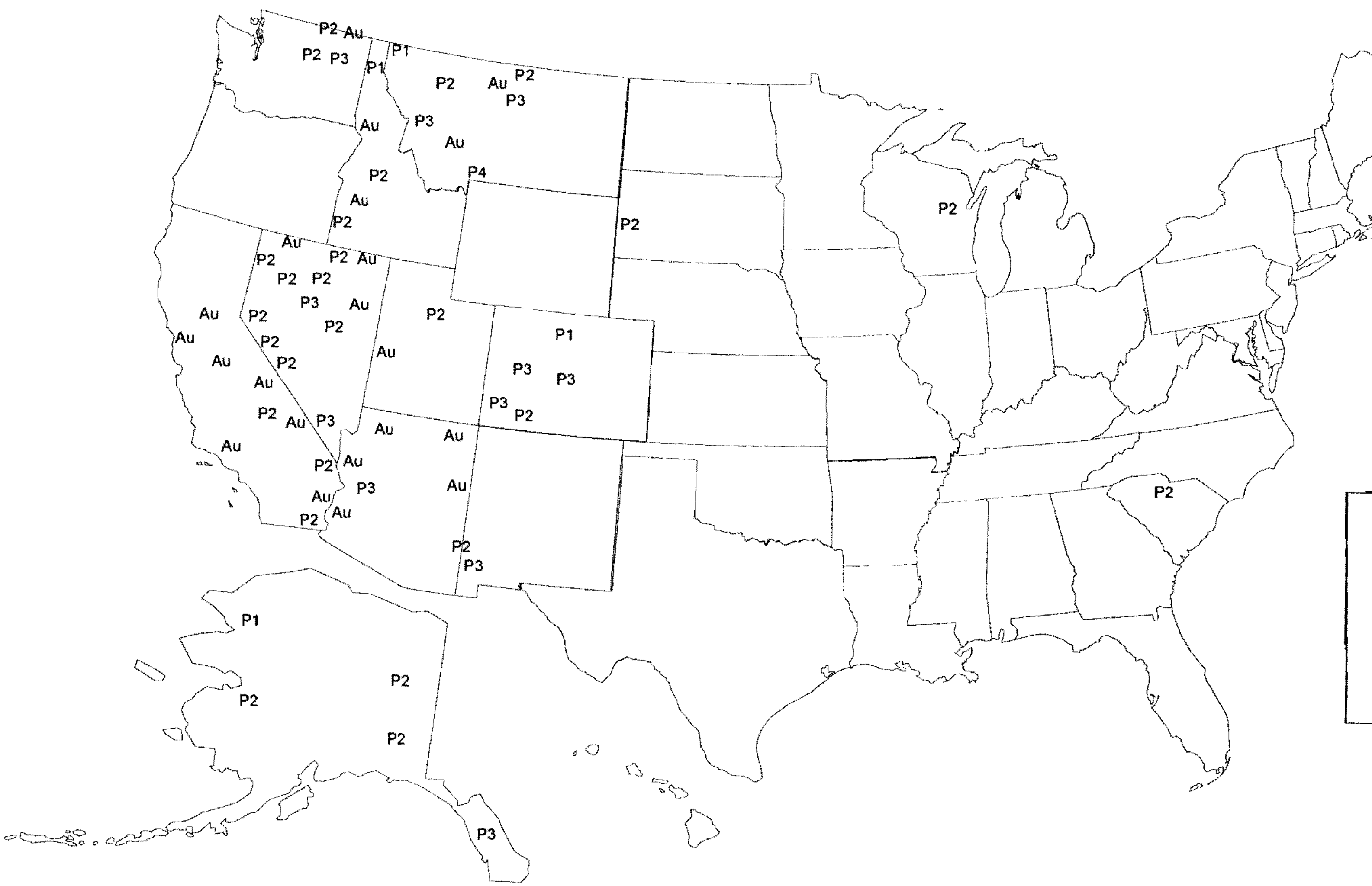
MAJOR BASE METAL PRODUCING AREAS



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	Molybenum
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 I

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	NaSulf	Sodium sulfate and trona
He	Helium	S	Sulfur
Irz	Ilmenite, rutile, and zircon	Talc	Talc/ pyrophyllite
I	Iodine	Vm	Vermiculite
Ky	Kyanite	Wol	Wollastonite
Mg	Magnesium compounds	Zeo	Zeolites

MAJOR INDUSTRIAL ROCK AND MINERAL PRODUCING AREAS - PART II

MINERAL SYMBOLS

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
QC	Quartz crystal/ lascas
Si	Silica/ industrial sand
Trip	Tripoli/novaculite

ALUMINUM[1]

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

Domestic Production and Use: In 1997, 13 companies operated 22 primary aluminum reduction plants. Montana, Oregon, and Washington accounted for 40% of the production; Kentucky, North Carolina, South Carolina, and Tennessee, 20%; other States, 40%. Based on published market prices, the value of primary metal production in 1997 was $5.9 billion. Aluminum consumption, by an estimated 25,000 firms, was centered in the East Central United States. Transportation accounted for an estimated 32% of domestic consumption in 1997; packaging, 26%; building, 16%; electrical, 8%; consumer durables, 8%; and other, 10%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Primary	3,695	3,299	3,375	3,577	3,600
Secondary (from old scrap)	1,630	1,500	1,510	1,570	1,700
Imports for consumption	2,540	3,380	2,970	2,810	3,100
Exports	1,210	1,370	1,610	1,500	1,600
Shipments from Government stockpile excesses	—	—	—	—	57
Consumption, apparent[2]	6,600	6,880	6,320	6,620	6,900
Price, ingot, average U.S. market (spot), cents per pound	53.3	71.2	85.9	71.3	75
Stocks: Aluminum industry, yearend	1,980	2,070	2,000	1,830	1,800
LME, U.S. warehouses, yearend	168	16	14	12	10
Employment, primary reduction, number	18,800	17,800	17,800	18,200	18,000
Net import reliance[3] as a percent of apparent consumption	19	30	23	22	23

Recycling: Aluminum recovered in 1997 from purchased scrap was about 3.5 million tons, of which about 50% came from new (manufacturing) scrap and 50% from old scrap (discarded aluminum products). Aluminum recovered from old scrap was equivalent to about 25% of apparent consumption.

Import Sources (1993-96): Canada, 62%; Russia, 18%; Venezuela, 5%; Mexico, 3%; and other, 12%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Unwrought (in coils)	7601.10.3000	2.6% ad val.	18.5% ad val.
Unwrought (other than aluminum alloys)	7601.10.6000	Free	11.0% ad val.
Waste and scrap	7602.00.0000	Free	Free.

Depletion Allowance: None.[1]

Government Stockpile:

Stockpile Status—9-30-97[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Aluminum	9	5	9	57	48

Prepared by **Patricia A. Plunkert, (703) 648-4979 [Fax: (703) 648-7757].**

ALUMINUM

Events, Trends, and Issues: Domestic primary aluminum production remained relatively stable in 1997. Domestic smelters continued to operate at about 85% of engineered or rated capacity.

U.S. imports for consumption increased in 1997, reversing the downward trend that began in 1995. Although Russia remained second only to Canada as a major shipper of aluminum materials to the United States, the level of its shipments has declined over the last few years from the record high level reached in 1994 and appears to have stabilized at about 400,000 tons of aluminum per year.

The 1997 Defense Authorization Act authorized the Defense Logistics Agency to sell the entire inventory of 57,045 tons (62,882 short tons) of aluminum metal from the National Defense Stockpile. Sales began on April 15, and, by the end of October, the entire inventory had been sold.

The price of primary aluminum ingot in the United States fluctuated within the range of 75 to 80 cents per pound during most of the year. In January, the average monthly U.S. market price for primary ingot quoted by Platt's Metals Week was 76.1 cents per pound; by August the price had risen to 80.1 cents per pound. However, there were indications that the price would turn downward again in September. Prices on the London Metal Exchange (LME) followed the trend of the U.S. market prices. The monthly average LME cash price for August was 77.6 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 53- to 54-cent-per-pound range in January to a 59- to 60-cent-per-pound range at the end of August.

World production increased as producers continued to bring back on-stream primary capacity that had been temporarily idled and to start-up new capacity expansions. Inventories of metal held by producers, as reported by the International Primary Aluminium Institute, declined slightly during the first half of 1997. Inventories of metal held by the LME also declined during the same period before beginning to increase in August.

World Smelter Production and Capacity:

	Production		Yearend capacity	
	1996	1997[e]	1996	1997[e]
United States	3,577	3,600	4,200	4,200
Australia	1,372	1,390	1,450	1,570
Brazil	1,190	1,200	1,210	1,220
Canada	2,282	2,300	2,280	2,290
China	1,780	1,800	1,750	1,800
France	365	400	430	430
Norway	874	880	924	953
Russia	2,800	2,880	2,970	2,970
South Africa	620	670	578	666
Venezuela	600	630	635	638
Other countries	5,210	5,400	6,450	6,650
World total (rounded)	20,700	21,200	22,900	23,400

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.
[2]Domestic primary metal production + recovery from old aluminum scrap + net import reliance.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B.
[5]See Appendix C for definitions.

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 was recovered as a byproduct of the smelting of lead and silver-copper ores. Virtually all primary antimony metal and oxide produced domestically was derived from imports. Primary antimony metal and oxide were produced by six companies at processing plants that used both foreign and domestic feed material. Two plants were in Texas, and single plants were in Idaho, Montana, Nebraska, and New Jersey. The estimated value of primary antimony metal and oxide produced in 1997 was $70 million. Secondary antimony was recovered, mostly in alloy form, at lead smelters; its value, based on the price of antimony metal, was about $17 million. The estimated distribution of antimony uses was flame retardants, 55%; transportation, including batteries, 18%; chemicals, 10%; ceramics and glass, 7%; and other, 10%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Mine (recoverable antimony)[1]	266	215	262	242	NA
Smelter: Primary	22,000	25,500	23,500	25,700	24,000
Secondary[2]	9,620	12,200	10,500	7,900	7,000
Imports for consumption	30,900	41,500	36,600	37,600	36,000
Exports of metal, alloys,[3] oxide, and waste and scrap[3]	4,220	7,850	8,200	4,450	4,500
Shipments from Government Stockpile	2,660	1,850	1,130	4,300	4,500
Consumption, apparent[4]	38,900	46,100	43,300	45,000	NA
Price, metal, average, cents per pound[5]	77	178	228	147	110
Stocks, yearend	9,080	10,900	10,600	11,200	10,000
Employment, plant, number[e]	100	100	100	100	100
Net import reliance[6] as a percent of apparent consumption	75	73	75	82	NA

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 (1993-96): Metal: China, 79%; Hong Kong, 5%; Mexico, 6%; Kyrgyzstan, 6%; and other, 4%. Ore and concentrate: Bolivia, 46%; China, 19%; Canada, 16%; Kyrgyzstan, 10%; and other, 9%. Oxide: China, 38%; Mexico, 18%; South Africa, 16%; Bolivia, 14%; and other, 14%. Total: China, 55%; Mexico, 11%; Bolivia, 10%; South Africa, 7%; and other, 17%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[7] 12/31/97
Ore and concentrates	2617.10.0000	Free	Free.
Antimony and articles thereof, including waste and scrap	8110.00.0000	Free	4.4¢/kg.
Antimony oxide	2825.80.0000	Free	4.4¢/kg.

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

Government Stockpile:

Stockpile Status—9-30-97[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Antimony	21,300	2,640	21,200	4,540	3,650

Prepared by **James F. Carlin, Jr., (703) 648-4985 [Fax: (703) 648-7757].**

ANTIMONY

Events, Trends, and Issues: In 1997, 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 only about one-fifth of the estimated domestic demand.

The antimony metal price experienced a fairly steady decline during 1997. The price started the year at $1.30 per pound; by spring it had declined to $1.10 per pound, and by fall it had slipped to $1.05 per pound. These prices were still somewhat higher than the price range for antimony metal that had prevailed for years prior to the sharp price increases of 1994.

A major domestic nonferrous producer announced that its lead refinery in Omaha, NE, had ceased operation as of June 30, 1997. The plant was also a smelter/refiner for antimony and bismuth products. In its antimony operations, this plant processed primarily antimony ore, but also treated crude antimony trioxide, upgrading it to a higher purity. It was one of only six domestic antimony smelter/refiners.

Government stockpile sales of antimony continued for the fifth year, after being resumed in 1993 for the first time since 1988. Public Law 104-201 provided the authorization for the sales. During the year, the Defense Logistics Agency (DLA) changed its date of sales for antimony from the second Tuesday of the month to the fourth Tuesday of the month, with the format still being the negotiated bid process. The DLA announced that its Annual Materials Program for fiscal year 1997 permitted the disposal of up to 5,000 tons of antimony, up from the 3,000 tons allotted for fiscal year 1996. Antimony was stockpiled in 12 DLA depots, with the largest inventories stored in New Haven, IN, and Somerville, NJ.

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[9]	Reserve base[9]
	1996	1997[e]		
United States	242	NA	80,000	90,000
Bolivia	6,600	7,000	310,000	320,000
China	98,000	95,000	900,000	1,900,000
Kyrgyzstan	1,200	1,200	120,000	150,000
Russia	6,000	6,000	350,000	370,000
South Africa	4,800	4,500	240,000	250,000
Tajikistan	500	500	50,000	60,000
Other countries	9,000	9,000	25,000	75,000
World total (may be rounded)	126,000	124,000	2,400,000	3,600,000

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. NA Not available.
[1]Data for 1993-96 from 10-K reports.
[2]After intensive review of the industry, 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.
[8]See Appendix C for definitions.
[9]See Appendix D for definitions.

ARSENIC

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: Arsenic was not recovered from domestic ores; all arsenic metal and compounds consumed in the United States were imported. It is estimated that domestic arsenic consumption ranged between 20,000 and 25,000 tons annually. More than 95% of the arsenic consumed was 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 used 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 of high-purity arsenic is used in the manufacture of semiconductor material. The value of arsenic metal and compounds consumed domestically was estimated at $20 million.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Imports for consumption:					
Metal	767	1,330	557	252	1,200
Trioxide[1]	27,500	26,800	29,000	28,000	30,000
Arsenic acid	—	5	(2)	1	1
Exports, metal	364	79	430	36	90
Price, cents per pound, average:[3]					
Metal, Chinese	44	40	66	40	30
Trioxide, total	26	26	24	22	21
Net import reliance[4] as a percent of apparent consumption	100	100	100	100	100

Recycling: Process water and contaminated runoff collected at wood treatment plants are reused in pressure treatment. 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 (1993-96): Metal: China, 88%; Japan, 5%; Hong Kong, 4%; and other, 3%. Trioxide: China, 48%; Chile, 20%; Mexico, 12%; and other, 20%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Metal	2804.80.0000	Free	13.2¢/kg.
Trioxide	2811.29.1000	Free	Free.
Sulfide	2813.90.1000	Free	Free.
Acid[5]	2811.19.1000	2.3% ad val.	4.9% ad val.

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

Government Stockpile: None.

Prepared by **Robert G. Reese, Jr., (703) 648-4981 [Fax: (703) 648-7757].**

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 the demand for new housing, and the 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.

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[7] (Arsenic content)
	1996	1997[e]	
United States	—	—	
Belgium	2,000	2,000	
Chile	9,000	9,000	World reserves and reserve base are thought to be about 20 and 30 times, respectively, annual world production.
China	15,000	15,000	
France	3,000	3,000	
Kazakstan	1,500	1,500	
Mexico	4,300	4,400	
Namibia	1,100	2,000	
Philippines	2,000	2,000	
Russia	1,500	1,500	
Other countries	2,700	3,000	
World total (rounded)	42,000	43,000	

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

Substitutes: Substitutes for arsenic compounds exist in most of its major uses, although arsenic compounds may be preferred because of lower cost and superior performance. The wood preservatives pentachlorophenol and creosote may be substituted for CCA when odor and paintability are not problems and where permitted by local regulations. A recently developed alternative, ammoniacal copper quaternary, which avoids using chrome and arsenic, has yet to gain widespread usage. Nonwood alternatives, such as concrete, steel, or plastic lumber, may be substituted in some applications for treated wood.

[e]Estimated.
[1]Arsenic trioxide (As_2O_3) contains 75.7% arsenic by weight.
[2]Less than ½ unit.
[3]Calculated from Bureau of the Census import data.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix B.
[6]Tariff is free for Canada, Israel, Caribbean Basin countries, and designated Beneficiary Andean and developing countries.
[7]See Appendix D for definitions. The reserve base for the United States was estimated at 80,000 tons.

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, 50%; friction products, 33%; gaskets, 12%; and other, 5%.

Salient Statistics—United States:	**1993**	**1994**	**1995**	**1996**	**1997[e]**
Production (sales), mine	14	10	9	10	9
Imports for consumption	31	26	22	22	21
Exports[1]	28	18	15	15	13
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent	32	27	22	22	21
Price, average value, dollars per ton, f.o.b.	435	506	W	W	W
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number	70	30	30	30	30
Net import reliance[2] as a percent of apparent consumption	9	30	32	32	38

Recycling: Insignificant.

Import Sources (1993-96): Canada, 99%; and other, 1%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Asbestos	2524.00.0000	Free	Free.

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

Government Stockpile:

Stockpile Status—9-30-97[4]
(Metric tons)

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Amosite	30,394	—	30,849	30,849	—
Chrysotile	8,875	—	8,814	8,814	—
Crocidolite	33	—	33	33	—

Prepared by **Robert L. Virta, (703) 648-7726 [Fax: (703) 648-7722].**

ASBESTOS

Events, Trends, and Issues: Domestic sales of asbestos decreased slightly from those of 1996. Imports and exports also decreased according to the Bureau of the Census. Some exports under the export category were likely to have been reexports, asbestos-containing products, or nonasbestos products. Exports of asbestos fiber were estimated to be approximately 9,000 tons. Apparent consumption decreased slightly. 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[5]	Reserve base[5]
	1996	1997[e]		
United States	10	9	Moderate	Large
Brazil	170	170	Moderate	Moderate
Canada	521	510	Large	Large
China	250	250	Large	Large
Kazakstan	225	225	Large	Large
Russia	720	720	Large	Large
South Africa	90	85	Moderate	Moderate
Zimbabwe	165	160	Moderate	Moderate
Other countries	139	130	Large	Large
World total (rounded)	2,290	2,260	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.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B.
[4]See Appendix C for definitions.
[5]See Appendix D for definitions.

BARITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Barite sales in 1997 increased significantly from the 1996 level of 662,000 tons to about 700,000 tons, and the value increased accordingly to about $18 million. Sales came from six States, with slightly less than 80% of the total coming from Nevada. The second largest producing State was Georgia. About 2.1 million tons of ground barite from both domestic production and imports was sold in 1997 as reported by the domestic grinders and crushers. Nearly 90% of the barite sold in the United States was used as a weighing agent in oil- and gas-well-drilling fluids, mostly in the Gulf of Mexico region with much 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 γ 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.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Sold or used, mine	315	583	543	662	700
Imports for consumption: Crude barite	766	1,010	965	1,470	1,700
Ground barite	38	58	80	70	70
Other	11	13	10	14	15
Exports	18	14	16	31	35
Consumption, apparent[1] (crude barite)	1,100	1,640	1,570	2,170	2,435
Consumption[2] (ground and crushed)	1,090	1,250	1,370	1,870	2,100
Price, average value, dollars per ton, mine	61.16	32.76	19.15	22.21	25.00
Employment, mine and mill, number[e]	330	350	400	350	380
Net import reliance[3] as a percent of apparent consumption	72	64	65	70	71

Recycling: None.

Import Sources (1993-96): China, 48%; India, 21%; Mexico, 6%; Morocco, 2%; and other, 23%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Crude barite	2511.10.5000	$1.25/t	$3.94/t.
Ground barite	2511.10.1000	$1.28/t	$7.38/t.
Witherite	2511.20.0000	1.2% ad val.	30% ad val.
Oxide, hydroxide, and peroxide	2816.30.0000	2% ad val.	10.5% ad val.
Other sulfates	2833.27.0000	0.6% ad val.	4.2% ad val.
Other chlorides	2827.38.0000	4.2% ad val.	28.5% ad val.
Other nitrates	2834.29.5000	3.5% ad val.	10% ad val.
Carbonate	2836.60.0000	2.3% ad val.	8.4% ad val.

Depletion Allowance: 14% (Domestic), 14% (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 increased strongly following expansions in the exploration and development activities both onshore and offshore along the Gulf Coast of the United States. Worldwide barite consumption grew modestly as there was an overcapacity in the oil-producing countries, centered in the Organization of Petroleum Exporting Countries (OPEC). Several of the OPEC countries withheld petroleum production to maintain stable prices in petroleum and gas markets, and drilled only for required development. Other, non-OPEC oil producing countries have had medium growth, which required both exploratory and development drilling, which also needed barite. Due to relatively long lead times in the petroleum industry, it was rational to explore and develop while in overcapacity.

Exploration/production drilling in the Gulf of Mexico for deeper natural gas deposits in Louisiana, Texas, and onshore Oklahoma continued unabated. The average futures price for light sweet crude was $25.64 per barrel during the week

Prepared by **James P. Searls, (703) 648-7724 [Fax: (703) 648-7722].**

BARITE

of January 3, 1997, decreasing 22% to $19.96 per barrel, by the week of July 4, 1997. The futures price average for November 10, 1997, was $22.06 per barrel. The week average futures natural gas price were $2.86 per million British thermal unit average during the week of January 3, 1997, but that dropped to $2.11 per million British thermal unit average during the week of July 4, 1997. The quoted price was up to $2.96 per million British thermal unit for the week of November 10, 1997. The rotary rig count in the United States rose from 845 for the week of January 3, 1997, to 965 in the week of July 19, 1996. The rig count continued to climb through the rest of the year, reaching 974 rigs in the week of November 10, 1997.

In the United States, estimated barite prices at the mine rose slightly, following demand increases. That is, more ground barite was sold through the mine-located and independent mills relative to the amount of crude and jigged ore sold directly from the mines.

Imports for consumption of lower cost foreign barite were nearly triple domestic production. The major sources of imported barite have high-grade deposits, relatively low labor costs, and relatively low cost (per ton-mile) of ocean transportation to the U.S. Gulf Coast grinding plants. Often the cost of ocean transportation from other continents is lower per ton than the cost of rail transportation from Georgia and Missouri to the end-use regions. Nevada mines, crushers, and grinders are competitive in the California market and are trying to reenter the Gulf of Mexico market through negotiated railroad tariff reductions. Over the past several years, China and India have had flooding and quality problems trying to supply low-cost barite into the gulf coast, but not enough to encourage domestic owners of Missouri mines to reopen any of those mines. The last, active Missouri barite mine and mill commenced shut-down procedures during the year.

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 other than 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]
	1996	1997[e]		
United States	662	700	28,000	60,000
Canada	61	70	11,000	14,600
China	1,500	1,500	35,000	150,000
France	75	80	2,000	2,500
Germany	150	160	1,000	1,500
India	500	550	28,000	32,000
Iran	150	150	NA	NA
Kazakstan	250	270	NA	NA
Mexico	250	260	7,000	8,500
Morocco	265	270	10,000	11,000
Thailand	59	60	9,000	15,000
Turkey	144	160	4,000	20,000
United Kingdom	102	110	100	600
Other countries	292	260	20,000	161,000
World total (may be rounded)	4,460	4,600	170,000	500,000

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]See Appendix B.
[5]See Appendix D 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 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 6.2 million tons, with four Bayer refineries in operation at yearend.

Salient Statistics—United States:[2]	1993	1994	1995	1996	1997[e]
Production, bauxite, mine	W	W	W	NA	NA
Imports of bauxite for consumption[3]	11,900	11,200	10,800	10,700	11,200
Imports of alumina[4]	3,940	3,120	4,000	4,320	4,200
Exports of bauxite[3]	92	137	120	154	100
Exports of alumina[4]	1,240	1,040	1,040	918	1,200
Shipments of bauxite from Government stockpile excesses	565	5	874	612	750
Consumption, apparent, bauxite and alumina (in aluminum equivalents)[5]	4,510	3,840	4,330	4,360	4,300
Price, bauxite, average value U.S. imports (f.a.s.) dollars per ton	28	26	24	27	27
Stocks, bauxite, industry, yearend	1,600	1,600	1,730	2,060	2,000
Net import reliance,[6] bauxite and alumina as a percent of apparent consumption	100	99	99	100	100

Recycling: None.

Import Sources (1993-96):[7] Bauxite: Guinea, 37%; Jamaica, 29%; Brazil, 16%; Guyana, 10%; and other, 8%. Alumina: Australia, 70%; Jamaica, 9%; Suriname, 8%; and other, 13%. Total: Australia, 31%; Guinea, 21%; Jamaica, 20%; Brazil, 9%; and other, 19%.

Tariff: Import duties on bauxite and alumina were abolished in 1971 by Public Law 92-151. Only imports from non-most-favored nations were dutiable. Countries that supplied commercial quantities of bauxite or alumina to the United States during the first 7 months of 1997 had most-favored-nation status.

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

Government Stockpile:

	Stockpile Status—9-30-97[8]				
Material	**Uncommitted inventory**	**Committed inventory**	**Authorized for disposal**	**Disposal plan FY 1997**	**Disposals FY 1997**
Bauxite, metal grade:					
Jamaica-type	9,890	659	9,710	610	610
Suriname-type	4,250	704	4,250	305	310
Bauxite, refractory-grade, calcined	92	65	22	81	[9]62

Prepared by **Patricia A. Plunkert, (703) 648-4979 [Fax: (703) 648-7757].**

BAUXITE AND ALUMINA

Events, Trends, and Issues: World output of bauxite and alumina for 1997 increased slightly to accommodate the modest increase in world primary aluminum metal production.

U.S. alumina plant engineered capacity remained essentially unchanged from that of yearend 1996. The 600,000-ton-per-year alumina plant in St. Croix, VI, remained idle.

Spot prices for metallurgical-grade alumina, as published by Metal Bulletin, fluctuated during 1997. The published price range began the year at $150 to $160 per ton. The price increased during the first quarter to $225 to $245 per ton. By the end of the second quarter, the price has decreased to $195 to $205 per ton. The price range again reversed direction and gradually increased during the third quarter to reach $210 to $230 per ton on October 1.

The fiscal year (FY) Annual Materials Plan (AMP) submitted by the Defense National Stockpile Center proposed the sale of 915,000 dry metric tons of metallurgical-grade bauxite (610,000 tons of Jamaica-type and 305,000 tons of Suriname-type) during the period October 1, 1997 to September 30, 1998. In addition, the FY 1998 AMP provided for the sale of 81,000 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[10]	Reserve base[10]
	1996	1997[e]		
United States	NA	NA	20,000	40,000
Australia	43,100	43,500	5,600,000	7,900,000
Brazil	9,700	9,700	2,800,000	2,900,000
China	6,200	7,000	720,000	2,000,000
Guinea	14,000	14,000	5,600,000	5,900,000
Guyana	2,000	2,000	700,000	900,000
India	5,100	5,500	1,000,000	1,200,000
Jamaica	11,829	12,000	2,000,000	2,000,000
Russia	3,300	3,300	200,000	200,000
Suriname	4,000	4,000	580,000	600,000
Venezuela	5,600	5,600	320,000	350,000
Other countries	8,928	8,900	3,800,000	4,400,000
World total (rounded)	114,000	115,000	23,000,000	28,000,000

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, provides 1 ton of primary aluminum metal.

[2]Includes U.S. Virgin Islands.

[3]Includes all forms of bauxite, expressed as dry equivalent weights.

[4]Calcined equivalent weights.

[5]The sum of U.S. bauxite production and net import reliance (all in aluminum equivalents).

[6]Defined as imports - exports + adjustments for Government and industry stock changes (all in aluminum equivalents).

[7]Aluminum equivalents.

[8]See Appendix C for definitions.

[9]Dry equivalent weight—95,800 metric tons.

[10]See Appendix D 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 domestic 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. Small quantities of beryl were recovered as a byproduct of U.S. pegmatite mining operations in various States. Beryllium consumption of 205 tons was valued at more than $70 million, based on the 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 more than 80% of consumption.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, mine shipments	198	173	202	211	210
Imports for consumption, ore and metal	8	53	32	20	45
Exports, metal	20	29	61	57	45
Shipments from Government stockpile excesses[1]	[2]31	[2](2)	[2](19)	—	—
Consumption: Apparent	183	198	198	204	205
Reported	196	174	227	234	230
Price, dollars:					
Domestic, metal, vacuum-cast ingot, per pound	308	275	308	327	327
Domestic, metal, powder blend, per pound	295	295	295	385	385
Domestic, beryllium-copper master alloy, per pound of contained beryllium	160	160	160	160	160
Domestic, beryllium oxide, powder, per pound	72.50	72.50	70.50	77.00	77.00
Stocks, consumer, yearend	114	113	162	139	144
Employment, number:					
Mine, full-time equivalent employees[e]	25	25	25	25	25
Primary refineries[e]	400	400	400	400	400
Net import reliance[3] as a percent of apparent consumption	E	13	E	E	E

Recycling: Quantities of new scrap generated in the processing of beryllium-copper alloys and quantities of obsolete military equipment containing metallic beryllium were recycled.

Import Sources (1993-96): Ore, metal, scrap, and master alloy: Russia, 46%; Kazakstan, 20%; China, 9%; France, 9%; and other, 16%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Beryllium ore and concentrates	2617.90.0030	Free	Free.
Beryllium oxide or hydroxide	2825.90.1000	3.7% ad val.	25.0% ad val.
Beryllium-copper master alloy	7405.00.6030	2.4% ad val.	28.0% ad val.
Beryllium unwrought:			
Waste and scrap	8112.11.3000	Free	Free.
Other	8112.11.6000	8.5% ad val.	25.0% ad val.
Beryllium, wrought	8112.19.0000	5.5% ad val.	45.0% ad val.

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

Government Stockpile:

Stockpile Status—9-30-97[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Beryl ore (11% BeO)	469	43	469	73	73
Beryllium-copper master alloy	268	—	—	—	—
Beryllium metal	363	—	—	—	—

Prepared by **Larry D. Cunningham, (703) 648-4977 [Fax: (703) 648-7757].**

BERYLLIUM

Events, Trends, and Issues: For the first one-half year, sales of beryllium products increased compared with those of the previous year, reflecting continued strength in electronics markets and increasing demand for beryllium-aluminum alloys. Imports for consumption of ore and metal were up, with Canada providing most of the ore imports and Russia the leading supplier of metal imports. Metal exports continued to decline, with Canada, Germany, and Japan being the major recipients of the materials.

In January, the International Trade Administration (ITA) made a final determination that beryllium metal and high-beryllium alloys (beryllium content equal to or greater than 30%) from Kazakstan were being sold in the United States at less than fair value. The ITA determined that the material would be subject retroactively to a 16.56% dumping margin for the period of investigation of July 1, 1995, through December 31, 1995. However, in March, the International Trade Commission determined that an industry in the United States is not materially injured or threatened with material injury, and the establishment of an industry in the United States is not materially retarded, by reason of imports from Kazakstan of beryllium metal and high-beryllium alloys. Thus, the investigation was terminated and all securities posted refunded or canceled. The United States imported 23 tons of subject products in 1995, no imports of the materials were recorded in 1996, and about 3 tons of imports were recorded through July 1997.

For fiscal year 1997, ending September 30, 1997, the Defense Logistics Agency sold about 1,800 tons of beryl from the National Defense Stockpile valued at $400,000, which exhausted the fiscal year Annual Materials Plan (AMP) quantity for beryl disposals. In its fiscal year 1998 AMP, the Department of Defense (DOD) also has authority to sell about 1,800 tons of beryl. Additionally, the DOD proposed to dispose of about 1,130 tons of beryllium copper master alloy in fiscal year 1998.

Beryllium dust and fines have been recognized as the cause of berylliosis, a chronic lung disease. Harmful effects are minimized by maintaining a clean workplace and requiring the use of safety equipment.

World Mine Production, Reserves, and Reserve Base:

	Mine production	
	1996	1997[e]
United States	211	210
Brazil	34	35
China[e]	55	55
Kazakstan[e]	4	4
Russia[e]	32	30
Other countries	(7)	1
World total	336	335

Reserves and reserve base[6]

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. Domestic deposits of bertrandite ores in Utah and Texas contain about 21,000 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. The identified resources of beryllium in known domestic deposits are estimated at 66,000 tons of contained beryllium.

Substitutes: Because of the relatively high price of beryllium, uses are expected to continue principally in applications that require its light weight, high strength, and high thermal conductivity. Steel, titanium, and graphite composites may be substituted for beryllium metal; phosphor bronze may be substituted for beryllium-copper alloys, but with substantial loss of performance. Aluminum nitride can substitute for beryllium oxide in some applications.

[e]Estimated. E Net exporter.
[1]Data in parentheses denote stockpile acquisitions.
[2]Data represent the net 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.
[5]See Appendix C for definitions.
[6]See Appendix D for definitions.
[7]Less than ½ unit.

BISMUTH

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

Domestic Production and Use: One refinery in Nebraska produced bismuth as a byproduct of lead refining, but bismuth operations ceased on June 30, 1997. There is no longer any domestic production of primary bismuth. Thirty-five companies in the Eastern United States accounted for an estimated three-fourths of the bismuth consumed in 1997. Based on the average annual price, the value of bismuth consumed was estimated at more than $11.6 million. About 51% of bismuth was used in pharmaceuticals and chemicals, 30% in fusible alloys and solders, 16% in metallurgical additives, and 3% in other uses.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, refinery	W	W	W	W	W
Imports for consumption	1,330	1,660	1,450	1,490	2,000
Exports[1]	70	160	261	151	200
Shipments from Government stockpile excesses	—	145	139	137	144
Consumption, reported	1,300	1,490	2,150	1,520	1,500
Price, average, domestic dealer, dollars per pound	2.50	3.25	3.85	3.65	3.50
Stocks, yearend, consumer	323	402	390	122	110
Employment, plant, number[e 2]	30	30	30	30	30
Net import reliance[3] as a percent of apparent consumption	W	W	W	W	W

Recycling: Bismuth was recovered from fusible alloy scrap, contributing about 5% of the U.S. supply.

Import Sources (1993-96): Mexico, 34%; Belgium, 34%; China, 10%; the United Kingdom, 8%; and other, 14%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Articles thereof, including waste and scrap	8106.00.0000	Free	7.5% ad val.

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

Government Stockpile:

Stockpile Status—9-30-97[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Bismuth	85	2	85	136	144

Events, Trends, and Issues: On April 15, 1996, the only domestic producer announced that it had reached agreement with the City of Omaha, NE, to cease all operations at its Omaha refinery by February 1, 1998, and remediate the property for use as a park. The company stopped refining lead at Omaha on June 1, 1996, but had planned to continue processing other materials, including bismuth, at the plant until February 1998. However, bismuth production ceased on June 30, 1997.

Prepared by **Robert D. Brown, Jr., (703) 648-4984 [Fax: (703) 648-7757].**

BISMUTH

Bismuth was used in several applications designed to provide nontoxic substitutes for lead. Such products include bismuth fishing sinkers; bismuth shot for waterfowl hunting; and bismuth-containing brass, pigments, ceramic glazes, solders, lubricating greases, and crystal ware. To make a large impact on the bismuth market, lead would have to be banned or severely restricted nationwide for a significant demand use. In response to California court action, major faucet makers agreed in July 1995 to remove lead from plumbing fixtures. The Safe Drinking Water Act Amendments of 1996 will eventually require all pipes and fixtures for potable water to be lead-free. However, demand for bismuth in this sector had increased only slightly in 1997.

The use of bismuth in shot for waterfowl hunting increased significantly in 1997. The U.S. Fish and Wildlife Service granted final approval for the use of 97% bismuth-3% tin shot for waterfowl hunting. The shot is nontoxic to waterfowl who discover and ingest spent shot. It is an alternative to steel shot, which replaced lead shot for waterfowl hunting in 1991. Bismuth-tin shot has much better dropping power than steel shot.

World lead production has remained relatively unchanged in recent years, limiting the amount of bismuth that can be produced; world production of bismuth rose less than 1% in 1997. The domestic price fell from $3.30 per pound to $3.20 per pound during the first quarter, then rose to nearly $4.00 per pound during the second quarter. The price drifted back down to $3.50 per pound, the average price for the year. The price has decreased 2 years in a row.

The Defense Logistics Agency (DLA) sold 144 tons of bismuth from the National Defense Stockpile in fiscal year 1997. The DLA was authorized to dispose of the remaining inventory of 85 tons in fiscal year 1998, and had done so by November 1997.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1996	1997[e]		
United States	W	W	9,000	14,000
Australia	—	—	18,000	27,000
Bolivia	125	150	10,000	20,000
Canada	185	185	5,000	30,000
China	700	700	20,000	40,000
Japan	169	170	9,000	18,000
Kazakstan	155	150	5,000	10,000
Mexico	1,000	1,000	10,000	20,000
Peru	1,000	1,000	11,000	42,000
Other countries	105	110	15,000	35,000
World total (rounded)	[7]3,440	[7]3,470	110,000	260,000

World Resources: World reserves of bismuth are usually associated with lead deposits, except in China and North Korea, where 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 tungsten ores, although extraction of bismuth from these ores is usually 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 alloys jigs used for holding meal shapes during machining. Glycerine-filled glass bulbs replace bismuth alloys as a triggering device for fire sprinklers. Selenium, tellurium, or lead could replace bismuth in free machining alloys.

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Includes bismuth, bismuth alloys, and waste and scrap.
[2]Data for first 6 months of 1997.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B.
[5]See Appendix C for definitions.
[6]See Appendix D for definitions.
[7]Excludes U.S. production.

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 1997 was $503 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 estimated distribution pattern for boron compounds consumed in the United States in 1997 was as follows: Glass products, 56%; agriculture, 7%; fire retardants, 6%; soaps and detergents, 5%; and other, 26%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production[1]	574	550	728	581	622
Imports for consumption, gross weight:					
Borax	40	9	9	NA	NA
Boric acid	17	20	16	18	NA
Colemanite	90	27	45	NA	NA
Ulexite	149	120	153	NA	NA
Exports, gross weight of boric acid and refined borates	481	498	588	381	NA
Consumption: Apparent	481	389	312	234	NA
Consumption: Reported	321	296	NA	NA	NA
Price, dollars per ton, granulated pentahydrate borax in bulk, carload, works[2]	304	324	324	375	340
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 (1993-96): Boric acid: Chile, 36%; Italy, 25%; Turkey, 24%; and other, 15%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Borates:			
Refined borax:			
Anhydrous	2840.11.0000	0.3% ad val.	1.2% ad val.
Other	2840.19.0000	0.1% ad val.	0.4% ad val.
Other	2840.20.0000	3.7% ad val.	25% ad val.
Perborates:			
Sodium	2840.30.0010	3.7% ad val.	25% ad val.
Other	2840.30.0050	3.7% ad val.	25% ad val.
Boric acids	2810.00.0000	1.5% ad val.	8.5% ad val.
Natural borates:			
Sodium	2528.10.0000	Free	Free.
Other:			
Calcium	2528.90.0010	Free	Free.
Other	2528.90.0050	Free	Free.

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

Government Stockpile: None.

Prepared by **Phyllis A. Lyday, (703) 648-7713 [Fax: (703) 649-7722].**

BORON

Events, Trends, and Issues: The United States was the world's largest producer of boron compounds during 1997 and exported about one-half of domestic production. Exported materials competed with borax, boric acid, colemanite, and ulexite primarily from Turkey, the largest producer of boron ore in the world.

Imports 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.

A domestic company in California celebrated 125 years of sustained development. The Chairman and Chief Operating Officer of the company was installed by the Governor of California as manufacturer of the year for 1997. The company continues to improve methods by which overall production costs are contained, global distribution is effected, and reliability of supply is ensured. The company has developed a process to reclaim borates content of tailings, estimated to be about 10% boron oxide content. In addition to the benefit of reclaiming the boron content, about 350 hectares of land will be reclaimed and restored to natural desert habitat over the next 20 years.

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

The only domestic underground operation increased production during the year.

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

	Production—all forms		Reserves[7]	Reserve base[7]
	1996	1997[e]		
United States	1,150	1,200	40,000	80,000
Argentina	245	240	2,000	9,000
Bolivia	7	10	4,000	19,000
Chile	90	90	8,000	41,000
China	180	180	27,000	36,000
Iran	1	1	1,000	1,000
Kazakstan	80	80	14,000	15,000
Peru	30	30	4,000	22,000
Russia	220	220	40,000	100,000
Turkey	1,200	1,200	30,000	150,000
World total (may be rounded)	3,200	3,250	170,000	470,000

World Resources: Large domestic resources 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 to supply demand at current rates 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 the use of 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]See Appendix B.
[6]Gross weight of ore in thousand metric tons.
[7]See Appendix D 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 $240 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.

Estimated bromine use was 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:	1993	1994	1995	1996	1997[e]
Production[1]	177	195	218	227	250
Imports for consumption, elemental bromine and compounds[2]	18	23	8	15	15
Exports, elemental bromine and compounds	19	18	14	14	14
Consumption, apparent[3]	267	197	306	318	341
Price, cents per kilogram, bulk, purified bromine	69.5	79.5	85.3	66.1	98.8
Stocks, producer, yearend, elemental bromine[e]	—	—	—	—	—
Employment, number	1,600	1,600	1,600	1,700	1,700
Net import reliance[4] as a percent of apparent consumption	—	—	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 (1993-96): Israel, 89%; The Netherlands, 7%; France, 3%; and other, 1%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Bromine	2801.30.2000	6.3% ad val.	37% ad val.
Bromochloromethane	2903.49.1000	Free	25% ad val.
Ammonium, calcium, or zinc bromide	2827.59.2500	Free	25% ad val.
Decabromodiphenyl and octabromodiphenyl oxide	2909.30.0700	15.6% ad val.	15.4¢/kg + 70.5% ad val.
Ethylene dibromide	2903.30.0500	5.4% ad val.	46.3% ad val.
Hydrobromic acid	2811.19.3000	1.7% ad val.	25% ad val.
Potassium bromate	2829.90.0500	1.2% ad val.	25% ad val.
Potassium or sodium bromide	2827.51.0000	Free	22¢/kg.
Methyl bromide	2903.30.1520	Free	25% ad val.
Sodium bromate	2829.90.2500	1.5% ad val.	25% ad val.
Tetrabromobisphenol A	2908.10.2500	1.0¢/kg + 15.2% ad val.	15.4¢/kg + 62% ad val.

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

Government Stockpile: None.

Prepared by **Phyllis A. Lyday, (703) 648-7713 [Fax: (703) 648-7722].**

BROMINE

Events, Trends, and Issues: Three bromine companies accounted for more than 75% of world production. Two of these companies are located in the United States and accounted for about 50% of 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. In the second quarter of 1998, the first new domestic bromine plant built since 1976 is expected to begin production in Manistee, MI. Production capacity was expected to be 9,000 tons per year of elemental bromine and brominated salts.

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 60% 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.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1996	1997[e]		
United States[1]	227	250	11,000	11,000
Azerbaijan	2.0	2.0	300	300
China	30	30	NA	NA
France	2.2	2.2	1,600	1,600
India	1.5	1.5	([7])	([7])
Israel	135.0	135.0	([8])	([8])
Italy	.3	.3	([7])	([7])
Japan	15.0	15.0	([9])	([9])
Spain	.2	.2	1,400	1,400
Turkmenistan	7.0	7.0	700	700
Ukraine	3.0	3.0	400	400
United Kingdom	28.0	28.0	([7])	([7])
World total (rounded)	450.0	470.0	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 beginning in 1993.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix B.
[6]See Appendix D for definitions.
[7]From waste bitterns associated with solar salt. See World Resources section.
[8]From the Dead Sea. See World Resources section.
[9]From seawater. See World Resources section.

CADMIUM

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

Domestic Production and Uses: Primary cadmium 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 1997 was valued at about $3.8 million. About 69% of total apparent cadmium consumption was for batteries. The remaining 31% was distributed as follows: pigments, 13%; coatings and plating, 8%; stabilizers for plastics, 7%; nonferrous alloys, 2%; and other uses, 1%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, refinery[1]	1,090	1,010	1,270	1,530	1,750
Imports for consumption, metal	1,420	1,110	848	843	800
Exports of metal, alloys, and scrap	38	1,450	1,050	201	100
Shipments from Government stockpile excesses	185	210	220	230	200
Consumption, apparent	3,010	1,040	1,160	2,250	2,600
Price, metal, dollars per pound[2]	0.45	1.13	1.84	1.24	1.00
Stocks, yearend, producer and distributor	579	423	543	693	750
Employment, smelter and refinery, number	195	125	125	145	150
Net import reliance[3] as a percent of apparent consumption	64	3	E	32	33

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 1996, the U.S. steel industry generated more than 0.5 million tons of EAF dust, typically containing 0.003% to 0.07% cadmium. At least nine States required collection of rechargeable Ni-Cd batteries.

Import Sources (1993-96): Metal: Canada, 45%; Mexico, 13%; Belgium, 12%; Germany, 7%; and other, 23%.

Tariff: Item	Number	Canada and Mexico 12/31/97	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Cadmium sulfide	2830.30.0000	Free	3.1% ad val.	25% ad val.
Pigments and preparations based on cadmium compounds	3206.30.0000	Free	3.1% ad val.	25% ad val.
Unwrought cadmium; waste and scrap; powders	8107.10.0000	Free	Free	33¢/kg.

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

Government Stockpile:

Stockpile Status—9-30-97[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Cadmium	1,870	36	1,870	544	148

Prepared by **Jozef Plachy, (703) 648-4982 [Fax: (703) 648-7757].**

CADMIUM

Events, Trends, and Issues: More than 60% of the cadmium consumed by Western countries goes into batteries, making batteries the principal end use. Canada has replaced Japan as the largest refiner of cadmium. However, Japan continued to be the largest net importer of cadmium metal.

About 75% of the batteries being produced by Western manufacturers are for cellular telephones and other cordless electronic equipment. The remaining 25% are 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 captured about a 30% share of Japan's rechargeable battery market. The current consumption pattern is expected to change as the manufacture of electrical vehicles accelerates in the United States, the European Union, and Japan. If this market develops, then recycling of Ni-Cd batteries on a large scale will be required, both for environmental reasons and to assure adequate supply of cadmium metal.

Additional inducement for recycling will come from a new U.S. law entitled *"The Mercury-Containing and Rechargeable Battery Management Act of 1996"* (Public Law 104-142) that will become effective by May 1998. Title I of the act establishes uniform national labeling requirements and provides for the streamlining of regulations governing battery collection and recycling.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[6]	Reserve base[6]
	1996	1997[e]		
United States	1,530	1,750	70,000	210,000
Australia	682	700	63,000	190,000
Belgium	1,580	1,500	—	—
Canada	2,540	2,600	60,000	170,000
Germany	1,150	1,100	6,000	8,000
Japan	2,340	2,300	10,000	15,000
Mexico	675	700	35,000	40,000
Other countries	8,400	8,850	280,000	380,000
World total (rounded)	18,900	19,500	530,000	1,000,000

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 resources of cadmium in addition to those in the reserve base category.

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 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.
[5]See Appendix C for definitions.
[6]See Appendix D for definitions.

CEMENT

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

Domestic Production and Use: In 1997, approximately 77 million tons of portland cement and 3.6 million tons of masonry cement were produced at a total of 118 plants, spread among 37 States, by 1 State agency and 43 companies. In addition, there were two cement plants in Puerto Rico. The explant value of production, excluding Puerto Rico, was about $6 billion, and the dominant portland cement component was used to make concrete worth at least $26 billion. Total cement consumption was about 94 million tons. There were 108 plants making clinker—the main intermediate product in cement manufacture—with a total calculated annual production capacity of about 74 million tons. Together with 8 other cement plants that were just grinding facilities for clinker produced elsewhere, total finish grinding capacity at yearend amounted to almost 91 million tons. If Puerto Rico is included, the clinker and grinding capacities become about 76 million tons and about 93 million tons, respectively. The top 5 cement companies together accounted for about 38% of total U.S. clinker production and capacity and the top 10 companies accounted for about 60%. California, Texas, Pennsylvania, Michigan, Missouri, and Alabama, in descending order, were the six largest cement-producing States and together accounted for 51% of total U.S. production. In terms of use, cement manufacturers sold about 70% of their portland cement output to ready mixed concrete producers; 11% to producers of concrete products, such as block, pipe, and precast slabs; 10% to contractors (largely for roadpaving); 4% to building material dealers; and 5% to miscellaneous users, including Government and other contractors.

Salient Statistics—United States:[2]	1993	1994	1995	1996	1997[e]
Production, portland and masonry[3]	73,807	77,948	76,906	79,266	80,900
Shipments to final customers, including exports	80,099	85,934	86,561	92,965	95,000
Imports for consumption[4]	5,532	9,072	10,900	11,419	13,500
Exports	625	633	759	803	850
Consumption, apparent[5]	79,198	86,370	86,039	90,501	93,600
Price, average mill value, dollars per ton	55.65	61.26	67.87	71.15	74.50
Stocks, mill, yearend	4,788	4,805	5,813	5,525	5,525
Employment, mine and mill, number[e]	17,900	17,900	17,800	17,900	17,900
Net import reliance[6] as a percent of apparent consumption	7	10	11	12	14

Recycling: None.

Import Sources (1993-96):[7] Canada, 39%; Spain, 11%; Venezuela, 9%; Mexico, 8%; and other, 33%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[8] 12/31/97
Cement clinker	2523.10.0000	Free	$1.32/t.
White nonstaining portland cement	2523.21.0000	13¢/t	$1.76/t.
Other portland cement	2523.29.0000	Free	$1.32/t.
Aluminous cement	2523.30.0000	Free	$1.32/t.
Other hydraulic cement	2523.90.0000	Free	$1.32/t.

Depletion Allowance: Certain raw materials for cement production, such as limestone, bauxite, and gypsum, have depletion allowances.

Government Stockpile: None.

Events, Trends, and Issues: The robust construction market in 1997 generated higher consumption levels for cement. Demand growth in 1997 was met through a combination of increased production and imports, with imports playing a larger role than in 1996. There was expectation of higher interest rates in 1998, which may dampen demand somewhat, but the overall prognosis for cement consumption growth remains optimistic. A number of plants were engaged in projects to upgrade their capacities.

Prepared by **Hendrik G. van Oss, (703) 648-7712 [Fax: (703) 648-7722].**

CEMENT

There continued to be concern over the environmental impact of cement manufacture, particularly the emissions of carbon dioxide and cement kiln dust (CKD). The Environmental Protection Agency has yet to release guidelines on CKD emissions, and it has, as yet, to designate the material a hazardous waste. 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 appears to be towards increased use of waste fuels, but some individual companies are abandoning the practice. 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 having hydraulic cementitious properties when interground with free lime; 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 monetary and environmental costs of cement manufacture. In the United States, most pozzolan consumption continued to be by concrete manufacturers rather than by cement plants.

<u>World Production and Capacity</u>:

	Cement production		Yearend clinker capacity	
	1996	1997[e]	1996[e]	1997[e]
United States (includes Puerto Rico)	80,818	82,500	77,155	74,500
Brazil	34,597	36,000	38,500	39,000
China	490,000	510,000	410,000	420,000
France	[e]20,000	20,000	24,000	24,000
Germany	[e]40,000	40,000	41,900	42,000
India	76,220	80,000	67,500	70,000
Indonesia	25,000	30,000	24,000	25,000
Italy	[e]34,000	34,000	45,700	46,000
Japan	94,492	95,000	97,032	97,500
Korea, Republic of	57,334	59,000	55,800	56,000
Mexico	22,829	25,000	43,000	43,000
Russia	27,800	30,000	67,500	67,500
Spain	25,157	26,000	33,800	39,000
Taiwan	21,537	21,500	23,000	23,000
Thailand	[e]35,000	30,000	30,000	30,000
Turkey	32,500	33,500	28,600	28,600
Other countries	[e]367,280	350,000	336,000	340,000
World total (rounded)	[e]1,485,000	1,500,000	1,440,000	1,470,000

<u>World Resources</u>: Although individual company reserves are subject to exhaustion, cement raw materials, especially limestone, are geologically widespread and abundant; 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 on the world market.

<u>Substitutes</u>: 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, and stone. In the important road paving market, the main competitor is asphalt. There is a small but growing use in the United States of natural and synthetic pozzolans 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]Hydraulic cement. Excludes clinker.
[5]Production of cement (including from imported clinker) + imports (excluding clinker) - exports - changes in stocks.
[6]Defined as imports - exports + adjustments for Government and industry stock changes.
[7]Includes clinker.
[8]See Appendix B.

CESIUM

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

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

Salient Statistics—United States: Salient statistics, such as production, consumption, imports, and exports, are not available. The domestic 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 1997, one company offered 1-gram ampoules of 99.98% grade cesium metal at $43.70. The price for 100 grams of the same material from this company was $573.00, or $5.73 per gram. At another company, the price for a 1-gram ampoule of 99.95% pure cesium was $39.30.

Recycling: None.

Import Sources (1993-96): 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	Most favored nation (MFN) 12/31/97	Non-MFN[1] 12/31/97
Alkali metals, other	2805.19.0000	6.2% ad val.	25% ad val.
Chlorides, other	2827.39.5000	3.7% ad val.	25% ad val.

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

Government Stockpile: None.

Prepared by **Robert G. Reese, Jr., (703) 648-4981 [Fax: (703) 648-7757].**

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 by-product with other pegmatite minerals; commercial concentrates of pollucite contain about 20% cesium by weight.

	Reserves[2]	Reserve base[2]
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 B.
[2]See Appendix D for definitions.

CHROMIUM

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

Domestic Production and Use: The United States consumes about 12% of world chromite ore production in various forms of imported materials (chromite ore, chromium ferroalloys, chromium metal, and chromium chemicals). Imported chromite was consumed by two chemical firms, one metallurgical firm, and four refractory firms to produce chromium chemicals, chromium ferroalloys, and chromite-containing refractories, respectively. Consumption of chromium ferroalloys and metal by end use was: stainless and heat-resisting steel, 68%; full-alloy steel, 8%; superalloys, 3%; and others, 21%. The value of chromium materials consumption was about $460 million. Secondary chromium is recovered from stainless steel scrap.

Salient Statistics—United States:[1]	1993	1994	1995	1996	1997[e]
Production: Mine	—	—	—	—	—
Secondary	92	99	112	98	124
Imports for consumption	330	273	416	362	373
Exports	21	33	27	51	33
Government stockpile releases	68	49	44	52	39
Consumption: Reported (excludes secondary)	327	310	298	277	315
Apparent[2] (includes secondary)	484	390	565	467	513
Price, chromite, yearend:					
Turkish, dollars per metric ton, Turkey	110	110	230	230	150
South African, dollars per metric ton, South Africa	60	60	80	80	75
Stocks, industry, yearend	103	101	80	74	64
Net import reliance[3] as a percent of apparent consumption	81	75	80	79	76

Recycling: In 1997, chromium contained in purchased stainless steel scrap accounted for 24% of demand.

Import Sources (1993-96): Chromium contained in chromite ore and chromium ferroalloys and metal: South Africa, 37%; Turkey, 13%; Russia, 13%; Kazakstan, 8%; Zimbabwe, 7%; and other, 22%.

Tariff:[4] Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Ore and concentrate	2610.00.0000	Free	Free.
Ferrochromium, high-carbon	7202.41.0000	1.9% ad val.	7.5% ad val.

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

Government Stockpile: The National Defense Stockpile Agency submitted the Annual Materials Plan for 1998 in February 1997. In addition to the stockpile grade uncommitted inventory listed below, the stockpile contains the following nonstockpile grade uncommitted inventory, in thousand metric tons: 36.6, metallurgical chromite ore; 0.6, high-carbon ferrochromium; 10.4, low-carbon ferrochromium; and 1.24, ferrochromiumsilicon.

Stockpile Status—9-30-97[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997	Average chromium content
Chromite ore:						
Chemical-grade	162	55.6	112	90.7	10.0	28.6%
Metallurgical-grade	319	237	349	—	72.8	28.6%
Refractory-grade	208	101	77.0	90.7	8.66	[e]23.9%
Chromium ferroalloys:						
Ferrochromium:						
High-carbon	680	9.13	462	31.8	15.3	71.4%
Low-carbon	272	—	—	—	—	71.4%
Ferrochromium-silicon	51.4	0.002	—	—	—	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. Virtually all of Brazilian production is consumed in Brazil. Cuban production is relatively small. The three largest chromite ore producers, accounting for about two-thirds

Prepared by **John F. Papp, (703) 648-4963 [Fax: (703) 648-7757].**

CHROMIUM

of world production, are India, Kazakstan, and South Africa. These countries are currently in the process of major political change. Economic and political reorganization in the Former Soviet Union has resulted in reduced demand. This lull in demand may be followed by strong growth-driven demand resulting from the institution of reforms in those countries. South Africa has been the major supplier of chromite ore to Western industrialized countries. In 1995, prices recovered from having been suppressed by excess production capacity resulting from the dissolution of the U.S.S.R.[7] in 1991 and excess ferrochromium capacity resulting from expansion worldwide during 1990-92. Western economy demand remains firm while industry restructures. Chromium markets strengthened in 1997 after having weakened in 1996 following 2 consecutive years of stainless steel growth in excess of 10%. It was estimated that stainless steel production in 1997 would increase about 5% resulting in similar growth in ferrochromium demand. This was reflected in increased ferrochromium prices.

Chromium releases into the environment are regulated by the U.S. Environmental Protection Agency. Workplace exposure is regulated by the U.S. Occupational Safety and Health Administration.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[8]	Reserve base[8]
	1996	1997[e]	(shipping grade)[9]	
United States	—	—	—	10,000
Albania	235	250	6,100	6,100
Brazil	450	400	14,000	23,000
Finland	582	600	41,000	120,000
India	1,363	1,400	27,000	67,000
Iran	129	100	2,400	2,400
Kazakstan	1,190	1,200	320,000	320,000
Russia	97	100	4,000	460,000
South Africa	5,018	5,000	3,000,000	5,500,000
Turkey	2,000	2,000	8,000	20,000
Zimbabwe	428	500	140,000	930,000
Other countries	428	400	29,000	37,000
World total (may be rounded)	12,190	12,000	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 are geographically concentrated in southern Africa. Reserves and reserve base are geographically concentrated in southern Africa and Kazakstan. 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. According to the National Academy of Sciences, 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]Calculated demand for chromium is production + imports - exports + stock adjustment.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]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.
[5]See Appendix B.
[6]See Appendix C for definitions.
[7]As constituted before Dec. 1991.
[8]See Appendix D for definitions. Reserves and reserve base data are rounded to no more than two significant figures.
[9]Shipping-grade chromite ore is deposit quantity and grade normalized to 45% Cr_2O_3.

CLAYS

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: In 1997, clays were produced in most States except Alaska, Delaware, Hawaii, Rhode Island, Vermont, and Wisconsin. The leading 50 firms supplied 70% of the tonnage, and 225 firms provided the remainder. Together, these firms operated approximately 739 mines. The estimated value of all marketable clay produced was about $1.75 billion. Major domestic uses for specific clays were estimated as follows: ball clay—26% floor and wall tile, 25% sanitaryware, and 14% pottery; bentonite—23% foundry sand bond, 20% iron ore pelletizing, 18% pet waste absorbent, and 17% drilling mud; common clay—50% brick, 27% cement, and 15% lightweight aggregate; fire clay—70% refractories; fuller's earth—73% absorbent uses and 11% insecticide dispersant; and kaolin—55% paper, 13% refractories, 7% fiberglass, and 4% paint.

Salient Statistics—United States:[1]	1993	1994	1995	1996	1997[e]
Production, mine:					
Ball clay	911	1,050	993	973	1,030
Bentonite	2,870	3,290	3,820	3,740	3,780
Common clay	25,300	25,900	25,600	26,200	26,900
Fire clay[2]	459	458	583	505	403
Fuller's earth	2,480	2,640	2,640	2,600	2,570
Kaolin	8,830	8,770	9,480	9,120	9,180
Total[3]	40,700	42,000	43,100	43,100	43,900
Imports for consumption	39	36	35	45	53
Exports	4,150	4,620	4,680	4,830	4,970
Consumption, apparent	36,600	37,600	38,500	38,300	39,000
Price, average, dollars per ton:					
Ball clay	42	43	46	44	49
Bentonite	36	41	36	36	36
Common clay	5	5	6	5	7
Fire clay	25	25	22	21	25
Fuller's earth	92	92	101	106	97
Kaolin	107	116	117	120	121
Stocks, yearend[4]	NA	NA	NA	NA	NA
Employment, number:[e] Mine	4,500	3,950	4,900	4,900	4,900
Mill	9,000	9,000	9,000	9,000	9,000
Net import reliance[5] as a percent of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1993-96): Mexico, 35%; the United Kingdom, 19%; China, 15%; Canada, 7%; and other, 24%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[6] 12/31/97
Kaolin and other kaolinitic clays, whether or not calcined	2507.00.0000	13¢/t	$2.46/t.
Bentonite	2508.10.0000	15.8¢/t	$3.20/t.
Fuller's and decolorizing earths	2508.20.0000	9.8¢/t	$1.48/t.
Fire clay	2508.30.0000	19.7¢/t	$1.97/t.
Common blue and other ball clays	2508.40.0010	18.7¢/t	$1.97/t.
Other clays	2508.40.0050	18.7¢/t	$1.97/t.
Chamotte or dinas earth	2508.70.0000	Free	Free.
Activated clays and earths	3802.90.2000	2.5% ad val.	0.6¢ per kg + 30% ad val.
Expanded clays and mixtures	6806.20.0000	2% ad val.	30% ad val.

Depletion Allowance: Kaolin, ball clay, bentonite, fuller's earth, and fire clay, 14% (Domestic), 14% (Foreign); clay used for extraction of alumina or aluminum compounds, 22% (Domestic); clay and shale used for making brick, tile, and lightweight aggregate, 7.5% (Domestic), 7.5% (Foreign); clay used in making drainage and roofing tile, flowerpots, and kindred products, 5% (Domestic), 5% (Foreign).

Government Stockpile: None.

Prepared by **Robert L. Virta (703) 648-7726 [Fax: (703) 648-7722].**

CLAYS

Events, Trends, and Issues: The total tonnage of clays sold or used by domestic producers increased slightly in 1997. There was an increase in sales and/or use for ball clay, bentonite, common clay, and kaolin. Imports for consumption increased to 53,000 tons. Mexico and the United Kingdom were the major sources for imported clays. Exports increased to 4.97 million tons. Canada, Finland, Japan, and the Netherlands were major markets for exported clays. U.S. apparent consumption was estimated to be 39 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 talc and whiting, 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.

[6]See Appendix B.

COBALT

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

Domestic Production and Use: With the exception of negligible amounts of byproduct cobalt produced as intermediate products from some mining operations, the United States did not mine or refine cobalt in 1997. U.S. supply was comprised of imports, stock releases, and secondary sources such as superalloy scrap, cemented carbide scrap, and spent catalysts. About 13 recyclers accounted for nearly all the cobalt recycled in superalloy scrap. There were two 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. About 85% of U.S. consumption of cobalt was in five major end uses. Superalloys, used mainly in aircraft gas turbine engines, accounted for about 46% of U.S. demand; cemented carbides, paint driers, and magnetic alloys each accounted for about 10%; catalysts about 9%; and other, 15%. The total estimated value of cobalt consumed in 1997 was $420 million.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Mine	—	—	—	—	—
Secondary	1,570	1,570	1,540	1,670	2,000
Imports for consumption	5,950	6,780	6,440	6,710	7,400
Exports	795	1,360	1,300	1,660	1,700
Shipments from Government stockpile excesses	289	1,500	1,550	2,050	1,500
Consumption:					
Reported (includes secondary)	6,430	7,020	7,030	7,010	7,500
Apparent (includes secondary)	7,310	8,470	8,640	8,810	9,200
Price, average annual spot for cathodes, dollars per pound	13.79	24.66	29.21	25.50	23.00
Stocks, industry, yearend	1,460	1,490	1,080	1,030	1,030
Net import reliance[1] as a percent of apparent consumption	79	81	82	81	78

Recycling: About 2,000 tons of cobalt was recycled from purchased scrap in 1997. This represented about 27% of estimated reported consumption for the year.

Import Sources (1993-96): Cobalt contained in metal, oxide, and salts: Norway, 21%; Zambia, 19%; Finland, 16%; Canada, 14%; and other, 30%. Since 1991, imports from Congo (Kinshasa)[2] and Zambia have decreased, while imports from Finland, Norway, and Russia have increased.

Tariff: Item	Number	Most favored nation (MFN)[3] 12/31/97	Non-MFN[4] 12/31/97
Unwrought cobalt, alloys	8105.10.3000	4.8% ad val.	45% ad val.
Unwrought cobalt, other	8105.10.6000	Free	Free.
Cobalt matte, waste, and scrap	8105.10.9000	Free	Free.
Wrought cobalt and cobalt articles	8105.90.0000	4.4% ad val.	45% ad val.
Chemical compounds:			
Cobalt oxides and hydroxides	2822.00.0000	0.1% ad val.	1.7% ad val.
Cobalt sulfates	2833.29.1000	1.4% ad val.	6.5% ad val.
Cobalt chlorides	2827.34.0000	4.2% ad val.	30% ad val.
Cobalt carbonates	2836.99.1000	4.2% ad val.	30% ad val.
Cobalt acetates	2915.23.0000	4.2% ad val.	30% ad val.
Cobalt ores and concentrates	2605.00.0000	Free	Free.

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

Government Stockpile: Sales of National Defense Stockpile cobalt began in March 1993. The Department of Defense's proposed annual materials plan includes a cobalt disposal limit of 2,720 tons (6 million pounds) during fiscal year 1998.

Stockpile Status—9-30-97[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Cobalt	17,300	261	10,900	2,720	1,060

Prepared by **Kim B. Shedd, (703) 648-4974 [Fax: (703) 648-7757].**

COBALT

Events, Trends, and Issues: World cobalt production is expected to increase significantly in the next 5 years with the opening of new nickel and copper mines and the startup of projects to recover cobalt from stockpiled tailings, slags, and concentrates. World demand is also expected to increase, particularly in the superalloy and battery end-use sectors. In 1997, cobalt exports from Russia and sales from the National Defense stockpile continued to contribute to supply. The free market price for cobalt cathode decreased from approximately $22 per pound in January to a low of $19 per pound in March. The price then increased and peaked at $26 per pound in May, dropped to $22 per pound in June, then increased to $25 per pound in September.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1996	1997[e]		
United States	—	—	—	860,000
Australia	2,300	2,500	270,000	600,000
Canada	5,800	5,600	45,000	260,000
Congo (Kinshasa)[2]	2,000	2,500	2,000,000	2,500,000
Cuba	1,970	1,950	1,000,000	1,800,000
New Caledonia[7]	800	800	230,000	860,000
Philippines	—	—	—	400,000
Russia	3,300	4,300	140,000	230,000
Zambia	7,900	6,500	360,000	540,000
Other countries	2,920	2,920	90,000	1,200,000
World total (may be rounded)	27,000	27,000	4,000,000	9,000,000

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 will not be economical in the foreseeable future. In addition, with the exception of 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)[2] and Zambia. In addition, millions of tons of hypothetical and speculative cobalt resources exist in manganese nodules and crusts on the ocean floor. Cobalt reserves and reserve base for Australia have been revised to be consistent with data published by the Australian Bureau of Resource Sciences.

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]Formerly Zaire.
[3]No tariff for Canada or Mexico.
[4]See Appendix B.
[5]See Appendix C for definitions.
[6]See Appendix D for definitions.
[7]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 1997 was about $60 million. Major end-use distribution of reported columbium consumption was as follows: carbon steels, 29%; high-strength low-alloy steels, 24%; superalloys, 20%; alloy steels, 14%; stainless and heat-resisting steels, 12%; and other, 1%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, mine	—	—	—	—	—
Imports for consumption:					
Concentrates, tin slags, and other[1]	NA	NA	NA	NA	NA
Ferrocolumbium[e]	2,190	2,590	3,580	2,970	4,000
Exports, concentrate, metal, and alloys[e]	300	320	370	190	75
Consumption, reported:					
Raw material	NA	NA	NA	NA	NA
Ferrocolumbium[e 2]	2,470	2,750	2,900	3,020	3,000
Consumption, apparent	3,500	3,700	3,800	3,800	3,900
Price: Columbite, dollars per pound[3]	2.67	2.60	2.97	3.00	3.00
Pyrochlore, dollars per pound[4]	2.75	NA	NA	NA	NA
Stocks, industry, processor and consumer, yearend	NA	NA	NA	NA	NA
Employment	NA	NA	NA	NA	NA
Net import reliance[5] as a percent of apparent consumption	100	100	100	100	100

Recycling: Insignificant.

Import Sources (1993-96): Brazil, 66%; Canada, 21%; Germany, 4%; and other, 9%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[6] 12/31/97
Columbium ores and concentrates	2615.90.6030	Free	Free.
Columbium oxide	2825.90.1500	3.7% ad val.	25% ad val.
Ferrocolumbium	7202.93.0000	5.0% ad val.	25% ad val.
Columbium, unwrought:			
Waste and scrap	8112.91.0500	Free	Free.
Alloys, metal, and powders	8112.91.4000	4.9% ad val.	25% ad val.
Columbium, wrought	8112.99.0000	4.6% ad val.	45% ad val.

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

Government Stockpile: Sales of National Defense Stockpile (NDS) ferrocolumbium began in March 1997. According to the Defense Logistics Agency's (DLA) Annual Materials Plan for each of fiscal years 1997 and 1998, the maximum amount of ferrocolumbium that could be sold would be about 91 tons of columbium contained in ferrocolumbium. For fiscal year (FY) 1997, ending September 30, 1997, the DLA sold about 37 tons of columbium contained in ferrocolumbium valued at $537,000. For FY 1998, in October 1997, the DLA sold about 16 tons of columbium contained in ferrocolumbium valued at $225,000. Additionally, the Department of Defense proposed to dispose of about 10 tons of columbium contained in columbium carbide and about 91 tons of columbium contained in columbium concentrates in FY 1998. The NDS uncommitted inventories shown below include about 343 tons of columbium contained in nonstockpile-grade concentrates and about 148 tons of columbium contained in nonstockpile-grade ferrocolumbium.

Prepared by **Larry D. Cunningham, (703) 648-4977 [Fax: (703) 648-7757].**

COLUMBIUM (NIOBIUM)

Stockpile Status—9-30-97[7]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Columbium:					
Carbide powder	10	—	—	—	—
Concentrates	786	—	—	—	—
Ferrocolumbium	498	11	385	91	37
Metal	73	—	—	—	—

Events, Trends, and Issues: For the first one-half year, overall reported consumption of columbium increased by about 9% compared with that of the previous year. Consumption of columbium by the steelmaking sector rose by about 5%, while demand for columbium in superalloys was up by more than 20%. For the same period, overall columbium imports rose by more than 40%. Brazil was the leading supplier, providing more than 70% of total imports. Exports continued to decline owing to the diminished availability of Canadian pyrochlore concentrates for domestic steelmaking-grade ferrocolumbium production. This production was negligible in 1997. New steelmaking-grade ferrocolumbium capacity developed in Canada in late 1994 contributed to the rise in ferrocolumbium imports in 1997. In late October, the published price for columbite ore was quoted at a range of $2.80 to $3.20 per pound of contained columbium and tantalum pentoxides. The published price for steelmaking-grade ferrocolumbium was quoted at a range of $6.75 to $7 per pound of contained columbium, and high-purity ferrocolumbium was quoted at a range of $17.50 to $18 per pound of contained columbium.

It is estimated that in 1998 domestic columbium mine production will be zero and U.S. apparent consumption will be about 4 million kilograms. The majority of total U.S. demand will be supplied by columbium imports in upgraded forms.

World Mine Production, Reserves, and Reserve Base:

	Mine production 1996	Mine production 1997[e]	Reserves[e 8]	Reserve base[e 8]
United States	—	—	—	Negligible
Australia	112	120	NA	NA
Brazil	13,500	14,000	3,300,000	3,600,000
Canada	2,330	2,400	140,000	410,000
Congo (Kinshasa)[9]	—	—	32,000	91,000
Nigeria	10	10	64,000	91,000
Zimbabwe	1	1	NA	NA
Other countries[10]	—	1	6,000	9,000
World total (rounded)	16,000	16,500	3,500,000	4,200,000

World Resources: Most of the world's identified resources of columbium are outside the United States and occur mainly as pyrochlore in carbonatite deposits. On a worldwide basis, resources are more than adequate to supply projected needs. The United States has approximately 360,000 tons of columbium resources in identified deposits, most of which were considered uneconomic at 1997 prices for columbium.

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

[e]Estimated. NA Not available.
[1]Metal, alloys, synthetic concentrates, and columbium oxide.
[2]Includes nickel columbium and a small quantity of other columbium materials.
[3]Average value, contained pentoxides for material having a Nb_2O_5 to Ta_2O_5 ratio of 10 to 1.
[4]Average value, contained pentoxide.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]See Appendix B.
[7]See Appendix C for definitions.
[8]See Appendix D for definitions.
[9]Formerly Zaire.
[10]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 1997 was essentially unchanged at 1.9 million metric tons valued at about $4.6 billion. The five principal mining States, in descending order, Arizona, Utah, New Mexico, Nevada, and Montana, accounted for 98% of domestic production; copper was also recovered at mines in six other States. While copper was recovered at about 35 mines operating in the United States, 15 mines accounted for about 97% of production. Seven primary and 4 secondary smelters, 7 electrolytic and 6 fire refineries, and 15 solvent extraction-electrowinning facilities were operating at yearend. Refined copper and direct melt scrap were consumed at about 35 brass mills; 15 rod mills; and 600 foundries, chemical plants, and miscellaneous consumers. Copper and copper alloy products were consumed[1] in building construction, 43%; electric and electronic products, 24%; industrial machinery and equipment, 12%; transportation equipment, 12%; and consumer and general products, 9%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Mine	1,800	1,850	1,850	1,920	1,920
Refinery: Primary[2]	1,790	1,840	1,930	2,010	2,070
Secondary[3]	460	392	352	333	350
Copper from all old scrap	543	500	442	428	420
Import for consumption:					
Ores and concentrates	37	82	127	72	50
Refined	343	470	429	543	570
All imports	637	763	808	924	920
Exports: Ores and concentrates	227	261	239	195	130
Refined	217	157	217	169	120
All exports	685	752	894	683	670
Consumption: Refined, reported	2,360	2,680	2,530	2,620	2,720
Apparent, primary and old scrap[4]	2,510	2,690	2,540	2,830	2,830
Price, average, cents per pound:					
Domestic producer, cathode	91.6	111.0	138.3	109.0	108
London Metal Exchange, high-grade	86.8	104.6	133.1	104.0	104
Stocks, yearend, refined[5]	153	119	163	146	250
Employment, mine and mill, thousands	13.3	13.1	13.8	13.2	13.3
Net import reliance[6] as a percent of apparent consumption	7	13	7	14	12

Recycling: Old scrap, converted to refined metal and alloys, provided 420,000 tons of copper, equivalent to 15% of apparent consumption. Purchased new scrap, derived from copper fabricating operations, yielded 930,000 tons of contained copper; 80% of the copper contained in new scrap was consumed at brass mills. Of the total copper recovered from scrap, copper smelters and refiners recovered 28%; ingot makers, 9%; brass mills, 58%; and miscellaneous manufacturers, foundries, and chemical plants, 5%. Copper in all old and new, refined or remelted scrap comprised 36% of U.S. copper supply.

Import Sources (1993-96): Unmanufactured: Canada, 48%; Chile, 22%; Mexico, 13%; and other, 17%. Refined copper comprised 57% of imports of unwrought copper.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Canada 12/31/97	Mexico 12/31/97	Non-MFN[7] 12/31/97
Unrefined copper; anodes	7402.00.0000	0.4% ad val.[8]	Free	0.2% ad val.[8]	6% ad val.[8]
Refined and alloys; unwrought	7403.00.0000	1% ad val.	Free	Free	6% ad val.
Copper powder	7406.10.0000	2.2% ad val.	0.5% ad val.	Free	49% ad val.
Copper wire (bare)	7408.11.6000	3.4% ad val.	0.4% ad val.	Free	28% ad val.

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

Government Stockpile: None. 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.

Prepared by **Daniel L. Edelstein, (703) 648-4978 [Fax: (703) 648-7757].**

COPPER

Events, Trends, and Issues: World mine production of copper rose significantly for the third consecutive year, increasing by about 3% in 1997. Most of the increase in production came from Chile, where an estimated 300,000 tons of new capacity came on-stream. In the United States, mine production and capacity were essentially unchanged. Increased production from a major new mine in Nevada, which began production in 1996, and a new solvent-extraction electrowinning (SX-EW) operation in Arizona, was offset by closure of two smaller mines in Arizona during 1996, and depletion of ore at a third mine in Wisconsin in 1997. Production also declined at several SX-EW operations where mining of leach ore was curtailed and production limited to existing heaps. Though domestic production of refined copper was projected to rise about 3% for the year, it remained well below capacity owing to a shortage of anode copper during the first half of the year. The smelter in Utah, which had been plagued by problems since commissioning in 1995, was closed for 6 weeks for replacement of anode casting equipment.

Copper supply remained tight for the first 6 months of 1997 and prices trended upward, the U.S. producer price averaging almost $1.16 per pound. However, in July, commodity exchange inventories began to rise and prices declined. By the end of September, exchange inventories had more than doubled from yearend 1996 levels and the U.S. producer price had fallen to below $1.00 per pound. In response to the rising copper price, recovery of copper from both old and new scrap increased during the first half of the year, but then fell in the second half as the price fell and a secondary smelter in Pennsylvania closed.

Consumption of refined copper in the United States was projected to rise about 4% in 1997 owing to strong demand for wire mill products. At least one major wire rod producer reported operating above design capacity during 1997, despite having expanded capacity during 1996. Worldwide, the current surplus of refined copper is projected to increase in 1998, as world mine capacity is expected to increase about 900,000 tons in that year.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[9]	Reserve base[9]
	1996	1997[e]		
United States	1,920	1,920	45,000	90,000
Australia	525	520	7,000	23,000
Canada	689	660	10,000	23,000
Chile	3,120	3,380	88,000	163,000
China	439	440	18,000	37,000
Congo (Kinshasa)[10]	29	40	10,000	30,000
Indonesia	507	525	11,000	15,000
Kazakstan	250	230	14,000	20,000
Mexico	341	360	15,000	27,000
Peru	572	580	7,000	24,000
Poland	422	420	20,000	36,000
Russia	520	520	20,000	30,000
Zambia	334	350	12,000	34,000
Other countries	1,330	1,360	40,000	75,000
World total (rounded)	11,000	11,300	320,000	630,000

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. Estimated after Copper Development Association, 1996.
[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.
[5]Held by industry, the Commodity Exchange, Inc., and London Metal Exchange Ltd. warehouses in the United States.
[6]Defined as imports - exports + adjustments for Government and industry stock changes for refined copper.
[7]See Appendix B.
[8]Value of copper content.
[9]See Appendix D for definitions.
[10]Formerly Zaire.

DIAMOND (INDUSTRIAL)

(Data in million carats, unless otherwise noted)

Domestic Production and Use: Production reached a record high and the United States remained the world's largest consumer of industrial diamond in 1997. Virtually all output was synthetic grit and powder. Two firms, one in New Jersey and the other in Ohio, accounted for the production. Three firms recovered used industrial diamond as one of their principal operations. Most consumption was accounted for by the following industry sectors: machinery manufacturing, mineral services, stone and ceramic production, abrasive industries, construction, and transportation equipment manufacturing. Mineral services, primarily drilling, accounted for most industrial stone consumption.

Salient Statistics—United States:[1]	1993	1994	1995	1996	1997[e]
Bort, grit, and powder and dust; natural and synthetic:					
Production: Manufactured diamond	105	104	115	114	125
Secondary	15.9	16.0	26.1	20	10
Imports for consumption	133	174	188	218	243
Exports and reexports	107	153	101	108	135
Sales from Government stockpile excesses	—	2.0	.2	1	.7
Consumption, apparent	146	141	228	245	244
Price, value of imports, dollars per carat	.61	.51	.43	.46	.44
Net import reliance[2] as a percent of apparent consumption	18	15	38	45	45
Stones, natural:					
Production: Mine	—	—	—	([3])	([3])
Secondary	.1	.1	.3	.3	.3
Imports for consumption[4]	5.2	2.8	4.1	2.9	2.4
Exports and reexports[5]	3.4	4.4	5.2	3.3	3.8
Sales from Government stockpile excesses	1.3	3.1	.3	.5	.9
Consumption, apparent	NA	NA	NA	NA	NA
Price, value of imports, dollars per carat	6.85	9.41	6.62	7.54	10.06
Net import reliance[2] as a percent of apparent consumption	NA	NA	NA	NA	NA

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

Import Sources (1993-96): Bort, grit, and powder and dust; natural and synthetic: Ireland, 58%; China, 9%; Germany, 8%; and other, 25%. Stone, primarily natural: the United Kingdom, 37%; Congo (Kinshasa), 17%; Belgium, 16%; and other, 30%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[6] 12/31/97
Miners' diamond, carbonados	7102.21.1010	Free	Free.
Other	7102.21.1020	Free	Free.
Industrial diamond, natural advanced	7102.21.3000	2.0% ad val.	30% ad val.
Industrial diamond, natural not advanced	7102.21.4000	Free	Free.
Industrial diamond, other	7102.29.0000	Free	Free.
Dust, grit, or powder	7105.10.0000	Free	Free.

Prepared by **Ronald F. Balazik, (703) 648-7721 [Fax: (703) 648-7722].**

DIAMOND (INDUSTRIAL)

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

Government Stockpile:

Stockpile Status—9-30-97[7]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Crushing bort	0.0620	0.085	0.0008	1.0	0.723
Industrial stones	3.75	.462	.653	2.0	.877

Events, Trends, and Issues: The United States will continue to be the largest market for industrial diamond through the remainder of this decade. A new diamond mine in Colorado, the first in the United States in almost a century, could become a domestic source of natural industrial stones.

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[e 9]	Reserve base[e 9]
	1996	1997[e]		
United States	([3])	([3])	—	Unknown
Australia	23.1	23.0	500	900
Botswana	5.0	5.0	130	200
Brazil	.6	.6	5	15
China	.9	.9	10	20
Congo (Kinshasa)[10]	15.0	15.0	150	350
Russia	9.2	9.0	40	65
South Africa	6.0	5.5	70	150
Other countries	1.8	3.0	80	200
World total (may be rounded)	61.6	62.0	980	1,900

World Resources: Potential for the discovery of natural diamond resources in the United States, Canada, and Russia has improved. However, technologies to synthesize diamond powder, dust, and grit are used in at least 17 countries and account for about 90% of world industrial diamond output.

Substitutes: Competitive materials include manufactured abrasives (such as cubic boron nitride, fused aluminum oxide, and silicon carbide) and natural abrasives (such as garnet, emery, and corundum). Synthesized polycrystalline diamond is competitive with natural stones in many applications. Research continues on additional uses of synthetic polycrystalline compacts and shapes as substitutes for stones and on the uses of diamond films and diamond-like carbon coatings.

[e]Estimated. NA Not available.
[1]Industry stocks and employment are unknown.
[2]Defined as imports - exports including reexports + adjustments for Government and industry stock changes.
[3]Less than ½ unit.
[4]May include synthetic miners diamond.
[5]Includes diamonds in manufactured abrasive products.
[6]See Appendix B.
[7]See Appendix C for definitions.
[8]Natural industrial diamond only.
[9]See Appendix D for definitions.
[10]Formerly Zaire.

DIATOMITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: The estimated value of processed diatomite, f.o.b. plant, was $178 million in 1997. Six companies with 12 processing facilities in 4 States produced diatomite. California and Nevada were the principal producing States. End uses of diatomite were filter aid, 67%; fillers, 13%; and other, 20%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production[1]	599	613	687	698	705
Imports for consumption	([2])	([2])	([2])	([2])	([2])
Exports	165	157	144	143	144
Consumption, apparent	436	456	543	555	561
Price, average value, dollars per ton, f.o.b. plant	251	248	249	252	252
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 (1993-96): France, 49%; Mexico, 40%; and other, 11%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Diatomite, crude or processed	2512.00.0000	Free	Free.

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

Government Stockpile: None.

Prepared by **Lloyd E. Antonides, (703) 648-7710 [Fax: (703) 648-7722].**

DIATOMITE

Events, Trends, and Issues: The United States remained the largest producer and consumer of diatomite and exported processed diatomite to 77 countries, primarily for filtration use.

Diatomite use in filtration applications is decreasing with the market share going to ceramic, polymeric, and carbon membrane technologies. However, applications as an absorbent are growing.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	1996	1997[e]		
United States[1]	698	705	250,000	500,000
Denmark[6]	96	96		NA
France	85	85	Other	2,000
Germany	50	50	countries:	NA
Korea, Republic of	80	80	550,000	NA
Mexico	56	60		2,000
Spain	40	40		NA
Former Soviet Union[7]	100	100		NA
Other countries	205	194		NA
World total (may be rounded)	1,410	1,410	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 alternate materials can be substituted for diatomite. However, the unique properties of diatomite assure its continuing use for many applications. Expanded perlite, asbestos, and silica sand compete for filtration purposes, other filtration technologies utilize 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 brick, clay, asbestos, 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 B.
[5]See Appendix D for definitions.
[6]Includes sales of moler production.
[7]As constituted before Dec. 1991.

FELDSPAR

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: U.S. feldspar production (including aplite) in 1997 had an estimated value of $42 million. The three largest producers accounted for over one-half of the output, with eight other companies supplying the remainder. Operations in North Carolina provided about 54% of the output and facilities in six other States contributed smaller quantities.

Production of lithium ores and mica yielded moderate quantities of byproduct or coproduct feldspar and feldspar-silica mixtures, and 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 31 States and to foreign destinations, including Canada and Mexico. In ceramics and glass, feldspar functions as a flux. Estimated 1997 end-use distribution of domestic feldspar was glass, 70%, and pottery and other, 30%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, marketable	770	765	880	890	930
Imports for consumption	7	7	9	7	9
Exports	18	17	15	10	8
Consumption, apparent	759	755	874	887	931
Price, average value, marketable production, dollars per ton	40.78	40.78	42.50	44.27	45.09
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	E	E	—

Recycling: Insignificant.

Import Sources (1993-96): Mexico, 97%; and other, 3%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Feldspar	2529.10.0000	Free	49¢/t.

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

Government Stockpile: None.

Prepared by **Michael J. Potter, (703) 648-7723 [Fax: (703) 648-7722].**

FELDSPAR

Events, Trends, and Issues: A large U.S. feldspar producer announced a price increase in mid-1997, according to North American Minerals News, June 1997. The increase of around 4% covered products across the board from Spruce Pine, NC. Prices for 200 mesh, bulk, ceramic-grade material were increased in early 1997 from $70 per metric ton to about $73 per metric ton. Increases in fuel oil prices were reported to be a factor.

Feldspar usage in housing construction is reflected in tile, plumbing fixtures, and glass fiber insulation. Although housing starts in 1997 may decrease slightly compared with those of the previous year, growth in the remodeling industry should help to offset any decline in new construction, according to one source. Based on an informal survey taken by a national remodeling association, kitchens are the most likely area of the home to be remodeled, with bathrooms a close second.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[4]
	1996	1997[e]	
United States	890	930	Significant in the United States and assumed to be similar in other countries.
Brazil	205	200	
Columbia	60	60	
France	600	600	
Germany	375	375	
India	90	90	
Italy	1,800	1,800	
Japan	59	60	
Korea, Republic of	320	320	
Mexico	130	130	
Norway	65	65	
Russia	75	75	
Spain	225	230	
Thailand	650	650	
Turkey	500	500	
Uzbekistan	70	70	
Venezuela	170	170	
Other countries	466	475	
World total (may be rounded)	6,750	6,800	

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 immense, 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 alternate 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]See Appendix B.

[4]See Appendix D for definitions.

FLUORSPAR

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: There was no domestic mine production of fluorspar in 1997. 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. An estimated 90% of U.S. 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 68,800 tons of fluorosilicic acid (equivalent to 121,000 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:	1993	1994	1995	1996	1997[e]
Production: Finished, all grades[e 1]	[2]60	[2]49	[2]51	8	—
Fluorspar equivalent from phosphate rock	116	97	98	119	121
Imports for consumption:					
Acid grade	434	434	470	474	510
Metallurgical grade	63	59	88	39	68
Fluorspar equivalent from hydrofluoric acid plus cryolite	99	108	114	135	174
Exports[3]	13	24	42	62	60
Shipments from Government stockpile	19	251	153	81	182
Consumption: Apparent[4]	560	563	599	711	609
Reported	447	486	525	527	515
Stocks, yearend, consumer and dealer[5]	78	284	405	234	325
Employment, mine and mill, number	130	130	130	5	—
Net import reliance[6] as a percent of apparent consumption	89	91	91	99	100

Recycling: An estimated 10,000 tons of synthetic fluorspar is recovered from stainless steel pickling plants and at petroleum alkylation plants. Primary aluminum producers recycled HF and fluorides from smelting operations. HF is recycled in the petroleum alkylation process.

Import Sources (1993-96): China, 64%; South Africa, 20%; Mexico, 13%; and other, 3%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[7] 12/31/97
Acid grade (more than 97% CaF_2)	2529.22.0000	\$0.83/t or Free[8]	\$5.51/t.
Metallurgical grade (less than 97% CaF_2)	2529.21.0000	Free	13.5% ad val.

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

Government Stockpile: During fiscal year 1997, the Defense National Stockpile Center (DNSC) was authorized to sell 163,000 tons (180,000 short dry tons) of acid grade and 45,000 tons (50,000 short dry tons) of metallurgical grade. During the 1997 fiscal year, the DNSC sold 137,000 tons (151,000 short dry tons) of acid grade. Sales of metallurgical grade totaled 45,000 tons (50,000 short dry tons). Under the proposed fiscal year 1998 Annual Materials Plan, the DNSC will attempt to sell 163,000 tons (180,000 short dry tons) of acid grade and 45,000 tons (50,000 short dry tons) of metallurgical grade.

Prepared by **M. Michael Miller, (703) 648-7716 [Fax: (703) 648-7722].**

FLUORSPAR

Stockpile Status—9-30-97[9]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Acid grade	254	191	217	163	137
Metallurgical grade	238	16	238	45	45

Events, Trends, and Issues: Two major fluorspar conferences were held during the year. The "International Fluorspar Conference 1997" was held in March in Vail, CO, and "Fluorspar 1997" was held in Shanghai, China, in October. Solvay S.A. acquired all the outstanding shares of Okorusu Holdings Ltd., owner of Namibian fluorspar mining company Okorusu Fluorspar (Pty) Ltd. Okorusu Fluorspar has the capacity to produce about 50,000 tons of acid-grade fluorspar, all of which will be allocated to Solvay's hydrofluoric acid plant at Bad Wimpfen, Germany.[10] Mexico's Cia. Minera Las Cuevas completed construction of a new grinding and screening plant for metallurgical-grade fluorspar production and began construction of its new fluorspar refinery to produce high-purity, low-arsenic acid-grade fluorspar. The refinery will utilize a combination pyrometallurgical and leaching process to produce premium-grade fluorspar product.[11] Representatives of more than 100 governments met in Montreal, Canada, to discuss changes to the phaseout schedule for chemicals that deplete the ozone layer. An accelerated phaseout of hydrochlorofluorcarbons was rejected, maintaining the current deadline of 2020 for developed countries and 2040 for developing countries.[12]

World Mine Production, Reserves, and Reserve Base:

	Mine production 1996	Mine production 1997[e]	Reserves[13 14]	Reserve base[13 14]
United States	8	—	—	6,000
Brazil	52	50	W	W
China	2,150	2,200	23,000	94,000
France	105	105	10,000	14,000
Kenya	80	80	2,000	3,000
Mexico	540	480	32,000	40,000
Morocco	100	100	W	W
South Africa	217	230	30,000	36,000
Spain	105	105	6,000	8,000
United Kingdom	60	60	2,000	3,000
Other countries	723	700	[15]113,000	[15]167,000
World total (rounded)	4,140	4,110	218,000	371,000

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.

[8]Free in the case of Canada, Mexico, and designated countries under the Generalized System of Preferences, Caribbean Basin Economic Recovery Act, U.S./Israel Free Trade Area, and the Andean Trade Preference Act.

[9]See Appendix C for definitions.

[10]Industrial Minerals, 1997, Solvay Buys Okorusu Fluorspar: Industrial Minerals, no. 359, p. 15.

[11]Gaytan, Jose, 1997, Las Cuevas: A Vision to the Future: Fluorspar 1997 Conference, Shanghai, China, 1997, 26 p.

[12]Chemical Week, 1997, Accelerated HCFC Phaseout is Rejected: Chemical Week, v. 159, no. 36, p. 16.

[13]See Appendix D for definitions.

[14]Measured as 100% calcium fluoride.

[15]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 1997. 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 $7.0 million. Gallium arsenide (GaAs) components represented about 95% of domestic gallium consumption. About 59% 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 40% 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:	1992	1993	1994	1996	1997[e]
Production, primary	—	—	—	—	—
Imports for consumption	15,600	16,900	18,100	30,000	19,000
Exports	NA	NA	NA	NA	NA
Consumption: Reported	11,300	15,500	16,900	21,900	19,000
Apparent	NA	NA	NA	NA	NA
Price, yearend, dollars per kilogram, 99.99999%-pure	425	400	395	425	425
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 (1993-96): France, 50%; Russia, 18%; Canada, 9%; Germany, 8%; and other, 15%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[2] 12/31/97
Gallium metal	8112.91.1000	3.3% ad val.	25.0% ad val.
Gallium arsenide wafers, undoped	2851.00.0010	2.8% ad val.	25.0% ad val.
Gallium arsenide wafers, doped	3818.00.0010	Free	25.0% ad val.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Prepared by **Deborah A. Kramer, (703) 648-7719 [Fax: (703) 648-7722].**

GALLIUM

Events, Trends, and Issues: Increased demand for GaAs led to decisions by several U.S. firms to increase GaAs production capacity. Construction on new GaAs facilities began in 1996 in Colorado, New Jersey, and Oregon. The New Jersey and Oregon plants were scheduled to be completed in 1997 and the Colorado plant by 1998. The new facilities will have the capability to process 4-inch-diameter wafers, and some of the facilities will be able to be upgraded to process 6-inch-diameter wafers. (The 4-inch wafers are beginning to replace the 3-inch wafers as the industry standard.) Gallium prices were high throughout 1997, with consumers in the United States and Japan reporting prices as high as $400 per kilogram for crude (99.99%-pure) gallium and $600 per kilogram for 99.99999%-pure material.

In May, the largest world gallium producer announced that it would close its 50,000-kilogram-per-year extraction plant in Pinjarra, Western Australia, as a result of a slower-than-expected increase in demand. The company planned to operate its refineries in France and Germany using stockpiled gallium as feed material.

Demand for gallium in Japan was estimated to be 88 metric tons in 1996, with 6% supplied by domestic production, 38% supplied by imports and 56% supplied by recycled material. France and the United States were the principal sources of imported gallium. The 1996 demand was a 23% decline from the 1995 level. Gallium demand is projected to be 100 tons in 1997 if the demand for compound semiconductors increases steadily.

Research continued on developing blue LED's and laser diodes. One U.S. firm began marketing commercial quantities of a blue indium gallium nitride LED. The primary market for the LED is in consumer applications such as stereo equipment and appliances.

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 1997, world primary production was estimated to be about 54,000 kilograms, with Australia and Russia as the largest producers. Countries with smaller output were China, Hungary, Japan, and Slovakia. Refined gallium production was estimated to be about 68,000 kilograms. France was the largest producer of refined gallium, using as feed material crude gallium produced in Australia. Germany and Japan 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.
[2]See Appendix B.

GARNET (INDUSTRIAL)[1]

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

Domestic Production and Use: Garnet for industrial use was mined in 1997 by six firms, three in New York, two in Montana, and one in Idaho. Output of crude garnet was valued at $8 million, while refined material sold or used was valued at $13 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:	1993	1994	1995	1996	1997[e]
Production (crude)	55,800	51,000	53,000	68,200	71,000
Sold by producers	44,000	51,000	46,100	58,500	68,000
Imports for consumption[e]	12,200	6,000	6,000	8,000	8,000
Exports[e]	11,400	10,000	8,500	13,000	13,000
Consumption, apparent	44,800	47,000	45,600	51,500	59,000
Price, range of value, dollars per ton[2]	100-2,000	100-2,000	85-1,500	50-2,000	50-2,000
Stocks, producer[e]	10,000	10,000	8,000	10,000	14,000
Employment, mine and mill, number	150	160	180	210	250
Net import reliance[3] as a percent of apparent consumption	2	E	E	E	E

Recycling: Relatively small amounts of garnet reportedly are recycled.

Import Sources (1993-96[e]): Australia, 85%; India, 10%; and China, 5%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Emery, natural corundum, natural garnet, and other natural abrasives, crude	2513.20.1000	Free	Free.
Emery, natural corundum, natural garnet, and other natural abrasives, other than crude	2513.20.9000	0.3¢/kg.	2.2¢/kg.
Natural abrasives on woven textile	6805.10.0000	1% ad val.	20% ad val.
Natural abrasives on paper or paperboard	6805.20.0000	1% ad val.	20% ad val.
Natural abrasives sheets, strips, disks, belts, sleeves, or similar form	6805.30.1000	1% ad val.	20% ad val.

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

Government Stockpile: None.

Prepared by **Ronald F. Balazik, (703) 648-7721 [Fax: (703) 648-7722].**

GARNET (INDUSTRIAL)

Events, Trends, and Issues: A new garnet company, the second in two years, began reporting production in Montana. Production capacity in the United States and abroad is expanding in response to anticipated increases in demand. Some forecasts indicate that global markets for industrial garnet may grow beyond 300,000 tons within 5 years. Markets for blasting media and water jet cutting are expected to lead demand. Additional capacity planned in the United States and worldwide would help to restrain price increases.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	1996	1997[e]		
United States	68,200	73,000	5,000,000	25,000,000
Australia	40,000	40,000	1,000,000	7,000,000
China	15,000	15,000	Moderate to Large	Moderate to Large
India	15,000	15,000	500,000	20,000,000
Other countries	17,000	17,000	6,500,000	20,000,000
World total (rounded)	155,000	160,000	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 a coproduct with 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.

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

[e]Estimated. E Net exporter.
[1]Excludes gem and synthetic garnet.
[2]Includes both crude and refined garnet. Most prices range from $160 to $350 per ton.
[3]Defined as imports - exports + adjustments for industry stock changes.
[4]See Appendix B.
[5]See Appendix D for definitions.

GEMSTONES[1]

(Data in million dollars, unless otherwise noted)

Domestic Production and Use: Domestic commercial gemstone production includes amber, agates, beryls, coral, freshwater shell, garnet, jade, jasper, mother-of-pearl, opal, quartz, sapphire, topaz, turquoise, and many other gem materials. Output of natural gemstones was primarily from Alabama, Arizona, Arkansas, Kentucky, North Carolina, Oregon, and Tennessee. Reported output of synthetic gemstones was from five firms in Arizona, California, Michigan, and New York. There was notable production of turquoise in Arizona; beryl in Maine; sapphire in Montana; opal in Nevada; ruby in North Carolina; and freshwater shell and pearl in Tennessee. Major uses were jewelry, carvings, and gem and mineral collections.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production:[2] Natural[3]	57.7	50.5	48.7	43.6	40.0
Synthetic	18.1	22.2	26.0	26.0	27.0
Imports for consumption	5,850	6,440	6,540	7,240	8,000
Exports, including reexports	1,630	2,240	2,520	2,660	2,700
Consumption, apparent	4,300	4,270	4,100	4,570	5,370
Price	Variable, depending on size, type, and quality				
Stocks, yearend[4]	NA	NA	NA	NA	NA
Employment, mine, number[e]	1,000	1,000	850	800	800
Net import reliance[5] as a percent of apparent consumption	98	98	98	98	99

Recycling: Insignificant.

Import Sources (1993-96 by value): Israel, 30%; Belgium, 22%; India, 21%; and other, 27%. Diamond imports were about 90% of the total value of gem imports.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[6] 12/31/97
Diamonds, unworked or sawn	7102.31.0000	Free	Free.
Diamond, ½ carat or less	7102.39.0010	Free	10% ad val.
Diamond, cut, more than ½ carat	7102.39.0050	Free	10% ad val.
Precious stones, unworked	7103.10.2000	Free	Free.
Precious stones, simply sawn	7103.10.4000	14.7% ad val.	50% ad val.
Rubies, cut	7103.91.0010	Free	10% ad val.
Sapphires, cut	7103.91.0020	Free	10% ad val.
Emeralds, cut	7103.91.0030	Free	10% ad val.
Other precious, cut but not set	7103.99.1000	0.8% ad val.	10% ad val.
Other precious stones, other	7103.99.5000	14.7% ad val.	50% ad val.
Imitation precious stones	7018.10.2000	1.1% ad val.	20% ad val.
Synthetic cut, but not set	7104.90.1000	1.2% ad val.	10% ad val.
Pearls, natural	7101.10.0000	Free	10% ad val.
Pearls, cultured	7101.21.0000	0.8% ad val.	10 % ad val.
Pearls, imitation not strung	7018.10.1000	5.6% ad val	60% ad val.

Depletion Allowance: 14% (Domestic), 14% (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 Department of Defense is currently disposing of some NDS materials that may be gem quality.

Prepared by **Ronald F. Balazik, (703) 648-7721 [Fax: (703) 648-7722].**

GEMSTONES

Events, Trends, and Issues: Progress toward full-scale operations continued at a new Colorado diamond mine, the first commercial diamond mining operation in North America in almost a century. In addition, Federal permits were granted for further evaluations of diamond-bearing deposits at a State park in Arkansas.

Demand for gemstones, including synthetics and simulants, may increase in the United States and other industrialized nations as personal disposable income rises. A survey conducted by a domestic jewelry retailers association indicates that (in decreasing order of preference) diamonds, emeralds, sapphires, and rubies were the favorite gemstone jewelry of U.S. consumers.

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

	Mine production	
	1996	1997[e]
United States	([9])	([9])
Angola	3,600	4,000
Australia	18,900	19,000
Botswana	11,000	11,000
Brazil	700	700
Central African Republic	350	400
China	230	250
Congo (Kinshasa)	3,000	3,000
Namibia	1,300	1,300
Russia	9,300	9,500
South Africa	5,400	5,500
Venezuela	230	250
Other countries	1,400	1,100
World total (may be rounded)	55,400	56,000

Reserves and reserve base[8]

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

World Resources: Most of the world gem diamond reserves are in southern Africa, 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 gemstones. Synthetic materials that have the same appearance and chemical and physical properties are substituted for natural gemstones. Simulants, materials with a similar appearance but with different chemical and physical properties, also are substituted for natural gemstones.

[e]Estimated. NA Not available.
[1]Excludes industrial diamond and garnet. See Diamond (Industrial) and Garnet (Industrial).
[2]Estimated minimum production.
[3]Includes production of freshwater shell.
[4]Stock data are not available and are assumed to be zero for apparent consumption and net import reliance calculation.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]See Appendix B.
[7]Data in thousands of carats of gem diamond.
[8]See Appendix D for definitions.
[9]Less than ½ unit.

GERMANIUM

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

Domestic Production and Use: The value of domestic refinery production of germanium, based on the 1997 producer price, was approximately $30 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 1997. 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 another in Alaska. Both of these 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, 40%; polymerization catalysts, 20%; infrared optics, 10%; electrical/solar applications, 20%; and other uses (phosphors, metallurgy, and chemotherapy), 10%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, refinery[e]	10,000	10,000	10,000	18,000	20,000
Total imports[1]	15,000	15,000	16,000	27,000	17,000
Exports	NA	NA	NA	NA	NA
Consumption[e]	29,000	25,000	27,000	25,000	30,000
Price, producer, yearend, dollars per kilogram:					
Zone refined	1,060	1,060	1,375	2,000	1,475
Dioxide, electronic grade	660	660	880	1,300	950
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant,[2] number[e]	100	100	110	120	115
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. As a result of the low unit use of germanium in microelectronic devices, little germanium returns as old scrap.

Import Sources (1993-96):[4] Russia, 30%; the United Kingdom, 16%; China, 15%; Belgium, 14%; and other, 25%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Germanium oxides	2825.60.0000	3.7% ad val.	25% ad val.
Waste and scrap	8112.30.3000	Free	Free.
Metal, unwrought	8112.30.6000	3.3% ad val.	25% ad val.
Other	8112.30.9000	5.1% ad val.	45% ad val.

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

Government Stockpile:

Stockpile Status—9-30-97[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Germanium	63,623	1,044	35,441	6,000	4,566

Prepared by **Robert D. Brown, Jr., (703) 648-4984 [Fax: (703) 648-7757].**

GERMANIUM

Events, Trends, and Issues: World demand for germanium remained higher than world production. The tight supply situation encouraged recycling and sales from stocks. As a result, germanium prices fell dramatically from the 1996 high, as sales from the Russian, Ukrainian, and U.S. national stockpiles began. Japan was reluctant to purchase, owing to the weakness of the yen and to current economic reverses. The fiber optic sector has grown slowly in Japan, as compared to its growth in other industrialized countries. But worldwide, fiber optics was expected to continue to be the main growth sector for germanium.

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

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[7]	Reserve base[7]
	1996	1997[e]		
United States	18,000	20,000	450,000	500,000
Other countries	35,000	43,000	NA	NA
World total	53,000	63,000	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 dusts resulting from burning 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 in some high-frequency and high-power applications and more economical as a substrate for some light-emitting diode applications. In infrared guidance systems, zinc selenide or germanium glass substitute for germanium metal but at the expense of performance.

[e]Estimated. NA Not available.
[1]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 44% of the 1993-96 imports.
[5]See Appendix B.
[6]See Appendix C for definitions.
[7]See Appendix D for definitions.

GOLD

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

Domestic Production and Use: Gold was produced by 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. Twenty-five mines yielded the majority of the gold produced in the United States. The value of 1997 mine production was about $3.4 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. Jewelry manufacturing was principally centered in the New York, NY, and Providence, RI, areas with added concentrations of these businesses occurring in California, Florida, and Texas.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Mine	331	327	317	318	325
Refinery: Primary	243	241	([2])	([2])	([2])
Secondary	152	148	([2])	([2])	([2])
Imports[3]	144	114	126	159	180
Exports[3]	726	395	347	471	550
Consumption, reported	91	76	([2])	([2])	([2])
Stocks, yearend, Treasury[4]	8,140	8,140	8,140	8,140	8,140
Price, dollars per ounce	361	385	386	389	325
Employment, mine and mill, number[e]	14,700	14,100	14,700	14,900	14,000
Net import reliance[6] as a percent of apparent consumption	E	E	E	E	E

Import Sources (1993-96):[3] Canada, 63%; Mexico, 7%; Brazil, 6%; Chile, 6%; and other, 18%.

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

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

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

Prepared by **Earle B. Amey, (703) 648-4969 [Fax: (703) 648-7757].**

GOLD

Events, Trends, and Issues: Domestic gold mine production in 1997 was estimated at slightly below the record levels of 1992 and 1993, 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 75% of the U.S. total. Between July 1996 and June 1997, 8 gold mines were closed, 10 new gold mines were opened, and 7 gold mines were expanded in the United States. At the same time, the average output per mine has increased, resulting in a trend to fewer but larger gold mining operations in the United States. Most of the larger companies are successfully replacing their annual production with new reserves, but smaller companies are finding this more difficult. Projections by an industry association indicate that worldwide gold exploration expenditures increased in 1997; however, the expenditures of U.S. gold producers fell in 1997 owing to the declining gold price.

During the first 9 months of the year, the Engelhard Industries/London daily price of gold ranged from a low of about $318 per troy ounce, in July, to nearly $368, in January. This price range was below $369, the low price reported for all of 1996. The price drop was possibly associated with several countries central banks selling off significant shares of their gold holdings and the weakening of the currency in Southeast and East Asian countries.

World Mine Production, Reserves, and Reserve Base:

	Mine production 1996	Mine production 1997[e]	Reserves[7]	Reserve base[7]
United States	318	325	5,600	6,000
Australia	289	290	4,000	4,700
Brazil	63	75	800	1,200
Canada	164	150	1,500	3,500
China[e]	145	125	NA	NA
Russia	120	135	3,000	3,500
South Africa	498	490	18,500	38,000
Uzbekistan	72	65	2,000	3,000
Other countries	580	650	9,300	11,800
World total (may be rounded)	2,250	2,300	[8]45,000	[8]72,000

Of an estimated 123,000 tons of gold mined from historical times through 1997, about 15% is thought to have been lost, used in dissipative industrial uses, or otherwise unrecoverable or unaccounted for. Of the remaining 105,000 tons, an estimated 34,000 tons is official stocks held by central banks and about 71,000 tons is privately held as coin, bullion, and jewelry.

World Resources: Total world resources of gold are estimated at 89,000 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 12% 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 sufficiently complete 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: 582.2 (1993), 216.6 (1994), 243.9 (1995), and 373.0 (1996), and 162.0 (1997 estimated).
[4]Publication discontinued after 1994 owing to insufficient response by industry to the voluntary survey for consumption data..
[5]Includes gold in Exchange Stabilization Fund. Stocks were valued at the official price of $42.22 per troy ounce.
[6]Defined as imports - exports + adjustments for Government and industry stock changes.
[7]See Appendix D 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 1997. Natural graphite was consumed by approximately 200 manufacturing firms, primarily in the Northeastern and Great Lakes regions. The major uses of natural graphite did not significantly vary from those of 1996. Refractory applications, once again, led the way in use categories with 25%; brake linings was a close second with 22%; lubricants, 5%; dressings and molds in foundry operations, 6%; and miscellaneous uses making up the remaining 42%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, mine	—	—	—	—	—
Imports for consumption	52	53	61	53	54
Exports	17	20	37	26	27
Consumption, apparent	35	33	24	27	28
Price, imports (average dollars per ton at foreign ports):					
Flake	612	629	658	699	716
Lump and chip (Sri Lankan)	789	709	610	675	692
Amorphous (Mexican)	127	138	143	134	137
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 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 insulation.

Import Sources (1993-96): Canada, 30%; Mexico, 28%; China, 20%; Madagascar, 7%; and other, 15%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[2] 12/31/97
Crystalline flake (not including flake dust)	2504.10.1000	Free	3.6¢/kg.
Other	2504.90.0000	Free	10% ad val.

Depletion Allowance: 22% (Domestic lump and amorphous), 14% (Domestic flake), 14% (Foreign).

Government Stockpile:

Stockpile Status—9-30-97[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Sri Lanka, amorphous lump	5	—	—	—	—
Madagascar, crystalline flake	14	14	14	2	2
Other than Sri Lanka and Madagascar crystalline	—	—	—	1	—

Prepared by **Rustu S. Kalyoncu, (703) 648-7720 [Fax: (703) 648-7722].**

GRAPHITE (NATURAL)

Events, Trends, and Issues: Graphite was near to supply-demand balance in 1996. 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 due to increased efficiency of the iron and steel producers. Applicators of natural graphite in lubrication applications are also decreasing due to changes in lubricant compositions and processing technologies.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	1996	1997[e]		
United States	—	—	—	1,000
Brazil	36	36	500	1,000
Canada	22	22	1,500	2,700
China	—	250	5,500	310,000
India	120	100	740	740
Madagascar	16	15	980	980
Mexico	36	40	3,100	3,100
Other countries	204	204	5,500	43,000
World total (may be rounded)	644	667	21,000	380,000

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 oxidative 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.

[3]See Appendix C for definitions.

[4]See Appendix D for definitions.

GYPSUM

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: In 1997, output of crude gypsum was 17 million tons valued at $120 million. Leading producer States were Oklahoma, Texas, Iowa, Michigan, Nevada, California, and Indiana, which together accounted for 73% of total output. Overall, 30 companies mined crude gypsum at 61 mines in 20 States, and 10 companies calcined gypsum at 67 plants in 28 States. More than two-thirds of domestic consumption, which totaled about 26 million tons, was accounted for by manufacturers of wallboard and plaster products. About 5 million tons for cement production, 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 26 billion square feet per year while sales were 23.5 billion square feet, representing a capacity utilization of 90%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Crude	15,800	17,200	16,600	17,500	17,000
Byproduct[1]	800	900	1,200	1,300	1,400
Calcined	15,200	16,700	16,700	18,800	18,000
Wallboard products (million square feet)	23,200	22,500	24,000	23,700	23,500
Imports, crude, including anhydrite	7,390	8,470	8,160	8,050	8,100
Exports, crude, not ground or calcined	69	89	79	136	200
Consumption, crude, apparent[2]	24,000	26,300	26,400	26,500	26,300
Price: Average crude, f.o.b. mine, dollars per ton	6.74	6.70	7.29	7.10	7.10
Average calcined, f.o.b. plant, dollars per ton	17.88	17.23	17.37	20.30	20.30
Stocks, producer, crude, yearend	2,320	2,600	2,100	2,300	2,300
Employment, mine and calcining plant, number[e]	6,700	6,700	6,500	6,300	6,000
Net import reliance[3] as a percent of apparent consumption	31	31	32	29	30

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

Import Sources (1993-96): Canada, 69%; Mexico, 23%; Spain, 5%; and other, 3%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Gypsum; anhydrite	2520.10.0000	Free	Free.

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

Government Stockpile: None.

Prepared by **Ronald F. Balazik, (703) 648-7721 [Fax: (703) 648-7722].**

GYPSUM

Events, Trends, and Issues: A small decline in residential construction during the year reduced demand in some markets. However, forecasts indicate that overall gypsum demand in North American markets will rise by about 2% annually for the next few years. This demand will be driven primarily by 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. Several large wallboard plants under construction and designed to use only byproduct gypsum will accelerate substitution they become operational.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	1996	1997[e]		
United States	17,500	17,000	700,000	Large
Australia	2,000	2,000		
Canada	8,330	8,300	450,000	Large
China	8,000	9,000		
Egypt	1,200	1,200		
France	5,000	5,000		
India	1,700	1,700		
Iran	8,300	8,300		
Italy	1,200	1,200	Reserves and reserve base are large in major producing countries, but data are not available.	
Japan	5,350	5,300		
Mexico	5,260	5,300		
Poland	1,100	1,100		
Spain	8,000	8,000		
Thailand	8,900	8,600		
United Kingdom	2,000	2,000		
Other countries	15,900	16,000		
World total (rounded)	99,700	100,000	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, midcontinent region, and California. Foreign resources are adequate, but are not evenly distributed.

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 in wallboard manufacturing, cement production, and agricultural applications.

[e]Estimated.
[1]Estimated byproduct used for wallboard.
[2]Defined as crude + byproduct + net import reliance.
[3]Defined as imports - exports + adjustments for industry stock changes.
[4]See Appendix B.
[5]See Appendix D for definitions.

HELIUM

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

Domestic Production and Use: During 1997, the estimated value of Grade-A (99.995% or better) helium extracted at the Bureau of Land Management's Exell Helium Plant was $11.9 million; the estimated value of Grade-A helium extracted by private industry was about $186.5 million. The total sales value for domestic consumption and exports was $198.4 million. Ten private industry plants and one Government facility purified helium: four of the privately owned plants were in Kansas, two in Texas, two in Colorado, and one each in Utah, Oklahoma, and Wyoming. Crude helium was extracted from natural gas by an additional 10 private industry plants, and this helium was either stored in the Government's crude helium pipeline system or purified by 1 of the purification plants. Six of these crude helium plants were in Kansas, one in Oklahoma, and three in Texas. The estimated 1997 domestic consumption of 69.5 million cubic meters (2.5 billion cubic feet) was used for cryogenic applications, 24%; for welding cover gas, 18%; for pressurizing and purging, 20%; for controlled atmospheres, 16%; leak detection, 6%; breathing mixtures, 3%; and other, 13%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Helium extracted from natural gas[2]	99.3	112.0	101.0	103	106
Withdrawn from storage[3]	(3.8)	(11.6)	(5.2)	(8.3)	(10.1)
Grade-A helium sales	95.6	100.4	96.1	94.7	98.0
Imports for consumption	—	—	—	—	—
Exports[4]	28.0	25.0	27.7	26.3	28.0
Consumption, apparent[4]	67.5	75.4	68.1	67.1	69.5
Employment, plant, number[e]	600	615	635	631	631
Net import reliance[5] as a percent of apparent consumption	E	E	E	E	E

Price: The price of Grade-A gaseous helium was $1.983 per cubic meter ($55 per thousand cubic feet) f.o.b. Helium Operations facilities in 1996. The Federal Government's price for bulk liquid helium was $2.524 per cubic meter measured as gas ($70 per thousand cubic feet), with additional charges for container services and rent. Private industry's price for gaseous helium was about $1.802 per cubic meter ($50 per thousand cubic feet), with some producers posting surcharges to this price.

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

Import Sources (1993-96): None.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[6] 12/31/97
Helium	2804.29.0010	3.7% ad val.	25.0% 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 86-777. During 1997, Helium Operations accepted over 37 million cubic meters (1,334 million cubic feet) of private helium for storage and redelivered nearly 21 million cubic meters (757 million cubic feet) for a net increase in privately owned storage of more than 16 million cubic meters (577 million cubic feet). As of September 30, 1997, 125 million cubic meters (4.5 billion cubic feet) was owned by private firms, which is the largest amount to date.

Stockpile Status—9-30-97[7]
(Billion cubic meters)

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Helium	839.8	—	839.2	—	—

Events, Trends, and Issues: Several events occurred during 1997. A crude helium plant in the northern Texas Panhandle resumed production in February 1997, and a crude plant in southeastern Kansas began production. The Bureau of Land Management's Helium Operations halted dewar sales of liquid helium in preparation for its mandated closure. The Helium Privatization Act of 1996 legislated an end to production and sale of refined helium by

Prepared by **Joseph B. Peterson,[8] (806) 324-2614 [Fax: (806) 324-2315].**

HELIUM

Helium Operations for Federal agencies' use by April 1998. Other parts of the Helium Program, such as operation of the helium storage system for both Government and private organizations and collection of helium royalties and fees, will continue.

It is estimated that in 1998 domestic production of helium will be over 101 million cubic meters (3.6 billion cubic feet) and that U.S. apparent consumption will be more than 72 million cubic meters (2.6 billion cubic feet). Exports from the United States are expected to decline because of planned production increases of an Algerian helium plant.

World Production, Reserves, and Reserve Base:

	Production		Reserves[9]	Reserve base[9]
	1996	1997[e]		
United States	103	106	8,200	[10]12,200
Algeria	3.8	5.3	NA	2,100
Canada	NA	NA	NA	2,100
China	NA	NA	NA	1,100
Netherlands	NA	NA	NA	720
Poland	1.4	1.4	NA	830
Former Soviet Union[11]	4.2	4.2	4.2	9,200
Other countries	NA	NA	NA	2,100
World total (rounded)	111	112	NA	31,000

World Resources: The identified helium resources of the United States were estimated to be about 12.2 billion cubic meters (440 billion cubic feet) as of January 1, 1996. This includes 1.0 billion cubic meters (35 billion cubic feet) of helium stored in the Cliffside Field, 6.0 billion cubic meters (216 billion cubic feet) of helium in helium-rich natural gas (0.30% helium or more), and 5.2 billion cubic meters (188 billion cubic feet) in helium-lean natural gas (less than 0.30% helium). The Hugoton and Riley Ridge Fields are currently depleting gasfields and contain an estimated 4.2 billion cubic meters (151 billion cubic feet) of helium. Riley Ridge contains 3.2 billion cubic meters (116 billion cubic feet) of helium of which 1.9 billion cubic meters (68 billion cubic feet) is included in the depleting classification because this gas is now being produced. Future supplies will probably come from known helium-rich natural gas with little fuel value and from helium-lean resources. The identified helium-lean resources of 5.2 billion cubic meters (188 billion cubic feet) include 1.2 billion cubic meters (44 billion cubic feet) of measured and 4.0 billion cubic meters (144 billion cubic feet) of indicated helium resources. No resource studies have been performed since this report was last published; estimated production was subtracted from previous resource values where applicable.

Helium resources of the world exclusive of the United States were estimated to be 18.0 billion cubic meters (650 billion cubic feet). The locations and volumes of the principal deposits, in billion cubic meters, are the Former Soviet Union, 9.2; Algeria, 2.1; Canada, 2.1; China, 1.1; Poland, 0.8; and the Netherlands, 0.7. As of January 1, 1997, Helium Operations 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.

[7]See Appendix C for definitions.

[8]The author is an industrial engineer with the Bureau of Land Management, Helium Operations, in Amarillo, TX.

[9]See Appendix D for definitions.

[10]All domestic measured and indicated helium resources in the United States.

[11]As constituted before Dec. 1991.

ILMENITE[1]

(Data in thousand metric tons of contained TiO_2, unless otherwise noted)

Domestic Production and Use: Two firms produced ilmenite concentrate 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 ilmenite production data was withheld to avoid revealing company proprietary data. Based on average prices, the value of U.S. ilmenite and titanium slag consumption in 1997 was about $280 million. Major coproducts of mining from heavy-mineral deposits are rutile and zircon. About 99% of the ilmenite and slag was consumed by five titanium pigment producers. The remainder was used in welding rod coatings and for manufacturing alloys, carbides, and chemicals.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production	W	W	W	W	W
Imports for consumption[2]	564	584	586	641	601
Exports[e]	7	9	15	7	11
Consumption, reported[2]	889	W	1,010	1,010	1,060
Price, dollars per metric ton:					
Ilmenite:					
Bulk, 54% TiO_2, f.o.b. Australian ports	63	77	83	87	83
Slag:[e]					
80% TiO_2, f.o.b. Sorel, Quebec	276	278	244	292	294
85% TiO_2, f.o.b. Richards Bay, South Africa	330	334	349	353	390
Stocks, mine, distributor and consumer, yearend[2]	218	208	137	267	200
Employment, mine and mill,[3] number	395	400	400	400	400
Net import reliance[4] as a percent of apparent consumption	W	W	W	W	W

Recycling: None.

Import Sources (1993-96): South Africa, 56%; Australia, 28%; Canada, 6%; and other, 10%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Ilmenite and ilmenite sand	2614.00.6020	Free	Free.
Titanium slag	2620.90.5000	Free	Free.

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

Government Stockpile: None.

Prepared by **Joseph M. Gambogi, (703) 648-7718 [Fax: (703) 648-7722].**

ILMENITE

Events, Trends, and Issues: The United States relies heavily on imports of ilmenite and titanium slag to satisfy most of its domestic needs. Based on increased production of titanium pigment, domestic consumption of ilmenite and titanium slag concentrates was estimated to have increased 5% compared with 1996. However, owing to an increased reliance on existing inventories, imports of Ilmenite and titanium slag decreased an estimated 6% compared with 1996. Based on export data for all forms of titanium concentrates, exports of ilmenite concentrates were expected to increase significantly compared with 1996.

In Australia, a major mining operation was commissioned at Beenup, Western Australia. Ilmenite from Beenup was used to produce a chloride-grade slag at an existing titanium slag operation in Tyssedal, Norway. In the past, the Tyssedal operation used ilmenite from the Tellnes, Norway, mine to produce a sulfate-grade slag. At full production, the Tyssedal operation was expected to produce up to 200,000 tons of chloride-grade slag. The titanium slag producer in Sorel, Quebec, commissioned a project to upgrade its sulfate-grade slag to chloride-grade slag. Initial capacity of the upgrade plant was reported to be 200,000 tons per year. In the United States, a mining operation was commissioned at the Old Hickory deposit near Richmond, VA. Initial capacity was expected to be up to 100,000 tons per year of ilmenite (59% to 60% TiO_2), 3,500 tons per year of a higher grade feedstock (85% TiO_2), and 30,000 tons per year of zircon.

Exploration and development of titanium mineral deposits continued in 1997. These activities were most evident in Australia, Canada, India, Indonesia, Kenya, Mozambique, Russia, South Africa, Ukraine, the United States, and Vietnam. Producers continued efforts to develop higher grade concentrates.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1996	1997[e]		
United States	W	W	8,000	59,000
Australia	1,150	1,190	33,000	88,000
Brazil	58	55	18,000	18,000
Canada (slag)	760	720	31,000	36,000
China	83	83	30,000	41,000
Egypt	—	—	—	1,700
Finland	—	—	1,400	1,400
India	162	162	30,000	38,000
Italy	—	—	—	2,200
Madagascar	—	—	—	19,000
Malaysia	135	138	—	1,000
Norway (ilmenite and slag)	338	225	40,000	40,000
South Africa (slag)	842	850	63,000	63,000
Sri Lanka	33	16	13,000	13,000
Ukraine	53	53	5,900	13,000
Other countries	5	5	1,000	1,000
World total (rounded)	[7]3,620	[7]3,500	270,000	440,000

World Resources: Ilmenite supplies about 90% of the world's demand for titaniferous material. World ilmenite resources total about 1 billion tons of titanium dioxide. Major resources occur in Australia, Canada, China, India, New Zealand, Norway, South Africa, Ukraine, and the United States.

Substitutes: Rutile and synthetic rutile were extensively used to produce titanium dioxide pigment.

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]See also Rutile and Titanium and Titanium Dioxide.
[2]Includes titanium slag from Canada, Norway, and South Africa and leucoxene from Australia.
[3]Includes operating employees shown under Rutile, subject to the same footnoted comments.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix B.
[6]See Appendix D for definitions.
[7]Excludes U.S. production.

INDIUM

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: No indium was recovered from ores in the United States in 1997. Domestically produced 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 1997. Several firms produced high-purity indium shapes, alloys, and compounds. Thin-film coatings, which are used in applications such as liquid crystal displays 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 1997 was about the same as in 1996: coatings, 45%; solders and alloys, 35%; electrical components and semiconductors, 15%; and research and other, 5%. The estimated value of primary metal consumed in 1997, based on the annual average price, was $15.4 million.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, refinery	—	—	—	—	—
Imports for consumption	73.4	70.2	85.2	33.2	80
Exports	NA	NA	NA	NA	NA
Consumption[e]	35.0	40.0	43.0	45.0	50
Price, annual average, dollars per kilogram (99.97% indium)	200	138	375	370	309
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, has become significant.

Import Sources (1993-96): Canada, 40%; Russia, 13%; France, 10%; Italy, 8%; and other, 29%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[2] 12/31/97
Unwrought, waste and scrap	8112.91.3000	Free	25% ad. val.

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

Government Stockpile:

Stockpile Status—9-30-97[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Indium	0.44	—	—	1.09	1.12

Prepared by **Robert D. Brown, Jr., (703) 648-4984 [Fax: (703) 648-7757].**

INDIUM

Events, Trends, and Issues: Estimated domestic indium consumption increased to about 50 tons in 1997. The indium market appeared to be more stable in 1997 than it was in 1995 and 1996. In 1995, prices rose steadily over concerns about supply, while demand remained strong. In 1996, significant quantities of indium were recycled, the result of high prices and large supplies of indium-tin-oxide manufacturing scrap and spent sputtering targets. This brought about a steady decrease in prices and significantly lower U.S. imports. In 1997, there were at least three major fluctuations in price, in which the market activities of Japan as a buyer, and China as a seller were significant factors. The domestic price started the year at $210 per kilogram, rose to about $325 per kilogram by May, then fell to $285 per kilogram by July. The price finally rose to $303 per kilogram in mid-September, at which level it remained through the rest of the year. The long range outlook for the indium market remains promising.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production[e]		Reserves[4]	Reserve base[4]
	1996	1997		
United States	—	—	300	600
Belgium	15	12	([5])	([5])
Canada	15	50	700	2,000
China	45	45	400	1,000
France	45	45	([5])	([5])
Italy	12	12	([5])	([5])
Japan	40	40	100	150
Peru	4	4	100	150
Russia	20	20	200	300
Other countries	4	4	800	1,500
World total (may be rounded)	200	230	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 anyway. 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.
[3]See Appendix C for definitions
[4]Estimate based on the indium content of zinc ores. See Appendix D for definitions.
[5]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 1997 from companies operating in Oklahoma accounted for 100% of the elemental iodine value estimated at $24 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 production, and reopened a world class plant that was closed in 1993 because of low market prices for iodine. A third company continued production at Vici, OK, for domestic use and export to Germany. Of the consumers that participate in the annual survey, 28 plants reported consumption of iodine in 1996. Major consumers were located in the East. Prices of crude iodine in drums, published for October, ranged between $16 and $17 per kilogram. Imports of iodine through October averaged $13.50 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 uses.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production	1,940	1,630	1,220	1,270	1,330
Imports for consumption, crude content	3,620	4,360	3,950	4,810	5,000
Exports	1,220	1,200	1,220	2,380	2,400
Shipments from Government stockpile excesses	0.045	218	133	—	204
Consumption:					
Apparent	4,330	4,780	3,540	3,700	3,700
Reported	3,550	3,690	3,680	3,910	NA
Price, average c.i.f. value, dollars per kilogram, crude	7.98	8.02	10.32	12.90	14.60
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, number	50	35	35	40	40
Net import reliance[1] as a percent of apparent consumption	56	66	90	66	65

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

Import Sources (1993-96): Japan, 53%; Chile, 46%; and other, 1%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[2] 12/31/97
Iodine, crude	2801.20.0000	Free	Free.
Iodide, calcium or of copper	2827.60.1000	Free	25% ad val.
Iodide, potassium	2827.60.2000	2.8% ad val.	7.5% ad val.
Iodides and iodide oxides, other	2827.60.5000	4.2% ad val.	25% ad val.

Depletion Allowance: 5% on brine wells (Domestic and Foreign); 14% on solid minerals (Domestic), 14% (Foreign).

Government Stockpile:

Stockpile Status—9-30-97[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Stockpile-grade	2,124	204	2,124	—	204

Prepared by **Phyllis A. Lyday, (703) 648-7713 [Fax: (703) 648-7722].**

IODINE

Events, Trends, and Issues: Chile was the largest producer of iodine in the world. A company announced it would develop the Aguas Blancas project in Region II, northern Chile, for the production of iodine, sodium sulfate, and potassium nitrate in 1999. In September, the company received approval of an environmental impact statement (EIS). The EIS approval is necessary for the completion of other permitting. The proven and probable reserves are 29.5 million tons averaging 683 parts per million of iodine. The largest iodine company in Chile announced the construction of a 1,500-ton-per-year plant in Region I, the northern most region of the country. Production from all the company's plants was expected to reach 8,000 tons per year by 1997. A Canadian company announced the completion of a plant in July in Northern Chile. The company began to process solutions from solar ponds. The nitrate plant processed raw salts from the solar ponds.

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 U.S. operation, which closed in 1992 because of low market prices for iodine, resumed production. Strong demand for crude iodine coupled with price increases made iodine production from this site profitable.

Methyl iodide was tested by the University of California at Riverside and was found to be an effective fumigant for controlling four species of fungi, one species of nematode, and seven species of weeds. Based on the results of 15 laboratory and field trials, methyl iodide was more effective than methyl bromide as a fumigant. Methyl bromide has an ozone depletion potential (ODP) of 0.65 and is scheduled to be phased out of production, importation, and use as an agricultural chemical in the United States by 2001. Under the Montreal protocol, it will be phased out in the rest of the world by 2010. Methyl iodide has an ODP of less than 0.016 and appears to be a replacement for methyl bromide in most uses. Methyl iodide is about five times more expensive, but could utilize the same equipment as methyl bromide.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	1996	1997[e]		
United States	1,270	1,330	550,000	550,000
Azerbaijan	300	300	171,000	NA
Chile	5,000	5,600	900,000	1,200,000
China	500	500	400,000	400,000
Indonesia	80	80	100,000	100,000
Japan	5,500	5,500	4,000,000	7,000,000
Russia	150	150	NA	NA
Turkmenistan	260	260	172,000	NA
World total (rounded)	13,100	13,700	[5]6,300,000	NA

World Resources: In addition to the fields listed in the reserve base, seawater contains 0.05 parts 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.
[3]See Appendix C.
[4]See Appendix D for definitions.
[5]Sum excludes countries for which data are not available.

IRON ORE[1]

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

Domestic Production and Use: Value of usable ore shipped from mines in Minnesota, Michigan, and six other States in 1997 was estimated at $1.7 billion. Iron ore was produced by 14 companies operating 14 mines, 10 concentration plants, and 10 pelletizing plants. The mines included 13 open pits and 1 underground operation. Virtually all ore was concentrated before shipment. Nine mines operated by five companies accounted for 98.7% of production.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, usable	55.7	58.4	62.5	62.1	62.0
Shipments	56.3	57.6	61.1	62.2	60.0
Imports for consumption	14.1	17.5	17.3	18.4	18.0
Exports	5.1	5.0	5.3	6.3	5.0
Consumption: Reported (ore and total agglomerate)[3]	76.8	80.2	83.1	79.3	78.0
Apparent	66.2	70.9	72.4	72.0	73.7
Price,[4] U.S. dollars per metric ton	24.65	24.49	28.36	30.76	30.41
Stocks, mine, dock, and consuming plant, yearend, excluding byproduct ore	21.3	21.3	23.5	25.7	27.0
Employment, mine, concentrating and pelletizing plant, quarterly average, number	7,800	7,200	7,400	7,400	7,500
Net import reliance[5] as a percent of apparent consumption (iron in ore)	14	18	14	14	15

Recycling: Insignificant.

Import Sources (1993-96): Canada, 54%; Brazil, 25%; Venezuela, 16%; Australia, 3%; and other, 2%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[6] 12/31/97
Concentrates	2601.11.0030	Free	Free.
Coarse ores	2601.11.0060	Free	Free.
Fine ores	2601.11.0090	Free	Free.
Pellets	2601.12.0030	Free	Free.
Briquettes	2601.12.0060	Free	Free.
Sinter	2601.12.0090	Free	Free.

Depletion Allowance:[7] 15.0% (Domestic), 14.0% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: Domestic iron ore production, consumption, and trade were about the same as in 1996. The U.S. steel industry was undergoing structural changes potentially negative to the iron ore sector. 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 benefit 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). Five projects were under consideration that, if completed, would increase U.S. DRI capacity from 0.5 to considerably more than 4 million metric tons per year. International prices are negotiated between seller and buyer on an annual basis.

Although iron ore is produced in more than 50 countries, 5 of them account for more than two-thirds of the total. The United States ranked sixth in world production, but only accounted for 6% of the total. Most ore was consumed domestically. Virtually all exports consisted of pellets shipped via the Great Lakes to Canadian steel companies that are partners in U.S. taconite projects in Michigan and Minnesota. The United States continued to be a net importer of iron ore.

Prepared by **William S. Kirk, (703) 648-4962 [Fax: (703) 648-7757].**

IRON ORE

World pig iron production levels have remained nearly flat since 1990, with 1997 production virtually the same as in 1990. During this period China, Europe, the Former Soviet Union (FSU),[8] Japan, and North America have accounted for 82% of the world's pig iron production. In Europe, Japan, and North America, pig iron production has remained virtually constant. Production fell considerably in the FSU and rose dramatically in China. Production has also increased substantially in other parts of Asia, particularly India, the Republic of Korea, and Taiwan. This trend is expected to continue.

The increase in consumption in Asia is primarily expected to benefit Australia. Australia and Brazil each accounted for about 30% of the world total of exports in 1997, while the next largest exporter accounted for less than 10% of the world total. Of the two, Australia appears to be better positioned to take advantage of growth of iron ore consumption in Asia because of Australia's proximity to Asian markets and the consequent lower freight rates.

World Mine Production, Reserves, and Reserve Base:[9]

	Mine production		Crude ore		Iron content	
	1996	1997[e]	Reserves	Reserve base	Reserves	Reserve base
United States	62	62	16,000	25,000	3,800	6,000
Australia	147	150	18,000	32,200	11,300	20,100
Brazil	180	190	11,000	17,000	6,500	10,000
Canada	36	38	12,000	26,000	4,600	10,000
China[e]	250	260	25,000	49,700	7,500	14,900
India	67	70	5,400	12,000	3,300	6,300
Kazakstan	13	15	7,600	9,300	2,800	3,500
Liberia	—	—	900	1,600	500	800
Mauritania	11	12	400	700	200	300
Russia	70	70	34,300	42,000	12,700	15,600
South Africa	31	30	4,000	9,300	2,500	5,900
Sweden	20	20	3,000	4,600	1,600	2,400
Ukraine	48	45	21,800	27,000	8,000	10,000
Other countries	86	70	7,400	16,000	2,300	6,300
World total (may be rounded)	1,020	1,030	167,000	272,000	68,000	112,000

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 up to 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 based on price of eastern Canadian ore.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]See Appendix B.
[7]Analagous 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.
[8]As constituted before Dec. 1991.
[9]See Appendix D 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 $75 billion. The steel industry consisted of 92 companies that produced raw steel at 126 locations, with combined raw steel production capability of 122 million tons. Indiana accounted for about 23% of total raw steel production, followed by Ohio, 14%, and Pennsylvania, 8%. Pig iron was produced by 14 companies operating integrated steel mills, with about 40 blast furnaces in continuous operation. Integrated companies accounted for about 62% of total steel production, including output of their electric arc furnaces. The distribution of steel shipments was estimated as follows: warehouses and steel service centers, 21%; transportation (predominantly for automotive production), 14%; construction, 13%; cans and containers, 4%; and others, 48%. Ferrous foundries, numbering about 1,100, continued to be importers of pig iron into the United States, mainly from Brazil and Russia.

Salient Statistics—United States:[1]	1993	1994	1995	1996	1997[e]
Pig iron production[2]	48.2	49.4	50.9	49.4	53.8
Steel production:	88.8	91.2	95.2	95.5	96.7
Basic oxygen furnaces, percent	60.6	60.7	59.6	57.4	60.1
Electric arc furnaces, percent	39.4	39.3	40.4	42.6	46.6
Continuously cast steel, percent	85.7	89.5	91.0	93.2	94.5
Shipments:					
Steel mill products	80.8	86.3	88.4	91.5	95.0
Steel castings[3]	1.4	1.0	1.1	1.2	1.3
Iron castings[3]	11.9	13.2	9.8	9.7	9.6
Imports of steel mill products	17.7	27.3	22.1	26.5	29.2
Exports of steel mill products	3.6	3.5	6.4	4.6	5.2
Apparent steel consumption[4]	92.0	104	108	108	113
Producer price index for steel mill products (1982=100)[5]	108.2	113.4	120.1	115.7	116.8
Steel mill product stocks at service centers, yearend[6]	5.7	6.6	5.9	7.0	7.1
Total employment, average,[7] number					
Blast furnaces and steel mills	175,000	172,000	171,000	168,000	169,000
Iron and steel foundries	119,000	125,000	130,000	129,000	128,000
Net import reliance[8] as a percent of apparent consumption	15	22	21	20	21

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

Import Sources (1993-96): European Union, 30%; Canada, 18%; Japan, 10%; Brazil, 8%; and other, 34%.

Tariff:[9] Item	Number	Most favored nation (MFN)[10] 12/31/97	Canada 12/31/97	Mexico 12/31/97	Non-MFN[11] 12/31/97
Pig iron	7201.10.0000	Free	Free	Free	$1.11/t.
Carbon steel:					
Semifinished	7207.12.0050	2.9%	0.4%	2.5%	20%.
Structural shapes	7216.33.0090	0.6%	Free	0.5%	2%.
Bars, hot-rolled	7213.20.0000	1.3%	0.1%	1.1%	5.5%.
Sheets, hot-rolled	7208.39.0030	3.4%	0.4%	2.9%	20%.
Hot-rolled, pickled	7208.27.0060	3.6%	0.5%	3.0%	0.4¢/kg+20%.
Cold-rolled	7209.18.2550	2.2%	0.3%	1.9%	20%.
Galvanized	7210.49.0090	4.6%	0.6%	3.9%	21.5%.
Stainless steel:					
Semifinished	7218.91.0015	3.6%	0.5%	3.1%	29%.
	7218.99.0015	3.6%	0.5%	3.1%	29%.
Bars, cold-finished	7222.20.0075	7.4%	1.0%	6.3%	29%.
Pipe and tube	7304.41.3045	[12]5.3%	[12]0.7%	Free	36%.
Cold-rolled sheets	7219.33.0035	7.1%	1.0%	6.0%	29%.

Prepared by **Michael Fenton, (703) 648-4972 [Fax: (703) 648-7757].**

IRON AND STEEL

Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: Pig iron production decreased slightly during 1997 as steel production and shipments continued to increase. Output was curbed by strikes, equipment failures, and delays of new capacity startups. The basic oxygen process used in integrated mills continued to decline in importance relative to the use of electric arc furnaces and continuous casting in minimills. Imports of steel products continued to increase significantly, exceeding those of 1994, and competed with increased domestic steelmaking capacity coming on line during 1997. Export activity increased relative to that of 1996, but was below the record 1995 level.

Integrated mills and minimills continued to increase usage of direct reduction and direct ironmaking technologies. The increasing burdens of environmental regulations and escalating capital costs associated with construction of blast furnaces and coke ovens and rising costs of low-residual scrap have created a strong demand for direct-reduced iron and iron made by direct smelting reduction processes. Nevertheless, capital expenditures on blast furnaces and cold-rolling and galvanizing facilities by integrated steelmakers was an estimated $2.1 billion in 1997, an increase of 24% over that of 1996. Capital expenditures in minimills declined to about $1.3 billion, 44% less than that of 1996.

World Production:

	Pig iron		Raw steel	
	1996	1997[e]	1996	1997[e]
United States	49.4	49.3	94.7	96.0
Brazil	25.1	24.6	25.7	26.2
China	105	113	100	106
European Union	91.8	96.6	147	157
Japan	74.6	78.6	98.8	105
Korea, Republic of	23.0	22.4	38.9	41.4
Russia	36.1	36.9	49.2	48.6
Ukraine	18.1	20.7	22.3	24.9
Other countries	138.9	93.9	181	168
World total (rounded)	562	536	758	773

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.
[11]See Appendix B.
[12]No tariff for use in civil aircraft.

IRON AND STEEL SCRAP[1]

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

Domestic Production and Use: Total value of 1997 domestic purchases (receipts of ferrous scrap by all domestic consumers from brokers, dealers, and other outside sources) and exports was estimated at $8 billion, about the same as in 1996. Manufacturers of pig iron, raw steel, and steel castings accounted for about three-fourths of scrap consumption by the domestic steel industry, using scrap together with pig 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 remainder 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.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Home scrap	22	20	20	20	21
Purchased scrap[2]	54	58	59	57	57
Imports for consumption[3]	1.6	1.9	2.3	2.9	3
Exports[3]	10.0	9.0	10.5	9.1	9
Consumption: Reported	68	70	72	72	70
Price, average, dollars per metric ton delivered:					
No. 1 Heavy Melting composite price, Iron Age Average: Pittsburgh, Philadephia, Chicago	109.98	124.58	131.29	126.02	124
Stocks, consumer, yearend	3.7	4.1	4.2	5.2	4.6
Employment, dealers, brokers, processors,[4] number	37,000	37,000	37,000	37,000	38,000
Net import reliance[5] as a percent of apparent consumption	E	E	E	E	E

Recycling: All iron and steel scrap is recycled material that is a vital raw material for the production of new steel and cast iron products. The steel and foundry industries in the United States have been structured to recycle scrap, and, as a result, are highly dependent upon scrap. The steel industry in North America has been recycling steel scrap for over 200 years. About 16,000 car dismantlers and 2,000 scrap processors are currently operating. In the United States alone, nearly 70 million tons of steel apparently was recycled in steel mills and foundries in 1997. 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 30% home scrap (new recirculating scrap from current operations), 24% prompt scrap (produced in steel-product manufacturing plants), and 46% obsolete (old) scrap.

Import Sources (1993-96): Canada, 77%; Venezuela, 8%; Mexico, 6%; Japan, 3%; and other, 6%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[6] 12/31/97
Iron and steel waste and scrap:			
No. 1 bundles	7204.41.0020	Free	74¢/t.
No. 1 Heavy Melting	7204.49.0020	Free	74¢/t.
No. 2 Heavy Melting	7204.49.0040	Free	74¢/t.
Shredded	7204.49.0070	Free	74¢/t.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Prepared by **Michael Fenton, (703) 648-4972 [Fax: (703) 648-7757].**

IRON AND STEEL SCRAP

Events, Trends, and Issues: Raw steel production in 1997 was an estimated 96.5 million tons, only slightly more than that produced in 1996. Net shipments of steel mill products were estimated at about 95 million tons compared with 96.5 million tons for 1996.

The domestic ferrous castings industry shipped an estimated 10 million tons of all types of iron castings in 1997 and an estimated 1.2 million tons of steel castings, including investment castings.

Scrap prices in the United States continued at fairly high levels throughout 1997 as a result of strong demand, but were slightly lower than 1996 prices. 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 $124 per metric ton.

As reported by Iron Age Scrap Price Bulletin, the average price for nickel-bearing stainless steel scrap delivered to purchasers in Pittsburgh was about $820 per metric ton in 1997, significantly higher than the 1996 average price of $712 per metric ton.

Total exports of ferrous scrap decreased to about 8.9 million metric tons, having an estimated value of about $1.3 billion, down from the 1996 figure of 9.1 million tons.

The problem of accidental meltings of radioactive sources contained in ferrous scrap, primarily lost or discarded shielded radioactive gauges, continues to be the concern of steelmakers. In the United States, 128 steelmaking mills use ferrous scrap in electric arc and basic oxygen furnaces, and most, if not all, perform radiation monitoring of incoming ferrous scrap. Hundreds of accidental meltings have been prevented because radioactive materials were discovered before they were melted. Over the period 1994 to June 30, 1997, 24 radioactive materials were detected and 4 were not detected and melted. During the period 1983 to June 30, 1997, 18 meltings of radioactive material occurred. The costs associated with melting a radioactive source, including decontaminating a facility, disposing and storing radioactive electric furnace dust, and shutdown of steel production, can be as high as $23 million per melt. The Nuclear Regulatory Commission (NRC)-State Working Group on Regulation of Radioactive Materials submitted recommendations to the NRC concerning the control of and accountability for licensed radioactive devices in November 1996. Subsequently, the NRC directed its staff to develop a plan to, among other things, quantify the risks associated with unaccounted for devices. The staff proposed a survey of steel mills in order to assess the risk of licensed radioactive materials entering the metal scrap stream.

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal is a global environmental treaty, sponsored by the United Nations Environmental Program and in force since 1992, that regulates the transboundary movements of hazardous wastes and ensures the environmentally sound management and disposal of hazardous wastes. The Technical Working Group (TWG), a subsidiary body of the Conference of the Parties of the Basel Convention, was formed in 1995 to prepare a list of specific wastes characterized as hazardous under the Basel Convention. Hazardous material may not be shipped to developing countries for recycling, and any such material destined for final disposal is banned from international trade. The U.S. ferrous scrap industry is concerned because unless ferrous scrap is excluded from the list of hazardous materials, businesses active in the export of scrap will be adversely affected. The TWG will present the result of its work at the Fourth Meeting of the Conference of the Parties to be held in February 1998 in Kuching, Sarawak.

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

World Resources: Not applicable.

Substitutes: About 1.6 million tons of direct-reduced iron was used in the United States in 1997 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.
[6]See Appendix B.

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 1997, approximately 21.4 million tons of iron and steel slags, valued at about $147 million[1] (f.o.b), were consumed. Of this, iron or blast furnace slag accounted for approximately 65% of the tonnage and was worth about $118 million. Steel slags, produced from open hearth, basic oxygen, and electric arc furnaces, accounted for the remainder. There were 16 slag-processing companies, of which 3 processed only iron slag, 5 processed only steel slag, and the remainder did both. Slag processing facilities spread over almost 100 locations Nationwide: iron slags at 25 sites in 13 States and steel slags at 82 sites in 29 States. The North Central region (Illinois, Indiana, Michigan, Ohio) accounted for 60% of total sales of slag of domestic origin. Iron and steel slags were used mainly in construction projects. The major uses for iron slag were for road bases, 43%; asphaltic concrete aggregate and other concrete applications, 40%; and fill, 11%. Steel slags were mainly used for road bases, 40%; fill, 20%; and asphaltic concrete aggregate, 16%. Approximately 90% of iron and steel slag shipments were by truck, generally to within a 65-kilometer (approximately 40-mile) radius of the plant, and rail and waterway transport each accounted for about 5% of shipments. Rail and waterway shipments included destinations farther afield.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, marketed[2]	19,000	20,100	21,000	20,500	21,000
Imports for consumption	162	199	280	346	350
Exports	4	4	4	3	3
Consumption, apparent	19,200	20,300	21,300	20,800	21,400
Price average value, dollars per ton, f.o.b. plant	6.65	6.99	6.89	6.90	7.00
Stocks, yearend	NA	NA	NA	NA	NA
Employment, number[e]	3,000	2,500	2,500	2,500	2,500
Net import reliance[3] as a percent of reported consumption	1	1	1	1	1

Recycling: No longer regarded as waste or minimally useful byproducts of iron- and steelmaking, ferrous slags today are viewed as valuable coproducts of ferrous smelting 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 utilized internally—being recycled to the furnaces as ferrous and flux feed. Entrained metal, particularly in steel slag, routinely is recovered during slag processing for return to the furnaces. However, data for such furnace feed uses are unavailable.

Import Sources (1993-96): NA. 1996 only: Canada, 47%; South Africa, 25%; and other, 28%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Granulated slag	2618.00.0000	Free	10% ad val.
Basic slag	3103.20.0000	Free	Free.
Slag, dross, scalings, from manufacture of iron and steel	2619.00.3000	17.7¢/ton	73.8¢/ton.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Prepared by **Rustu S. Kalyoncu (703) 648-7720 [Fax: (703) 648-7722].**

IRON AND STEEL SLAG

Events, Trends, and Issues: Sales of iron and steel slags are increasing slowly but are significantly affected by, to a large degree, the price and availability of natural aggregates—slag's main competitor in the construction sector. Although data are lacking, there appears to be growing demand in the U.S. concrete industry for granulated blast furnace slag as a pozzolan or cement extender (in blended cements); such use is common overseas. The long-term availability of iron slag likely will decline as remaining blast furnaces are decommissioned. 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 general chemical inertness, the industry has thus far succeeded at keeping slag exempted from such regulation.

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 recent 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 the predominant aggregate substitutes in the construction sector. Certain rock types, as well as silica fume and fly ash, are pozzolan substitutes in blended cements.

[e]Estimated. NA Not available,

[1]The reported value of slag 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]Data for actual production of marketable slag are unavailable. Output may be estimated as equivalent to 25% to 30% of crude (pig) iron production and 10% to 15% of crude steel output.

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

[4]See Appendix B.

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. Two companies produced synthetic mullite at one operation each; one was in Georgia and the other in Kentucky. 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:	1993	1994	1995	1996	1997[e]
Production: Mine	W	W	W	W	W
Synthetic mullite	W	W	W	W	W
Imports for consumption (andalusite)	12	8	3	11	8
Exports[e]	33	35	35	35	35
Shipments from Government stockpile excesses	—	—	—	—	1
Consumption, apparent	W	W	W	W	W
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	W	W	W	W	W

Price: U.S. kyanite, 54% to 60% Al_2O_3, 35-325 Tyler mesh, 18-ton lots, explant, raw, $140 to $168 per ton; calcined, $248 to $276 per ton. Andalusite, Transvaal, South Africa, 57.5% Al_2O_3, 2,000 ton bulk, f.o.b., $180 to $200; 59.5% Al_2O_3, 2,000 ton bulk, f.o.b., $220 to $240.

Recycling: Insignificant.

Import Sources (1993-96): South Africa, 97%; and other, 3%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[2] 12/31/97
Andalusite, kyanite, and sillimanite	2508.50.0000	Free	Free.
Mullite	2508.60.0000	2% ad val.	30% ad val.

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

Government Stockpile:

Stockpile Status—9-30-97[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Kyanite, lump	0.1	—	0.1	1.1	1.0

Prepared by **Michael J. Potter, (703) 648-7723 [Fax: (703) 648-7722].**

KYANITE AND RELATED MATERIALS

Events, Trends, and Issues: Kyanite, andalusite, sillimanite, mullite, synthetic mullite, and other alumina-containing materials are used in low, medium and high-alumina refractories. These provide a wide range of versatile brick and monolithic products. High alumina bricks and monolithics are growing in demand for most high temperature applications, according to a nongovernment source.

The steel industry has been the largest user of refractories in general. However, other industries, such as glass, non-ferrous metals, petrochemicals, incineration, and others, are also consumers of refractories. In all of these consuming industries, changes are being made in operation, lining design, refractory selection, etc., which has resulted in reduced refractory consumption. There is a trend toward higher quality, longer life and higher value refractories, according to another nongovernment source.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[4]
	1996	1997[e]	
United States	W	W	Large in the United States and South Africa; may be large in other countries.
France	45	50	
India	17	15	
South Africa[5]	210	210	
Other countries	8	5	
World total[6]	280	280	

World Resources: Immense 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. 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.
[3]See Appendix C for definitions.
[4]See Appendix D for definitions.
[5]Production is mostly andalusite.
[6]Excludes the United States and countries for which information is not available.

LEAD

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

Domestic Production and Use: The value of recoverable mined lead in 1997, based on the average U.S. producer price, was $440 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 30 plants that produced secondary lead, 17 had annual capacities of 10,000 tons or more and accounted for more than 95% of secondary production. Lead was consumed at about 170 manufacturing plants. The transportation industries were the principal users of lead, consuming 71% of it for batteries, fuel tanks, solder, seals, and bearings. Electrical, electronic, and communications uses (including batteries), ammunition, television glass, construction (including radiation shielding), and protective coatings accounted for approximately 23% of consumption. The balance was used in ballast and weights, ceramics and crystal glass, tubes and containers, type metal, foil, wire, and specialized chemicals.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Mine, lead in concentrates	362	370	394	436	450
Primary refinery:					
From domestic ore	310	328	374	326	340
From imported materials[1]	25	23	W	W	W
Secondary refinery, old scrap	838	877	963	1,060	1,100
Imports for consumption, lead in concentrates	1	1	3	7	10
Exports, lead in concentrates	42	39	66	60	30
Imports for consumption, refined metal, wrought and unwrought	202	237	271	278	260
Exports, refined metal, wrought and unwrought	59	54	57	61	60
Shipments from Government stockpile excesses, metal	19	65	34	39	25
Consumption: Reported	1,290	1,450	1,560	1,530	1,600
Apparent	1,340	1,490	1,570	1,660	1,660
Price, average, cents per pound: U.S.	31.7	37.2	42.3	48.8	47
London	18.4	24.8	28.6	35.1	29
Stocks, metal, producers, consumers, yearend	95	78	94	80	75
Employment: Mine and mill (peak), number	1,500	1,300	1,200	1,200	1,200
Primary smelter, refineries	600	600	600	500	450
Secondary smelters, refineries	1,800	1,800	1,800	1,800	1,800
Net import reliance[2] as a percent of apparent consumption	15	19	17	16	14

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 990,000 tons (equivalent to 62% of domestic lead consumption) was recovered from used batteries alone.

Import Sources (1993-96): Lead in concentrates: Mexico, 49%; Canada, 45%; Peru, 1%; and other, 5%. Metal, wrought and unwrought: Canada, 69%; Mexico, 20%; Peru, 9%; Australia, 1%; and other, 1%. Total lead content: Canada, 69%; Mexico, 19%; Peru, 9%; Australia, 1%; and other, 2%.

Tariff: Item	Number	Most favored nation (MFN)[3] 12/31/97	Non-MFN[4] 12/31/97
Unwrought (refined)	7801.10.0000	2.9% ad val.	10.0% ad val.

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

Government Stockpile:

Stockpile Status—9-30-97[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Lead	360	13	360	54	31

Prepared by **Gerald R. Smith, (703) 648-4983 [Fax: (703) 648-7757].**

LEAD

Events, Trends, and Issues: During 1997, the price for lead decreased in the U.S. and world markets. The average North American Producer and London Metal Exchange prices for the first 9 months of the year were about 4% and 16%, respectively, below the averages for the previous year, as stocks of refined lead in industrialized countries steadily increased to a level near that existing at the beginning of 1996. U.S. mine production rose by about 3% and primary refinery production increased by about 4% as refineries adjusted to the permanent closure of one refinery in mid-1996. Secondary refinery production continued to increase, rising by 3% over that of 1996. U.S. apparent consumption of lead remained near the level of the previous year owing to the continued demand for both original equipment and replacement lead-acid batteries in the automotive industry. In addition, demand for industrial-type batteries, particularly in the telecommunications and computer sectors, remained strong.

Settlement of a dispute between mining companies and aboriginal Native Title claimants cleared the way for development of a large zinc-lead deposit in Australia, said to be capable of coming into production by yearend 2000 and augmenting world mine production by about 2%.

In China, production of lead and zinc was projected to decline by as much as 40% by the year 2000. Factors cited as contributing to this expected decline were the significant depletion of reserves at several of China's large, and relatively old, state-owned mines and the decreasing investment in these mines. China reportedly hoped to reverse the trend toward lower mine production by encouraging foreign investment in the mining sector. Under China's new Mineral Resource Act, which became effective at the beginning of the year, foreign companies were permitted to own equity interests in Chinese projects. Previously, foreign companies were permitted to own only other types of financial interests.

In March, the U.S. Centers for Disease Control reported results from Phase II of the third National Health and Nutrition Examination Survey (NHANES III), conducted during the period 1991 through 1994, showing a continued decline in blood lead levels in the U.S. population. Despite this decline, however, the results of NHANES III, Phase II also showed that the risk for lead exposure remained disproportionately high for some groups, including children who are poor, black non-Hispanic, Mexican American, living in large metropolitan areas, or living in older housing.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1996	1997[e]		
United States	436	450	7,000	18,000
Australia	522	530	18,000	32,000
Canada	241	190	4,000	13,000
China	500	450	6,000	10,000
Kazakstan	40	40	2,000	2,000
Mexico	174	170	1,000	2,000
Morocco	72	70	500	1,000
Peru	249	250	2,000	3,000
South Africa	89	90	2,000	3,000
Sweden	100	100	500	1,000
Other countries	497	550	22,000	34,000
World total (may be rounded)	2,920	2,900	65,000	120,000

World Resources: In recent years, significant lead resources have been demonstrated in association with zinc and/or silver or copper in Alaska, Australia, Canada, China, India, Mexico, Pakistan, and South Africa. 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. W Withheld to avoid disclosing company proprietary data; Included with "From domestic ore."
[1]Included in imports for calculating net import reliance (see footnote 2).
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]No tariff for Mexico and 0.3% ad val. for Canada.
[4]See Appendix B.
[5]See Appendix C for definitions.
[6]See Appendix D for definitions.

LIME[1]

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

Domestic Production and Use: In 1997, lime producers at 115 plants in 34 States sold or used 19.3 million tons (21.3 million short tons) of lime valued at about $1.13 billion, an increase of about 200,000 tons (220,000 short tons) and a decrease of about $10 million from 1996 levels. Ten companies, operating 35 plants, accounted for 68% of the total output. Principal producing States, each with production over 1 million tons, were Alabama, Kentucky, Missouri, Ohio, Pennsylvania, and Texas. These six States produced about 10.9 million tons (9.89 million short tons) or 56% of the total output.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production[3]	16,700	17,400	18,500	19,100	19,300
Imports for consumption	201	204	289	262	230
Exports	69	74	72	50	58
Consumption, apparent[4]	16,900	17,500	18,700	19,300	19,500
Quicklime average value, dollars per ton at plant	55.02	56.43	56.77	56.68	55.40
Hydrate average value, dollars per ton at plant	67.84	67.71	72.09	79.64	73.80
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and plant, number	5,500	5,500	5,500	5,600	5,700
Net import reliance[5] as a percent of apparent consumption	—	—	—	1	1

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

Import Sources (1993-96): Canada, 91%; and Mexico, 9%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[6] 12/31/97
Quicklime	2522.10.0000	Free	0.2¢/kg.[7]
Slaked lime	2522.20.0000	Free	0.3¢/kg.[7]
Hydraulic lime	2522.30.0000	Free	0.2¢/kg.[7]

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

Government Stockpile: None.

Prepared by **M. Michael Miller, (703) 648-7716 [Fax: (703) 648-7722].**

LIME

Events, Trends, and Issues: The lime industry continued to add new capacity in 1997. New lime plants were constructed in Alabama and Ohio, and capacity was added at existing plants in Alabama, Kentucky, and Ohio. Subtracting capacity lost with the closure of one small plant in Pennsylvania and the shut down of old kilns being replaced by new kilns, the net capacity increase was about 960,000 tons (1,060,000 short tons). After several years of large capacity increases the pace of construction activity appears to be slowing, although there are still a few new plants or kilns scheduled for start up in the 1998-99 time frame.

International discussions on reducing greenhouse gas emissions are being monitored very closely by the lime industry. Lime production produces carbon dioxide from the combustion of fuels (primarily coal) to fire the kilns and as a result of the calcination process, which dissociates calcium carbonate into calcium oxide (lime) and carbon dioxide. Any program regulating carbon dioxide emissions would have a direct impact on the lime industry.

World Lime Production and Limestone Reserves and Reserve Base:

	Production		Reserves and reserve base[8]
	1996	1997[e]	
United States	19,100	19,300	Adequate for all countries listed.
Belgium	1,800	1,800	
Brazil	5,700	5,700	
Canada	2,500	2,500	
China	20,000	22,000	
France	3,000	3,000	
Germany	8,000	8,000	
Italy[9]	3,500	3,500	
Japan (quicklime only)	7,670	7,700	
Mexico	6,600	6,600	
Poland	2,500	2,500	
Romania	1,700	1,700	
South Africa (sales)	1,691	1,700	
United Kingdom	2,500	2,500	
Other countries	35,000	35,000	
World total (rounded)	121,000	124,000	

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 to 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.

[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]See Appendix B.
[7]Rates include weight of the container.
[8]See Appendix D for definitions.
[9]Includes hydraulic lime.

LITHIUM

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

Domestic Production and Use: For the first time in history, Chile surpassed the United States as the largest producer of lithium in the world. The U.S. 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:	1993	1994	1995	1996	1997[e]
Production	W	W	W	W	W
Imports for consumption	810	851	1,140	884	1,100
Exports	1,700	1,700	1,900	2,200	2,300
Consumption: Apparent	W	W	W	W	W
Estimated[1]	2,300	2,500	2,600	2,700	2,700
Price, yearend, dollars per kilogram:					
Lithium carbonate	4.21	4.41	4.34	4.34	4.34
Lithium hydroxide, monohydrate	5.71	5.62	5.62	5.51	5.51
Stocks, producer, yearend	W	W	W	W	W
Employment, mine and mill, number[e]	230	230	230	230	230
Net import reliance[2] as a percent of apparent consumption	E	E	E	E	E

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

Import Sources (1993-96): Chile, 97%; and other, 3%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Other alkali metals	2805.19.0000	5.9% ad val.	25% ad val.
Lithium oxide and hydroxide	2825.20.0000	3.7% ad val.	25% ad val.
Lithium carbonate:			
U.S.P. grade	2836.91.0010	3.7% ad val.	25% ad val.
Other	2836.91.0050	3.7% ad val.	25% ad val.

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

Government Stockpile: None.

Prepared by **Joyce A. Ober, (703) 648-7717 [Fax: (703) 648-7722].**

LITHIUM

Events, Trends, and Issues: A second lithium brine operation in Chile completed its first full year of operation, with higher production of lithium carbonate for the year than was initially expected. Chile should continue as the world's leading lithium producer for the foreseeable future. A brine operation in Argentina was under development by one of the U.S. companies; it experienced some technical problems delaying the initial production at that site. Production began in the third quarter of 1997, and shipments were expected to commence by yearend. As the Argentine operation approaches full production, expected by the end of 1998, the company's spodumene mine in North Carolina will close to take advantage of the significantly lower production cost of lithium carbonate from brine. With this mine closure, lithium carbonate production from hard rock ores in the United States will end. Nearly all the lithium minerals mined in the world will then be used as ore concentrates rather than feedstock for lithium carbonate and other lithium compounds.

The increased production from Chile created an oversupply situation resulting in significantly lower prices for lithium carbonate, although official price listings do not reflect that trend. Reprocessed lithium salts from battery recycling and lithium hydroxide monohydrate from former Department of Energy stocks also were available at discounted prices, causing further downward pressure on lithium 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. A new lithium carbonate plant in Australia was temporarily closed, owing to technical problems and low prices.

Interest in lithium batteries for electric vehicles (EV's) continued to grow and research was ongoing. Lithium batteries could power the majority of future EV's, but the precise battery type and the timetable for implementation was still in question.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	1996	1997[e]		
United States	W	W	340,000	410,000
Argentina[e]	8	30	NA	NA
Australia[e]	3,700	2,000	150,000	160,000
Bolivia	—	—	—	5,400,000
Brazil	32	30	910	NA
Canada	690	690	180,000	360,000
Chile	2,700	4,500	3,000,000	3,000,000
China	2,800	2,500	NA	NA
Namibia[e]	48	50	NA	NA
Portugal	160	160	NA	NA
Russia[e 5]	800	800	NA	NA
Zimbabwe	500	500	23,000	27,000
World total (may be rounded)	[6]11,000	[6]11,000	[7]3,700,000	[8]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]Based primarily on monitoring at the concentrate stage and assuming a 15% lithium loss during conversion of concentrate into chemicals.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B.
[4]See Appendix D for definitions.
[5]These estimates denote only an approximate order of magnitude; no basis for more exact estimates is available. Output by Russia has never been reported.
[6]Excludes U.S. production.
[7]Excludes Argentina, China, Namibia, Portugal, and Russia.
[8]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 74% of U.S. magnesium compounds production. Magnesium oxide and other compounds were recovered from seawater by four companies in California, Delaware, Florida, and Texas; 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 64% 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:	1993	1994	1995	1996	1997[e]
Production	386	345	360	389	400
Imports for consumption	256	287	328	240	250
Exports	52	46	54	66	55
Consumption, apparent	590	586	634	563	595
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant, number[e]	650	650	600	600	600
Net import reliance[2] as a percent of apparent consumption	35	41	43	31	33

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

Import Sources (1993-96): China, 70%; Canada, 9%; Austria, 4%; Greece, 3%; and other, 14%.

Tariff:[3] Item	Number	Most favored nation (MFN) 12/31/97	Canada 12/31/97	Non-MFN[4] 12/31/97
Crude magnesite	2519.10.0000	Free	Free	$10.33/ton.
Dead-burned and fused magnesia	2519.90.1000	0.2¢/kg	Free	1.7¢/kg.
Caustic-calcined magnesia	2519.90.2000	83¢/ton	Free	$20.70/ton.

Depletion Allowance: Brucite, 10% (Domestic and Foreign); dolomite and magnesium carbonate, 14% (Domestic and Foreign); magnesium chloride, 5% (Domestic and Foreign); and olivine, 22% (Domestic) and 14% (Foreign).

Government Stockpile: None.

Prepared by **Deborah A. Kramer, (703) 648-7719 [Fax: (703) 648-7722].**

MAGNESIUM COMPOUNDS

Events, Trends, and Issues: The export licensing system instituted in China in 1994 has had a significant continuing effect on the U.S. market. Imports of magnesia from China have decreased in 1996 and 1997, while the average Customs value has increased significantly—from $79 per ton in 1994 to $156 per ton in 1996. This increase in value is a result of the licensing fees being passed on to the customers and the exporting of higher grade magnesia to U.S. markets.

In North America, water treatment applications for magnesia continue to grow. Some companies have shifted from traditional neutralization reagents such as caustic soda and lime to magnesium hydroxide for water treatment applications. Magnesium hydroxide, although more costly than the traditional reagents has several advantages including reduced sludge generation, removal of more dissolved heavy metals from the wastewater stream, and magnesium hydroxide's buffering ability.

Around the world, several countries completed new magnesia production plants. In India, a 50,000-ton-per-year seawater magnesia plant was commissioned in May. This is India's first magnesia plant to use seawater as a raw material, and most of the plant's production was targeted for domestic consumption. In Turkey, a $3 million crude magnesite processing plant, with an annual capacity of 120,000 tons, was completed in the beginning of the year. This plant will feed one firm's magnesite calcining plants and will serve as a central facility for processing crude magnesite from all of the company's mines.

World Mine Production, Reserves, and Reserve Base:

	Magnesite production		Magnesite reserves and reserve base[5]	
	1996	1997[e]	Reserves	Reserve base
United States	W	W	10,000	15,000
Australia	84	90	NA	NA
Austria	202	200	15,000	20,000
Brazil	92	90	45,000	65,000
China[e]	288	290	750,000	1,000,000
Greece	144	130	30,000	30,000
India	97	100	30,000	45,000
Korea, North[e]	461	460	450,000	750,000
Russia[e]	173	170	650,000	730,000
Serbia and Montenegro	22	20	5,000	10,000
Slovakia[e]	288	290	20,000	30,000
Spain	115	120	10,000	30,000
Turkey	576	580	65,000	160,000
Other countries	101	100	420,000	480,000
World total (may be rounded)	[6]2,640	[6]2,640	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 B.
[5]See Appendix D for definitions.
[6]Excludes the United States.

MAGNESIUM METAL[1]

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Three companies in Texas, Utah, and Washington produced primary magnesium in 1997 valued at approximately $378 million. An electrolytic process was used at plants in Texas and Utah to recover magnesium from seawater and lake brines, respectively. A thermic process was used to recover magnesium from dolomite in Washington. The aluminum industry remained the largest consumer of magnesium, accounting for 51% 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 24% of U.S. consumption of primary metal; desulfurization of iron and steel, 13%; cathodic protection, 5%; reducing agent in nonferrous metals production, 2%; and other uses, 5%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Primary	132	128	142	133	120
Secondary	59	62	65	71	70
Imports for consumption	37	29	35	47	59
Exports	39	45	38	41	40
Consumption: Reported, primary	101	112	109	102	105
Apparent	148	149	171	162	166
Price, yearend:					
Metals Week, U.S. spot Western, dollars per pound, average	1.46	1.63	2.09	1.75	1.65
Metal Bulletin, free market, dollars per metric ton, average	2,260	3,125	4,138	2,525	2,700
Stocks, producer and consumer, yearend	26	19	21	26	23
Employment, number[e]	1,400	1,400	1,400	1,400	1,400
Net import reliance[2] as a percent of apparent consumption	E	E	E	E	10

Recycling: In 1997, about 30,000 tons of the secondary production was recovered from old scrap.

Import Sources (1993-96): Canada, 44%; Russia, 35%; China, 4%; Mexico, 4%; and other, 13%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Canada 12/31/97	Mexico 12/31/97	Non-MFN[3] 12/31/97
Unwrought metal	8104.11.0000	8.0% ad val.	0.8% ad val.	Free	100% ad val.
Unwrought alloys	8104.19.0000	6.5% ad val.	0.6% ad val.	1.3% ad val.	60.5% ad val.
Wrought metal	8104.90.0000	14.8¢/kg on Mg content + 3.5% ad val.	1.4¢/kg on Mg content + 0.3% ad val.	Free	88¢/kg on Mg content + 20.0% ad val.

Depletion Allowance: Dolomite, 14% (Domestic and Foreign); magnesium chloride, 5% (Domestic and Foreign).

Government Stockpile: None.

Events, Trends, and Issues: Quoted magnesium prices continued the decline begun in 1996 through June 1997 and then began to increase slowly to reach about $2,600 per ton by the end of October. Price fluctuations, however, were not as wide as they have been in the past 2 years.

The International Trade Administration (ITA) continued to review duties on the largest Canadian magnesium producer. The following countervailing duties on pure and alloy magnesium were finalized: 9.86% ad valorem for the period December 6, 1991, to December 31, 1992; 7.34% ad valorem for the 1993 calendar year; 4.48% ad valorem for the 1994 calendar year; and 3.18% ad valorem for the 1995 calendar year. In the final results of an administrative review of antidumping duties assessed on magnesium imports from Canada, the ITA determined that the duty rate for the company was 0% for the period August 1, 1995, through July 31, 1996.

Automotive industry analysts estimated that the average unit content of magnesium diecastings in North American-built cars and light trucks will increase by 0.3 kilogram per vehicle from the 1997 model year to the 1998 model year. This increase represents an increase of 4,500 tons in total usage. The total magnesium content of each vehicle would average about 3 kilograms. U.S. auto manufacturers continued to incorporate magnesium into many of their new vehicles. Some of the new magnesium components include valve covers, transfer cases, and instrument support beams.

Prepared by **Deborah A. Kramer, (703) 648-7719 [Fax: (703) 648-7722].**

MAGNESIUM METAL

As a result of the continued interest in magnesium for automotive applications, one of the U.S. auto manufacturers entered into a partnership with the potential Australian magnesium producer. Under terms of an agreement, the automaker will invest $30 million in a pilot-plant study and will gain a long-term contract for the eventual supply of 45,000 tons per year of magnesium. The Australian firm was scheduled to commission a demonstration plant in early 1998. Commercial plant construction is expected to begin in mid-1999, with start-up by late 2002.

In Canada, work continued on construction of a new magnesium recovery facility and expansion of a second. The largest producer announced that it would double the annual capacity of its Becancour primary magnesium plant to 86,000 tons. Construction of the first phase of 25,000-tons-per-year capacity is scheduled to begin in 1998, with completion expected in 2000. The company also planned to increase its alloy production capacity by 15,000 tons per year. In March, the first magnesium ingot was cast at a new pilot plant in Salaberry-de-Valleyfield, Quebec. This was the first magnesium recovered from the nontraditional source of serpentine residues from asbestos mining. Construction of a commercial plant is scheduled to begin in April 1998, and annual production capacity at the facility will be 58,000 tons when it is fully operational.

By the end of April, 11 of 60 electrolytic cells at the new primary magnesium plant in Sdom, Israel, were operating. By December, the plant was expected to be operating at 80% of its 27,500-ton-per-year capacity; total 1997 production was estimated at 10,000 tons. In Kazakstan, the sole magnesium producer planned to resume magnesium production by the end of 1997. The company planned to complete construction of a carnallite processing facility by the third quarter and start magnesium production at a level of 5,000 to 10,000 tons per year in the fourth quarter. The magnesium plant has been idle since 1994. Two Canada-based firms announced plans to produce magnesium in Congo (Brazzaville) by 2002. The companies acquired two exploration permits in the Kouili region for areas that contain substantial quantities of magnesium and potassium salts, mainly in the form of carnallite. Carnallite reserves are estimated to be 8 billion tons, containing about 8% magnesium. Initial plans call for a 100,000-ton-per-year magnesium plant to be built near the mine, with a first-phase production capacity of 50,000 tons per year. A feasibility study was expected to be commissioned by the end of 1998, and a search for additional financing would begin after the study's completion. China announced plans to increase annual capacity from 7,000 tons to 10,000 tons by early 1999 at its largest magnesium plant. Investment for the upgrade was estimated to be $12 million. A 3,000-ton-per-year expansion at the same plant began operating in July 1997.

World Primary Production, Reserves, and Reserve Base:

	Primary production	
	1996	1997[e]
United States	133	120
Brazil	9	9
Canada	54	55
China[e]	50	50
France	14	14
Israel	—	10
Kazakstan[e]	—	1
Norway	30	30
Russia[e]	35	35
Serbia and Montenegro	3	2
Ukraine[e]	13	10
World total	341	336

Reserves and reserve base[4]

Domestic magnesium metal production is derived from natural brines and dolomite, and the reserves and reserve base for this metal are sufficient to supply current and future requirements. To a limited degree, the existing natural brines may be considered 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.
[1]See also Magnesium Compounds.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B.
[4]See Appendix D for definitions.

MANGANESE

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

Domestic Production and Use: Manganese ore containing 35% or more manganese was not produced domestically in 1997. 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. Leading identifiable end uses of manganese were construction, machinery, and transportation, which were estimated to be 23%, 14%, and 11%, 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 $420 million.

Salient Statistics—United States:[1]	1993	1994	1995	1996	1997[e]
Production, mine[2]	—	—	—	—	—
Imports for consumption:					
Manganese ore	232	331	394	478	380
Ferromanganese	347	336	374	350	310
Silicomanganese[3]	316	273	305	323	275
Exports:					
Manganese ore	16	15	15	32	54
Ferromanganese	18	11	11	10	9
Shipments from Government stockpile excesses:[4]					
Manganese ore	254	134	115	128	123
Ferromanganese	(1)	9	18	(2)	38
Consumption, reported:[5]					
Manganese ore[6]	389	449	486	478	485
Ferromanganese	341	347	348	315	330
Consumption, apparent, manganese[7]	696	694	676	776	715
Price, average value, 46% to 48% Mn metallurgical ore, dollars per mtu cont. Mn, c.i.f. U.S. ports	2.60	2.40	2.40	2.55	2.44
Stocks, producer and consumer, yearend:					
Manganese ore[6]	302	269	309	319	200
Ferromanganese	30	36	33	27	17
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 (1993-96): Manganese ore: Gabon, 58%; Australia, 18%; Mexico, 11%; South Africa, 7%; and other, 6%. Ferromanganese: South Africa, 38%; France, 26%; Brazil, 10%; Australia, 8%; and other, 18%. Manganese contained in all manganese imports: South Africa, 28%; Gabon, 16%; Australia, 13%; France, 12%; and other, 31%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[9] 12/31/97
Ore and concentrate	2602.00.0040/60	Free	2.2¢/kg of contained Mn.
Manganese dioxide	2820.10.0000	4.7% ad val.	25% ad val.
High-carbon ferromanganese	7202.11.5000	1.5% ad val.	10.5% ad val.
Silicomanganese	7202.30.0000	3.9% ad val.	23% ad val.
Metal, unwrought	8111.00.4500	14% ad val.	20% ad val.

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

Government Stockpile: In addition to the data tabulated, the stockpile contained additional uncommitted inventories of nonstockpile-grade materials, as follows, in tons: natural battery ore, 16,800; chemical ore, 81; and metallurgical ore, 427,000.

Prepared by **Thomas S. Jones, (703) 648-4973 [Fax: (703) 648-7757].**

MANGANESE

Stockpile Status—9-30-97[10]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Battery: Natural ore	108	0.2	108	—	7
Synthetic dioxide	3	—	3	—	—
Chemical ore	148	—	148	—	2
Metallurgical ore	782	35	530	—	106
Ferromanganese:					
High-carbon	940	9	695	—	27
Medium-carbon	13	5	—	—	5
Silicomanganese	—	0.005	—	—	0.2
Electrolytic metal	9	0.5	9	—	1

Events, Trends, and Issues: Although raw steel production, a major determinant of manganese demand, was trending up slightly in the United States and firmly on a global basis, prices decreased to lower levels for manganese ore and the principal manganese ferroalloys. Impending production of refined manganese ferroalloys by joint ventures between Japanese and South African companies foreshadowed strong competition in that sector of the manganese industry. 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:

	Mine production 1996	Mine production 1997[e]	Reserves[11]	Reserve base[11]
United States	—	—	—	—
Australia	1,020	1,000	30,000	80,000
Brazil	[e]858	860	21,000	56,000
China	[e]1,200	1,200	40,000	100,000
Gabon	[e]923	930	45,000	150,000
Georgia	[e]29	30	7,000	49,000
India	[e]659	630	24,000	36,000
Mexico	[e]173	175	4,000	9,000
South Africa	[e]1,380	1,320	370,000	4,000,000
Ukraine	[e]1,020	930	135,000	520,000
Other countries	[e]466	450	Small	Small
World total (rounded)	[e]7,730	7,500	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]For silicomanganese, imports more nearly represent amount consumed than does reported consumption; internal evaluation indicates that reported consumption of silicomanganese is considerably understated.

[4]Net quantity including effect of stockpile upgrading program. 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, 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.

[10]See Appendix C for definitions.

[11]Thousand metric tons, manganese content. See Appendix D for definitions.

MANUFACTURED ABRASIVES

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

Domestic Production and Use: Fused aluminum oxide was produced by four companies at nine plants in the United States and Canada. Production of regular-grade fused aluminum oxide was valued at about $35 million and production of high-purity fused aluminum oxide was valued at about $8 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 $35 million. Bonded and coated abrasive products account for most abrasive uses of fused aluminum oxide and silicon carbide.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, United States and Canada (crude):					
Fused aluminum oxide, regular	132,000	133,000	126,000	127,000	100,000
Fused aluminum oxide, high-purity	21,300	29,200	20,100	17,000	14,000
Silicon carbide	74,900	84,700	75,400	73,600	72,000
Imports for consumption:					
Fused aluminum oxide	158,000	145,000	213,000	131,000	115,000
Silicon carbide	115,000	110,000	172,000	182,000	226,000
Exports:					
Fused aluminum oxide	11,000	13,000	11,000	11,900	12,000
Silicon carbide	17,000	16,000	20,000	14,200	20,000
Consumption: Apparent					
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	362	361	358	353	371
Fused aluminum oxide, high-purity	621	557	468	576	572
Silicon carbide	540	531	495	490	490
Stocks, producer	NA	NA	NA	NA	NA
Employment, mine and mill, number	NA	NA	NA	160	160
Net import reliance[1] as a percent of apparent consumption	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 (1993-96): Fused aluminum oxide crude: Canada, 54%; Australia, 30%; and other, 16%. Fused aluminum oxide grain: China, 39%; Canada, 24%; Austria, 20%; and other, 17%. Silicon carbide crude: China, 65%; Canada, 27%; and other, 8%. Silicon carbide grain: Norway, 38%; Brazil, 29%; Canada, 7%; and other, 26%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[2] 12/31/97
Fused aluminum oxide, crude	2818.10.1000	Free	Free.
Fused aluminum oxide, grain	2818.10.2000	1.3% ad val.	4.1% ad val.
Silicon carbide, crude	2849.20.1000	Free	Free.
Silicon carbide, grain	2849.20.2000	0.5% ad val.	1.6% ad val.

Depletion Allowance: None.

Government Stockpile:

Stockpile Status—9-30-97[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Fused aluminum oxide, crude	142,318	—	142,318	27,273	27,273
Fused aluminum oxide, grain	25,840	—	25,840	54,555	4,435
Silicon carbide, crude	12,469	4,092	12,469	8,182	8,455

Prepared by **Ronald F. Balazik, (703) 648-7721 [Fax: (703) 648-7722].**

MANUFACTURED ABRASIVES

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, may persist and further curtail production in North America.

World Production Capacity:

	Fused aluminum oxide capacity		Silicon carbide capacity	
	1996	1997[e]	1996	1997[e]
United States and Canada	220,000	220,000	90,000	90,000
Argentina	—	—	5,000	5,000
Australia	75,000	50,000	—	—
Austria	60,000	60,000	—	—
Brazil	100,000	100,000	43,000	43,000
China	450,000	500,000	450,000	450,000
France	45,000	45,000	16,000	16,000
Germany	150,000	150,000	36,000	36,000
India	20,000	20,000	5,000	5,000
Japan	55,000	55,000	90,000	90,000
Mexico	—	—	60,000	60,000
Norway	—	—	80,000	80,000
Venezuela	—	—	40,000	40,000
Other countries	125,000	100,000	185,000	185,000
World total (rounded)	1,300,000	1,300,000	1,100,000	1,100,000

World Resources: Although domestic resources of raw materials for production of fused aluminum oxide may be 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.

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

[2]See Appendix B.

[3]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 worn out 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 electric and electronic applications. The remaining 35% was used for applications such as measuring and control instruments and dental amalgams.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Mine	W	W	W	W	W
Secondary, industrial	350	466	534	446	400
Imports for consumption	40	129	377	340	300
Exports	389	316	179	45	60
Shipments from Government stockpile excesses	543	86	—	—	—
Consumption: Reported	558	483	436	372	400
Apparent	W	W	W	W	W
Price, average value, dollars per flask, New York, dealer	187.00	194.45	247.39	261.61	200.00
Stocks, industry, yearend[2]	384	469	321	446	400
Net import reliance[3] as a percent of apparent consumption	W	W	W	W	W

Recycling: About 300 tons of mercury was recovered from old scrap in 1997.

Import Sources (1993-96): Russia, 42%; Canada, 32%; Spain, 9%; Kyrgyzstan, 9%; and other, 8%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Mercury	2805.40.0000	1.7% ad val.	5.7% ad val.

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

Government Stockpile: In addition to the quantities shown below, 146 tons of secondary mercury was held by the U.S. Department of Energy at Oak Ridge, TN.

Stockpile Status—9-30-97[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Mercury	4,410	—	4,410	—	—

Prepared by **Robert G. Reese, Jr., (703) 648-4981 [Fax: (703) 648-7757].**

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, the enactment of increasingly stringent environmental regulations are likely to continue as the major determinants of domestic mercury supply and demand. The major component of supply will remain the secondary industry, owing to the recycling of many worn out or obsolete products and various wastes to avoid deposition in landfills. Domestic primary production is expected to remain limited to byproduct production where the mercury is recovered to avoid emissions to the environment. Domestic mercury consumption will continue to decline as mercury is gradually eliminated in many products, or as substitute products are developed.

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

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1996	1997[e]		
United States	W	W	3,000	4,000
Algeria	300	300	2,000	3,000
Italy	—	—	—	69,000
Kyrgyzstan	580	600	7,500	13,000
Spain	1,500	1,500	76,000	90,000
Other countries	510	600	37,500	61,000
World total (may be rounded)	2,890	3,000	130,000	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. 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.
[5]See Appendix C for definitions
[6]See Appendix D 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 91,000 metric tons in 1997. North Carolina accounted for about 62% 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 from feldspar, kaolin, and lithium 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 1997 scrap mica production was estimated at $8.9 million. Ground mica in 1996 sales were valued at $34 million. There were 10 domestic producers of scrap and flake mica.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production:[2 3] Mine	88	109	108	97	91
Ground	92	95	98	103	97
Imports, mica powder and mica waste	14	18	22	18	21
Exports, mica powder and mica waste	5	6	7	8	7
Consumption, apparent[4]	105	97	112	107	100
Price, average, dollars per ton, reported:					
Scrap and flake	51	66	70	54	7
Ground:					
Wet	838	1,007	974	1,032	1,000
Dry	152	151	174	182	180
Stocks, producer, yearend[e]	7	14	13	7	11
Employment, mine, number[e 5]	80	364	360	NA	NA
Net import reliance[6] as a percent of apparent consumption	12	1	5	4	3

Recycling: None.

Import Sources (1993-96): Canada, 68%; India, 25%; Finland, 3%; Japan, 1%; and other, 3%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[7] 12/31/97
Mica powder	2525.20.0000	1.0% ad val.	20% ad val.
Mica waste	2525.30.0000	Free	8.8¢/ kg.

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

Government Stockpile: None.

Prepared by **James B. Hedrick, (703) 648-7725 [Fax: (703) 648-7722].**

MICA (NATURAL), SCRAP AND FLAKE

Events, Trends, and Issues: Production of ground mica in the United States decreased after 5 consecutive years of increases. The slight decline of mica used in the United States is partially the result of a decrease in housing starts in 1997. Part of the decrease is attributed to a decline in construction repairs as damage from catastrophic events, such as hurricanes and floods, declined in 1997. The United States remained the world's major producer of scrap and flake mica. Imported mica scrap and flake is used primarily for making mica paper and as a filler and reinforcer in plastics.

A new company began production of mica in Newell, SD. The mica was produced as a byproduct of feldspar mining. Mica production at the pegmatite operation was small.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[8]	Reserve base[8]
	1996	1997[e]		
United States[2]	97	91	Large	Large
Brazil	4	4	Large	Large
Canada	18	18	Large	Large
India	1	1	Large	Large
Korea, Republic of	36	36	Large	Large
Russia	20	20	Large	Large
Other countries	49	50	Large	Large
World total	225	220	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.
[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, including 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 B.
[8]See Appendix D 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 1997. The domestic consuming industry was dependent on imports and shipments of Government stockpile excesses to meet demand for sheet mica. During 1997, an estimated 5,800 tons of unworked mica split block and mica splittings valued at $2.4 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 1,600 tons of imported worked mica valued at $15.4 million was also consumed.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, mine[e]	(2)	(2)	(2)	(2)	(2)
Imports, plates, sheets, and strips; worked mica; split block; splittings; other > $0.55/kg	4,310	2,610	4,230	6,330	7,330
Exports, plates, sheets, and strips; worked mica; crude and rifted into sheet or splittings > $0.55/kg	909	1,003	935	831	1,280
Shipments from Government stockpile excesses	165	134	511	1,110	326
Consumption, apparent	2,180	1,740	3,800	6,540	6,380
Price, average value, dollars per kilogram, muscovite mica, reported:					
Block	95	66	73	77	80
Splittings	1.55	1.72	1.86	1.75	1.80
Stocks, fabricator and trader, yearend[e]	502	503	NA	NA	NA
Net import reliance[3] as a percent of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1993-96): India, 66%; Belgium, 13%; China, 5%; Brazil, 5%; and other, 11%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Split block mica	2525.10.0010	Free	Free.
Mica splittings	2525.10.0020	Free	Free.
Unworked—other	2525.10.0050	Free	Free.
Plates, sheets, and strips of agglomerated or reconstructed mica	6814.10.0000	3.7% ad val.	40% ad val.
Worked mica and articles of mica—other	6814.90.0000	3.6% ad val.	45% ad val.

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

Government Stockpile:

Stockpile Status—9-30-97[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Block:					
Muscovite	1,200	198	1,024	—	380
Phlogopite	59	—	—	—	—
Film, muscovite	16	44	—	115	99
Splittings:					
Muscovite	5,643	127	5,643	284	339
Phlogopite	265	23	265	227	61

Prepared by James B. Hedrick, (703) 648-7725 [Fax: (703) 648-7722].

MICA (NATURAL), SHEET

Events, Trends, and Issues: Demand for sheet mica increased as imports of splittings from India increased to meet demand for electrical equipment, especially transformers. Imports remained the principal source of sheet mica, and shipments from 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[5]	Reserve base[6]
	1996	1997[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 many 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 uses.

[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.
[5]See Appendix C for definitions.
[6]See Appendix D for definitions.

MOLYBDENUM

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

Domestic Production and Use: In 1997, molybdenum, valued at about $456 million (based on average oxide price), was produced by 14 mines. Molybdenum ore was produced at three mines in Colorado, New Mexico, and Idaho, whereas nine 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:	1993	1994	1995	1996	1997[e]
Production, mine	36,800	46,800	60,900	54,900	55,500
Imports for consumption	3,400	2,280	5,570	5,480	5,500
Exports, all primary forms	30,600	37,000	51,300	49,600	50,000
Consumption: Reported	17,700	18,800	19,900	20,300	20,000
Apparent	11,600	20,480	14,270	12,300	11,700
Price, average value, dollars per kilogram[1]	5.13	4.60	17.50	8.30	8.50
Stocks, mine and plant concentrates, product, and end-use	19,900	11,500	12,400	10,800	10,100
Employment, mine and plant, number	680	700	700	800	700
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. Although some molybdenum was recycled as a minor constituent of scrap alloy steels and iron, the use of such scrap did not generally depend on its molybdenum content.

Import Sources (1993-96): The United Kingdom, 30%; Chile, 20%; China, 18%; Canada, 13%; and other, 19%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Molybdenum ore and concentrates, roasted	2613.10.0000	13¢/kg + 1.8% ad val.	$1.10/kg + 15% ad val.
Molybdenum ore and concentrates, other	2613.90.0000	18.6¢/kg	77.2¢/kg.
Molybdenum chemicals:			
Molybdenum oxides and hydroxides	2825.70.0000	3.2% ad val.	20.5% ad val.
Molybdates of ammonium	2841.70.1000	4.3% ad val.	29% ad val.
Molybdates, all others	2841.70.5000	3.7% ad val.	25% ad val.
Molybdenum pigments:			
Molybdenum orange	3206.20.0020	3.7% ad val.	25% ad val.
Miscellaneous chemical products:			
Mix of two or more inorganic compounds of molybdenum	3824.90.3400	2.8% ad val.	18% ad val.
Ferroalloys:			
Ferromolybdenum	7202.70.0000	4.5% ad val.	31.5% ad val.
Molybdenum metals:			
Powders	8102.10.0000	11¢/kg + 1.6% ad val.	$1.10/kg + 15% ad val.
Unwrought	8102.91.1000	13.9¢/kg + 1.9% ad val.	$1.10/kg + 15% ad val.
Waste and scrap	8102.91.5000	Free	Free.
Wrought	8102.92.0000	6.6% ad val.	60% ad val.
Wire	8102.93.0000	5.3% ad val.	60% ad val.
Other	8102.99.0000	4.4% ad val.	45% ad val.

Prepared by **John W. Blossom, (703) 648-4964 [Fax: (703) 648-7757].**

MOLYBDENUM

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

Government Stockpile: None.

Events, Trends, and Issues: After startup in late 1996, the Questa molybdenum mine, Questa, NM, operated during the entire year of 1997. U.S. mine output of molybdenum in 1997 increased slightly compared with that of 1996. Reported consumption of molybdenum also was about the same; exports were about the same, and U.S. producer inventories were about the same as those of 1996.

The molybdenum industry was uneventful in 1997 and prices of concentrates and molybdenum products moderated toward the end of year. The domestic price for technical-grade molybdic oxide averaged $8.50 per kilogram of contained molybdenum during 1997. Mine capacity utilization was 50%.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	1996	1997[e]	(thousand metric tons)	
United States	54,900	55,500	2,700	5,400
Armenia	900	900	20	30
Canada	8,850	9,000	450	910
Chile	18,000	20,000	1,100	2,500
China	25,000	25,000	500	1,000
Iran	1,200	1,200	50	140
Kazakstan	800	800	130	200
Mexico	3,900	4,000	90	230
Mongolia	2,200	2,200	30	50
Peru	3,710	3,800	140	230
Russia	8,500	8,500	240	360
Uzbekistan	500	500	60	150
Other countries	—	—	—	590
World total (rounded)	128,000	131,000	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 both 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 B.
[4]See Appendix D 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 operated at full capacity in 1997. The smelter, near Riddle, OR, has been producing ferronickel primarily from imported ores. The adjoining mine is operated intermittently. On a monthly or annual basis, 133 facilities reported nickel consumption. The principal consuming State was Pennsylvania, followed by West Virginia and Ohio. Approximately 49% of the primary nickel consumed went into stainless and alloy steel production, 29% into nonferrous alloys and superalloys, 15% into electroplating, and 7% into other uses. Ultimate end uses were as follows: transportation, 26%; chemical industry, 15%; construction, 10%; electrical equipment, 9%; fabricated metal products, 9%; petroleum, 8%; machinery, 8%; household appliances, 7%; and other, 8%. Total estimated value of apparent primary consumption was $1.1 billion.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Mine	2,460	—	1,560	1,330	—
Plant	4,880	—	8,290	15,100	16,100
Imports: Ore	2,970	—	8,200	15,000	16,800
Primary[1]	126,000	127,000	149,000	142,000	146,000
Secondary[1]	6,710	6,070	7,930	8,060	11,000
Exports: Primary	7,180	7,420	9,750	13,100	17,300
Secondary	26,000	34,500	41,800	33,600	40,500
Consumption: Reported, primary	105,000	108,000	124,000	116,000	114,000
Reported, secondary	54,000	58,600	64,500	59,200	72,100
Apparent, primary	122,000	133,000	152,000	149,000	150,000
Price, average annual, London Metal Exchange					
Cash, dollars per metric ton	5,293	6,340	8,228	7,501	6,931
Cash, dollars per pound	2.401	2.876	3.732	3.402	3.144
Stocks: Government, yearend	31,600	26,800	19,800	15,900	9,240
Consumer, yearend	14,400	11,100	12,300	12,900	14,200
Producer, yearend[2]	15,700	10,200	12,700	11,200	11,500
Employment, yearend, number: Mine	2	1	17	8	4
Smelter	33	22	253	253	255
Port facility[3]	5	3	25	23	23
Net import reliance[4] as a percent of apparent consumption	63	64	60	59	54

Recycling: About 72,000 tons of nickel was recovered from purchased scrap in 1997. This represented about 39% of reported consumption for the year.

Import Sources (1993-96): Canada, 39%; Norway, 15%; Russia, 12%; Australia, 10%; and other, 24%.

Tariff: Item	Number	Canada, Mexico, and most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Nickel oxide, chemical grade	2825.40.0000	Free	Free.
Ferronickel	7202.60.0000	Free	6.6¢/kg.
Nickel oxide, metallurgical grade	7501.20.0000	Free	Free.
Unwrought nickel, not alloyed	7502.10.0000	Free	6.6¢/kg.
Waste and scrap	7503.00.0000	Free	6.6¢/kg.

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

Government Stockpile:

Stockpile Status—9-30-97[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Nickel	3,830	6,290	3,830	9,070	6,430

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 12% greater than that of 1996 despite a slowdown in the second half of 1997. At the same time, U.S. production of nickel-free grades weakened, increasing the austenitic share of U.S. stainless production from 63% to 70%. U.S. stainless producers continue to face stiff competition from imports, with imports accounting for about 32% of total U.S. stainless consumption in 1996.

Prepared by **Peter H. Kuck, (703) 648-4965, [Fax: (703) 648-7757].**

NICKEL

The world nickel supply began to exceed demand in mid-1997, causing the London Metal Exchange (LME) cash price to fall below $6,600 per metric ton ($2.99 per pound). The drop in price reportedly was triggered when speculators, concerned about financial problems in East Asia, began selling off holdings. Sizable exports of cathode and stainless steel scrap from Russia to the European Union kept prices depressed for the remainder of 1997. For the week ending November 21, 1997, the LME cash price for 99.8%-pure nickel averaged $6,102 per metric ton ($2.77 per pound). The nickel oversupply situation is expected to continue for 4 or 5 years. The long-term outlook for the metal is more sanguine. Since 1975, world demand for stainless steel has grown at an average rate of 4.5% per year. This growth rate is projected to continue or accelerate over the next 20 years, encouraging the development of new nickel mines in North America, Australia, and Oceania. Exploration teams have discovered additional resources along the suture line dividing the Nain and Churchill geological provinces of northeastern Canada. The original discovery—four sulfide ore bodies associated with a layered intrusion near Voisey's Bay, Labrador—is now scheduled to begin production in 2002. The pentlandite concentrate produced at Voisey's Bay is to be smelted at Argentia, Newfoundland. The Argentia complex will be the largest nickel smelting and refining facility outside of Russia. In October 1997, additional nickel mineralization was found in similar terrain some 100 kilometers south of the Voisey's Bay project.

Automotive manufacturers in France, Japan, and the United States have begun mass producing electric vehicles powered by advanced nickel-metal hydride or nickel-cadmium batteries. Whether these new vehicles will help reduce greenhouse emissions remains a matter of debate. Beginning in 2003, 10% of all motor vehicles sold within California must have zero tailpipe emissions. Several manufacturers are also developing hybrid automobiles that use an electric motor to power the vehicle in low-speed, stop-and-go city driving.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7]	Reserve base[7]
	1996	1997[e]		
United States	1,330	—	43,000	2,500,000
Australia	113,134	120,000	3,700,000	7,300,000
Botswana	24,200	22,600	780,000	830,000
Brazil	25,600	27,200	670,000	6,000,000
Canada	183,059	182,000	5,300,000	15,000,000
China	43,000	41,000	3,700,000	7,900,000
Colombia	27,700	29,600	560,000	1,100,000
Cuba	51,613	52,500	5,500,000	23,000,000
Dominican Republic	45,000	47,000	1,000,000	1,300,000
Greece	20,000	18,000	450,000	900,000
Indonesia	90,000	76,000	3,200,000	13,000,000
New Caledonia	142,200	157,000	4,500,000	15,000,000
Philippines	14,700	15,000	410,000	11,000,000
Russia	230,000	230,000	6,600,000	7,300,000
South Africa	33,613	31,800	2,500,000	11,800,000
Zimbabwe	11,600	10,300	240,000	260,000
Other countries	19,906	19,700	450,000	12,000,000
World total (may be rounded)	1,080,000	1,080,000	40,000,000	140,000,000

World Resources: Identified world resources in deposits averaging 1% nickel or greater contain a total of 130 million tons of nickel. About 60% of the nickel is in laterites and 40% is in sulfide deposits. In addition, there are extensive deep-sea resources of nickel 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. Present and potential nickel substitutes include aluminum, coated steels, and plastics in the construction and transportation industries; nickel-free specialty steels in the power generating, petrochemical, and petroleum industries; titanium and plastics in severe corrosive applications; and platinum, cobalt, and copper in catalytic uses.

[e]Estimated.
[1]Imports for consumption as reported by the U.S. Bureau of the Census.
[2]Stocks of producers, agents, and dealers held only in the United States.
[3]Employment at port facility in Coos Bay, OR, used exclusively for drying and transshipping imported nickel ore.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix B.
[6]See Appendix C for definitions.
[7]See Appendix D for definitions.

NITROGEN (FIXED)—AMMONIA

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

Domestic Production and Use: U.S. ammonia producers continued to operate at or near rated capacity. Fifty-nine 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.[1] The United States remained the world's second largest ammonia producer and consumer following China. Urea, ammonium nitrate, ammonium phosphates, ammonium sulfate, and nitric acid were the major derivatives of ammonia in the United States, in descending order of importance.

Approximately 86% 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]	1993	1994	1995	1996	1997[e]
Production[2]	12,800	13,400	13,000	13,200	13,000
Imports for consumption	2,660	3,450	2,630	2,460	2,600
Exports	378	215	319	435	500
Consumption, apparent	15,300	16,500	15,300	15,300	15,100
Stocks, producer, yearend	852	956	959	953	960
Price, dollars per ton, average annual, f.o.b. gulf coast[3]	121	211	212	225	192
Employment, plant, number	2,500	2,500	2,500	2,500	2,500
Net import reliance[4] as a percent of apparent consumption	17	19	16	13	14

Recycling: None.

Import Sources (1993-96): Trinidad and Tobago, 49%; Canada, 40%; Mexico, 6%; and other, 5%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Ammonia, anhydrous	2814.10.0000	Free	Free.
Ammonia, aqueous	2814.20.0000	Free	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Prepared by **David E. Morse, (703) 648-4994 [Fax: (703) 648-7722].**

NITROGEN (FIXED)—AMMONIA

Events, Trends, and Issues: The U.S. fertilizer industry experienced another robust year, which was bolstered by global supply-demand balance and good export demand for domestic produced fertilizers and grain. Ammonia prices retreated from the record highs of 1996, declining by about 20% from January through June, which was followed by a turn around of nearly 10% in July and August; prices decreased again in September. World demand for U.S. produced ammoniated phosphates continued at a high level.

On a worldwide basis, a capacity expansion was announced for Trinidad and Tobago; new capacity was announced for south Asia; and upgrading and modernizing was scheduled for facilities in the Former Soviet Union. A major industrial accident in Trinidad and Tobago in September severely curtailed production in the fourth quarter.

The outlook for the U.S. and world fertilizer industry continued to be optimistic because low world grain inventories should stimulate increased planting here and abroad.

World Ammonia Production, Reserves, and Reserve Base:

	Plant production		Reserves and reserve base[6]
	1996	1997[e]	
United States	13,200	13,000	Available atmospheric nitrogen and sources of natural gas for production of ammonia are considered adequate for all listed countries.
Canada	3,800	3,800	
China	23,000	23,000	
Germany	1,200	1,300	
India	7,800	7,700	
Indonesia	2,870	2,900	
Japan	1,560	1,600	
Mexico	2,150	2,200	
Netherlands	2,500	2,500	
Russia	7,000	7,000	
Trinidad and Tobago	1,800	1,600	
Ukraine	3,000	3,000	
Other countries	26,200	26,300	
World total (may be rounded)	96,000	96,000	

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 Fertilizer Intelligence Weekly, a Pike and Fischer publication.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix B.
[6]See Appendix D 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 million in 1997. Peat was harvested and processed by about 60 producers in 20 States; Florida, Michigan, and Minnesota were the largest producing States in order of importance. Reed-sedge peat accounted for about 70% of the total volume followed by sphagnum moss, 15%; 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, to a lesser extent, as a fuel source.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production	616	574	589	549	500
Commercial sales	612	552	660	640	620
Imports for consumption	648	669	669	667	680
Exports	8	23	20	19	20
Consumption, apparent[2]	1,290	1,240	1,110	1,240	1,200
Price, average value, f.o.b. mine, dollars per ton	27.54	27.22	25.80	28.90	26.00
Stocks, producer, yearend	269	252	384	342	300
Employment, mine and plant, number[e]	650	650	800	800	800
Net import reliance[3] as a percent of apparent consumption	53	53	57	56	58

Recycling: None.

Import Sources (1993-96): Canada, 100%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Peat	2703.00.0000	Free	Free.

Depletion Allowance: 5% (Domestic).

Government Stockpile: None.

Prepared by **Stephen Jasinski, (703) 648-7711 [Fax: (703) 648-7722].**

PEAT

Events, Trends, and Issues: The Canadian sphagnum peat industry continued to capitalize on the environmentally restricted U.S. peat industry by shipping another record high volume. In 1997, Canadian peat shipments to the United States were proceeding at an annual rate of 680,000 tons.

Estimated peat production from countries in the Former Soviet Union (FSU) accounts for a significant portion of global production. Because the quantity of peat produced in the FSU for agricultural purposes is not reported on a consistent and reliable basis, worthwhile estimates cannot be made; the quantity of peat produced in the FSU for agricultural purposes is not included in world production tabulations, even though the quantity produced is thought to be significant. Therefore, the world production numbers presented below are not comparable to previous years' reports.

The outlook for the domestic peat industry will likely be governed by several variables, including future wetlands regulation, the ability to permit new bogs, growth and competition from recycled yard wastes and other organic materials, and Canadian competition.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[5]	Reserve base[5]
	1996	1997[e]		
United States	549	500	15,000	6,400,000
Belarus[e 6]	279	300	([7])	([7])
Canada	783	900	22,000	300,000,000
Estonia[e 6]	950	1,000	([7])	([7])
Finland	5,450	5,500	64,000	6,400,000
Germany	2,980	3,000	42,000	450,000
Ireland	7,387	7,000	160,000	820,000
Latvia[e 6]	463	450	([7])	([7])
Lithuania[e 6]	200	200	([7])	([7])
Russia[e 6]	2,500	2,500	([7])	([7])
Sweden	1,650	1,700	([7])	([7])
Ukraine[e 6]	1,000	1,000	([7])	([7])
United Kingdom[e]	500	500	([7])	([7])
Other countries	1,560	1,600	4,900,000	150,000,000
World total (rounded)	25,800	26,000	5,200,000	460,000,000

World Resources: World resources of peat were estimated to be 1.9 trillion tons, of which the FSU has about 770 billion tons and Canada about 510 billion tons. Domestic deposits of peat occur in all 50 States, with estimated resources of about 310 billion tons or about 16% of the world total.

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 B.
[5]See Appendix D for definitions.
[6]Does not include agricultural peat production.
[7]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 1997 was $22.4 million. Crude ore production came from eight mines operated by six companies in five Western States. New Mexico continued to be the major producing State. Processed ore was expanded at 61 plants in 31 States. The principal end uses were building construction products, 71%; filter aid, 9%; horticultural aggregate, 9%; fillers, 8%; and other, 3%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production[1]	569	644	700	684	703
Imports for consumption[e]	70	70	84	125	125
Exports[e]	26	30	40	38	38
Consumption, apparent	613	684	744	771	790
Price, average value, dollars per ton, f.o.b. mine	30.63	30.03	27.93	28.25	31.82
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill	115	125	125	125	140
Net import reliance[2] as a percent of apparent consumption	7	6	6	11	11

Recycling: Not available.

Import Sources (1993-96): Greece, 100%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Mineral substances, not specifically provided for	2530.10.0000	Free	Free.

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

Government Stockpile: None.

Prepared by **Wallace P. Bolen, (703) 648-7727 [Fax: (703) 648-7722].**

PERLITE

Events, Trends, and Issues: Processed ore production increased nearly 3% in 1997 after decreasing 2% in 1996. Apparent consumption increased for the sixth straight year. New mines in Oregon and Utah were to be opened in 1997.

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 were being researched, which may increase domestic consumption.

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

	Production		Reserves[4]	Reserve base[4]
	1996	1997[e]		
United States	684	703	50,000	200,000
Greece	350	375	50,000	300,000
Japan	200	200	([5])	([5])
Turkey	160	170	([5])	([5])
Other countries	286	290	600,000	1,500,000
World total (may be rounded)	1,680	1,740	700,000	2,000,000

World Resources: Too little 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 B.
[4]See Appendix D for definitions.
[5]Included with "Other countries."

PHOSPHATE ROCK

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Phosphate rock ore was mined by 10 firms in 4 States, and upgraded into an estimated 46.5 million metric tons of marketable product valued at about $1,100 million f.o.b. mine. Florida and North Carolina accounted for about 85% of total domestic output, with the remainder produced in southeastern Idaho and northwestern Utah. Approximately 90% of U.S. phosphate rock demand was for conversion into wet-process phosphoric acid and superphosphoric acid, which are used principally as intermediates in the manufacture of granular and liquid ammonium phosphate fertilizers for domestic consumption and export. The remainder of the phosphate rock was used in industrial applications or was exported. About 50% of U.S. wet-process phosphoric acid production was consumed for exports in the form of upgraded granular diammonium and monoammonium phosphate fertilizer materials, triple superphosphate fertilizer, and merchant grade phosphoric acid. Calcium phosphate animal feed supplements, essential to livestock nutrition, were derived from defluorinated phosphoric acid and defluorinated phosphate rock, while purified phosphoric acid was used in a variety of industrial applications. Phosphate rock was mined by three western firms as feedstock for high-purity, industrial-grade elemental phosphorus manufacture in wholly owned electric furnace facilities in Idaho and Montana.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production[1]	35,500	41,100	43,500	45,400	46,300
Sold or used by producers	40,100	43,900	43,700	43,500	41,300
Imports for consumption	534	620	1,080	1,800	1,800
Exports	3,200	2,800	2,990	[2]1,570	[2]600
Consumption[3]	38,300	42,900	42,000	43,700	42,500
Price, average value, dollars per ton, f.o.b. mine[4]	21.38	21.14	21.75	23.40	23.70
Stocks, producer, yearend	9,220	5,980	5,710	6,390	8,600
Employment, mine and beneficiation plant, number	5,600	5,000	5,000	5,000	5,000
Net import reliance[5] as a percent of apparent consumption	4	5	E	E	E

Recycling: None. Limited to phosphate rock conversion products.

Import Sources (1993-96): Morocco, 99%; and other, 1%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[6] 12/31/97
Natural calcium phosphates:			
Unground	2510.10.0000	Free	Free.
Ground	2510.20.0000	Free	Free.

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

Government Stockpile: None.

Prepared by **Stephen Jasinski, (703) 648-7711 [Fax: (703) 648-7722].**

PHOSPHATE ROCK

Events, Trends, and Issues: Consolidation of the U.S. phosphate fertilizer industry continued with two U.S. companies expected to merge at the end of the year. One of the companies involved in the merger closed three mines in 1997, two temporarily and one permanently. The same company exchanged phosphate reserves with another Florida phosphate company. Another Florida phosphate fertilizer producer's plans to reopen a closed fertilizer plant were delayed due to permitting problems for improvements to its sulfuric acid plant.

A Canadian company announced plans to develop a phosphate deposit in Ontario and to upgrade its phosphate processing plant in Alberta. The company was considering the development of another unspecified deposit. A joint venture between the Government-owned Moroccan phosphate company and an Indian company will increase phosphoric acid production in Morocco. Two-thirds of the new production would be dedicated to meet the needs of the Indian partner.

Corn yields in the United States were projected to be lower than in 1996, causing industry analysts to predict increased fertilizer demand for 1998 to attempt to improve yields and raise grain stocks. Increased domestic fertilizer demand and continuing strength in fertilizer exports should result in another good year for phosphate producers in 1998. Imported fertilizers will continue to play a major role in meeting the plant nutrient needs in China and India with U.S. phosphate producers continuing to play a major role in supplying those needs.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7]	Reserve base[7]
	1996	1997[e]		
United States	45,400	46,300	1,200,000	4,400,000
Brazil	3,600	4,000	330,000	370,000
China	21,000	22,000	210,000	210,000
Israel	3,800	3,900	180,000	180,000
Jordan	5,350	5,500	90,000	570,000
Kazakstan	500	500	—	100,000
Morocco and Western Sahara	20,800	21,000	5,900,000	21,000,000
Russia	8,500	8,500	—	1,000,000
Senegal	1,600	1,600	—	160,000
South Africa	2,700	2,700	2,500,000	2,500,000
Togo	2,600	2,600	—	60,000
Tunisia	7,100	7,200	—	270,000
Other countries	10,100	10,000	1,000,000	2,500,000
World total (rounded)	133,000	136,000	11,000,000	33,000,000

World Resources: Phosphate rock resources occur principally as sedimentary marine phosphorites. Significant igneous occurrences are found in Russia and South Africa. Large phosphate resources have been identified on the continental shelves and on seamounts in the Atlantic and Pacific Oceans.

Substitutes: There are no substitutes for phosphorus in agriculture.

[e]Estimated. E Net exporter.
[1]Marketable.
[2]Source: Bureau of the Census.
[3]Defined as sold or used + imports - exports.
[4]Marketable phosphate rock, weighted value, all grades, domestic and export.
[5]Defined as imports - exports + adjustments for Government and industry stock changes.
[6]See Appendix B.
[7]See Appendix D for definitions.

PLATINUM-GROUP METALS

(Platinum, palladium, rhodium, ruthenium, iridium, osmium)
(Data in kilograms,[1] 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 about 350,000 metric tons of ore and recovered about 11,000 kilograms of PGM (primarily palladium) in 1997. Small quantities of PGM were also recovered as byproducts of copper refining by two companies in Texas and Utah. The automotive industry is the principal consumer of PGM as oxidation catalysts in catalytic converters to treat automobile exhaust emissions. Oxidation catalysts are also used in many 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:	1993	1994	1995	1996	1997[e]
Mine production:[2] Platinum	2,050	1,960	1,590	1,840	2,500
Palladium	6,780	6,440	5,260	6,100	8,300
Imports for consumption, refined:					
Platinum	57,200	56,500	71,500	75,800	76,000
Palladium	78,900	92,500	124,000	146,000	95,000
Rhodium	7,210	7,820	9,600	9,650	7,000
Ruthenium	4,490	9,880	7,520	15,600	14,000
Iridium	896	926	1,450	1,810	1,500
Osmium	130	55	73	329	100
Exports, refined:					
Platinum	16,100	15,500	15,000	12,700	17,000
Palladium	26,200	29,900	26,000	26,700	43,000
Rhodium	767	791	741	187	100
Price, average daily, New York, dollars per troy ounce:					
Platinum	374.77	411.30	425.36	397.97	394.83
Palladium	122.97	156.20	153.35	130.39	174.09
Rhodium	1,137.36	636.00	463.30	300.00	290.00
Employment, mine, number	400	445	500	500	550

Recycling: An estimated 63 metric tons of PGM was recovered from new and old scrap in 1997.

Import Sources (1993-96): Platinum: South Africa, 60%; Russia, 10%; the United Kingdom, 10%; Germany, 5%; and other, 15%. Palladium: Russia, 47%; South Africa, 22%; the United Kingdom, 10%; Belgium, 8%; and other, 13%.

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

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

Government Stockpile:

Stockpile Status—9-30-97[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Platinum	10,500	—	—	317	317
Palladium	38,800	—	—	470	470
Iridium	920	—	—	—	—

Prepared by **Henry E. Hilliard, (703) 648-4970 [Fax: (703) 648-7757].**

PLATINUM-GROUP METALS

Events, Trends, and Issues: The only U.S. PGM mine had completed about 75% of a three-stage expansion as of March 31, 1997, and was scheduled to complete the project on schedule by yearend. The mine's annual production of PGM rose from 7,900 kilograms in 1996 to about 11,000 kilograms in 1997. Once the smelter and refinery are completed, the facility will also have the ability to process secondary materials containing PGM, such as autocatalysts.

In August 1997, the Defense National Stockpile Center loaned 3,701 kilograms of 99.95% stockpile platinum to the U.S. Mint for use in its coinage operations. The terms of the agreement, signed August 5, 1997, requires that the Mint will return a like amount of similar quality platinum before the agreement expires in the year 2003. Also in August, the National Defense Stockpile Market Impact Committee published a *Federal Register* notice seeking public comment on the Department of Defense's (DOD) proposed sale of excess material from the National Defense Stockpile. The Committee was considering DOD's proposed new material disposals as well as revisions to current material disposals under the FY 1998 Annual Materials Plan (AMP), which must be approved by Congress. The revised AMP proposed the sale of 9,331 kilograms of palladium and 3,889 kilograms of platinum in fiscal year 1998.

World Mine Production, Reserves, and Reserve Base:

	Mine production				PGM	
	Platinum		Palladium		Reserves[4]	Reserve base[4]
	1996	1997[e]	1996	1997[e]		
United States[2]	1,840	2,500	6,100	8,300	570,000	800,000
Canada	8,260	8,300	5,270	5,300	311,000	380,000
Russia	18,000	18,500	48,000	50,000	6,220,000	6,600,000
South Africa	117,000	117,000	48,900	49,000	62,800,000	69,000,000
Other countries	900	1,200	2,730	3,000	666,000	730,000
World total (rounded)	146,000	148,000	111,000	116,000	70,600,000	77,500,000

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

Substitutes: Some automotive companies 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.

[e]Estimated.
[1]Multiply by 32.1507 to convert from kilograms to troy ounces.
[2]Estimates from published sources.
[3]See Appendix C for definitions.
[4]See Appendix D for definitions.

POTASH

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

Domestic Production and Use: In 1997, the value of production of marketable potash, f.o.b. mine was about $315 million, owing to sales of more expensive forms of potash and increasing prices. Domestic potash production was from three States. The majority of the production was from southwestern New Mexico, where three companies operated five mines at the beginning of the year. These five mines were conventional underground mines of bedded deposits, which have projected lifetimes that range from about 1 year to more than 100 years at present prices. New Mexico potash ore was beneficiated by flotation, heavy media separation, dissolution-recrystallization, and washing, and provided about 80% 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. In California the first domestic potash producer sold only from its remaining stockpiles, having closed potash operations last year. The fertilizer industry used more than 88% of the U.S. potash sales and the chemical industry used close to 12%. About 65% 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:	1993	1994	1995	1996	1997[e]
Production, marketable	1,510	1,400	1,480	1,390	1,430
Imports for consumption	4,360	4,800	4,820	4,950	4,910
Exports	415	464	409	481	450
Consumption, apparent	5,430	5,810	5,810	5,890	5,890
Price, dollars per metric ton of K_2O, average, muriate, f.o.b. mine[1]	128	131	137	133	140
Stocks, producer, yearend	305	234	312	265	265
Employment, number: Mine	795	845	900	880	850
Mill	910	810	840	810	800
Net import reliance[2] as a percent of apparent consumption	72	76	75	77	76

Recycling: None.

Import Sources (1993-96): Canada, 92%; Russia, 3%; Belarus, 2%; Israel, 1%; Germany, 1%; and other, 1%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Crude salts, sylvinite, etc.	3104.10.0000	Free	Free.
Potassium chloride	3104.20.0000	Free	Free.
Potassium sulfate	3104.30.0000	Free	Free.
Potassium nitrate	2834.21.0000	Free	Free.
Potassium-sodium nitrate mixtures	3105.90.0010	Free	Free.

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

Government Stockpile: None.

Events, Trends, and Issues: The world's largest potash producers operated at less than full capacity for another year. The world remained in over-capacity but production increased marginally. The Canadian potash industry operated at about 75% capacity, about 45% for the largest producer and 90% for all the others; the Former Soviet Union producers operated at about 60% capacity. New Mexico producers operated at about 85% capacity for the year. While capacity remained about the same as last year, U.S. production increased partially owing to increasing domestic demand and greater production of sulfate of potash; French production decreased owing to the approaching end of mine life, while Canada increased slightly. The Pacific Basin potash buyers apparently noted the price difference between the U.S. price and the international price, and demanded that Canada equalize prices. Muriate of potash price declined in the first half of the year in the Pacific Basin by about 6% while U.S. price rose by about 6%.[4] This was an improvement for the domestic muriate of potash producers who export less of their production and were struggling to stay in business. The reader should note the ownership changes during the year.

Prepared by **James P. Searls, (703) 648-7724 [Fax: (703) 648-7722].**

POTASH

The St. Paul, MN, civil, class action, antitrust lawsuit, which dated from the summer of 1993, approached resolution during the year. In January the Federal District Court Judge agreed with the magistrate's recommendation and dismissed the suit. The plaintiffs appealed to the 8th Circuit Court of Appeals in St. Paul, MN, and there were oral arguments in June without an immediate decision. In early December 1997 a Carlsbad, NM, mine was closed as unprofitable.

On June 18th, the Potash Company of Canada (Potacan) mine at Clover Hill, New Brunswick, Canada, an 800,000-ton muriate of potash mine was discovered to be subject to a water inflow problem. The flow was initially estimated to be 4,000 to 5,000 cubic meters per day. This mine was jointly owned by Kali und Salz GmbH of Kassel, Germany, a division of Kali und Salz Beteiligungs AG, and Entreprise Minière et Chemique of Paris, France.

In 1997, because the world cereal stocks have been below 17% of consumption since 1995,[5] there has been price pressure for more production of cereals. Fall fertilizer application was strong owing to good weather and expectations of El Niño's possible bad effects on next year's crop production, e.g., droughts in Indonesia and Australia, rain in the southeastern and northwestern United States, and a strengthening of the westerlies in the Southern Hemisphere during its winter season that brings heavy precipitation to parts of southern parts of South America.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1996	1997[e]		
United States	1,390	1,430	70,000	240,000
Azerbaijan[e]	50	50	NA	NA
Belarus	2,600	2,600	800,000	1,000,000
Brazil	270	300	50,000	600,000
Canada	8,165	8,400	4,400,000	9,700,000
Chile	50	50	10,000	50,000
China	110	130	320,000	320,000
France	800	730	9,000	25,000
Germany	3,200	3,200	720,000	870,000
Israel	1,320	1,300	42,000	[7]580,000
Jordan	1,200	1,200	42,000	[7]580,000
Russia	2,800	2,800	1,800,000	2,200,000
Spain	600	600	20,000	35,000
Ukraine	100	100	25,000	30,000
United Kingdom	580	600	22,000	30,000
Other countries	—	—	50,000	140,000
World total (may be rounded)	23,200	23,500	8,400,000	17,000,000

World Resources: Estimated domestic potash resources total about 6 billion tons. Most of this lies at depths between 6,000 and 10,000 feet in a 1,200-square-mile area of Montana and North Dakota as an extension of the Williston Basin deposits in Saskatchewan, Canada. The Paradox Basin in Utah contains approximately 2 billion tons, mostly at depths of more than 4,000 feet. An unknown, but large potash resource lies about 7,000 feet under central Michigan. The U.S. reserve figure above contains a conservative 25 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]Average prices based on actual sales; excludes soluble and chemical muriates.

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

[3]See Appendix B.

[4]Potash Corporation of Saskatchewan, 1997, 10-QC Second Quarter of 1997, ending June 30: Securities and Exchange Commission, August 12, p. 11.

[5]Soh, Kim Gai, 1997, Fertilizer demand and crops: International Fertilizer Industry Association, published as supplement of CONTACT No. 14, June, 7 p. (Accessed October 16, 1997, on the World Wide Web at URL http://www.fertilizer.org/CROPS/CROPS/globalag.htm)

[6]See Appendix D for definitions.

[7]Total 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 1997 was $14.1 million. Domestic output came from 14 producers in 6 States. The principal producing States were New Mexico and Oregon, with combined production accounting for about 64% of the national total. The remaining production was from Arizona, California, Idaho, and Kansas. About 50% of the pumice was consumed for building blocks and the remainder was used in abrasives, concrete, laundries, and many other uses.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, mine[1]	469	490	529	612	538
Imports for consumption	143	143	238	215	155
Exports[e]	18	18	16	13	13
Consumption, apparent	594	615	751	814	680
Price, average value, dollars per ton, f.o.b. mine or mill	25.68	24.08	24.99	24.19	26.29
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number	50	50	60	70	70
Net import reliance[2] as a percent of apparent consumption	21	20	30	25	21

Recycling: Not available.

Import Sources (1993-96): Greece, 87%; Turkey, 6%; Ecuador, 6%; and other, 1%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Crude or in irregular pieces, including crushed pumice	2513.11.0000	Free	Free.
Other	2513.19.0000	0.1¢/kg	1.7¢/kg.

Depletion Allowance: 5% (Domestic), 5% (Foreign).

Government Stockpile: None.

Prepared by **Wallace P. Bolen, (703) 648-7727 [Fax: (703) 648-7722].**

PUMICE AND PUMICITE

Events, Trends, and Issues: The apparent consumption of 680,000 tons in 1997 was 16% less than 1996's apparent consumption. The decrease in consumption was attributed to decreased demand for construction uses, including building block, and laundry uses.

It is estimated that in 1998 domestic mine production of pumice and pumicite will be about 550,000 tons, with U.S. apparent consumption at approximately 750,000 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 cost 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 1997 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[4]	Reserve base[4]
	1996	1997[e]		
United States[1]	612	538	Large	Large
Chile	450	450	NA	NA
France	450	475	NA	NA
Germany	600	550	NA	NA
Greece	1,200	1,200	NA	NA
Italy	4,600	4,500	NA	NA
Spain	600	600	NA	NA
Turkey	1,000	1,000	NA	NA
Other countries	1,600	2,000	NA	NA
World total (rounded)	11,100	11,300	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 B.
[4]See Appendix D for definitions.

QUARTZ CRYSTAL (INDUSTRIAL)

(Data in metric tons, unless otherwise noted)

Domestic Production and Use: Domestic production of cultured quartz crystal has been relatively stable for the past few years. Lascas[1] mining continued in Arkansas, and four U.S. firms produced cultured quartz crystal by using 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:	1993	1994	1995	1996	1997[e]
Production: Mine[2]	454	544	435	435	450
Plant, cultured (as grown)	394	294	351	327	340
Imports for consumption:					
Lascas	NA	NA	NA	NA	NA
Cultured	8	19	47	42	40
Exports:					
Lascas	—	—	90	90	90
Natural electronic	NA	NA	NA	NA	NA
Cultured (mostly lumbered)	24	38	35	89	90
Consumption, apparent:					
Natural electronic	([3])	([3])	([3])	([3])	([3])
Cultured	378	275	363	280	290
Price, average value, dollars per kilogram:					
Lascas	1.23	1.20	1.20	1.20	1.20
Cultured (lumbered)	251.69	300.00	300.00	300.00	300.00
Stocks, producer, yearend:					
Lascas (for cultured crystal only)	150	190	190	190	190
Natural electronic	([3])	([3])	([3])	([3])	([3])
Cultured	200	200	200	200	200
Employment, mine, processing plant, number[e]	10	15	15	15	15
Net import reliance[4] as a percent of apparent consumption, lascas	NA	NA	NA	NA	NA

Recycling: None.

Import Sources (1993-96): This information is no longer available.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Sands:			
Other than natural	2506.10.0010	Free	Free.
Other	2506.10.0050	Free	Free.
Quartzite	2506.21.0000	Free	Free.

Prepared by **Wallace P. Bolen, (703) 648-7727 [Fax: (703) 648-7722].**

QUARTZ CRYSTAL (INDUSTRIAL)

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

Government Stockpile:

Stockpile Status—9-30-97[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Quartz crystal	107	23	107	NA	—

Events, Trends, and Issues: Trends indicate that demand for quartz crystal devices should continue to grow, and consequently, quartz crystal production should remain strong well into the future. Growth of the consumer electronics market (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:

	Mine production		Reserves[7]	Reserve base[7]
	1996	1997[e]		
United States[e 2]	435	450	Moderate	Moderate
Brazil	NA	NA	Large	Large
Other countries	NA	NA	NA	NA
World total	NA	NA	Large	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.

[e]Estimated. NA Not available.

[1]Lascas is a nonelectronic-grade quartz used as a feedstock for growing cultured quartz crystal and for production of fused quartz.

[2]Lascas only; specimen and jewelry material excluded.

[3]Less than ½ unit.

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

[5]See Appendix B.

[6]See Appendix C for definitions.

[7]See Appendix D for definitions.

RARE EARTHS[1]

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

Domestic Production and Use: Rare earths were mined by one company in 1997. 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 $57 million. Refined rare-earth products were produced primarily by three companies; one with a plant in Mountain Pass, CA; another with operations in Phoenix, AZ, and Freeport, TX; and a third 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 1996 by end use was as follows: automotive catalytic converters, 46%; petroleum refining catalysts, 25%; permanent magnets, 12%; glass polishing and ceramics, 7%; metallurgical additives and alloys, 7%; phosphors, 3%; and miscellaneous <1%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production:					
Bastnasite concentrates[2]	17,800	20,700	22,200	20,400	20,000
Monazite concentrates	W	W	—	—	—
Imports:[3] Thorium ore (monazite)	—	—	22	56	—
Rare-earth metals, alloys	235	284	905	429	507
Cerium compounds	1,270	1,890	4,090	4,760	3,390
Mixed REO's	249	354	678	879	833
Rare-earth chlorides	1,080	2,410	1,250	1,070	988
Rare-earth oxide, compounds	3,730	5,140	6,500	10,300	9,060
Ferrocerium, alloys	105	92	78	86	158
Exports:[3] Thorium ore, monazite	3	27	—	—	—
Rare-earth metals, alloys	194	329	444	250	879
Cerium compounds	1,620	4,460	5,120	6,100	6,330
Other rare-earth compounds	1,090	2,410	1,550	2,210	1,640
Ferrocerium, alloys	4,270	3,020	3,470	4,420	3,380
Consumption, apparent[4]	17,000	18,200	W	W	W
Price, dollars per kilogram, yearend:					
Bastnasite concentrate, REO basis	2.87	2.87	2.87	2.87	2.87
Monazite concentrate, REO basis	.40	.46	.44	.48	.44
Mischmetal, metal basis	12.68	12.68	9.50	8.75	8.45
Stocks, producer and processor, yearend	NA	NA	NA	NA	NA
Employment, mine and mill, number	352	350	280	NA	NA
Net import reliance[4] as a percent of apparent consumption	E	E	6	18	12

Recycling: Small quantities, mostly permanent magnet scrap.

Import Sources (1993-96): Monazite: Australia, 86%; France, 14%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Thorium ores and concentrates (monazite)	2612.20.0000	Free	Free.
Rare-earth metals, whether or not intermixed or interalloyed	2805.30.0000	5.0% ad val.	31.3% ad val.
Cerium compounds	2846.10.0000	6.2% ad val.	35% ad val.
Mixtures of REO's except cerium oxide	2846.90.2010	Free	25% ad val.
Mixtures of rare-earth chlorides, except cerium chloride	2846.90.2050	Free	25% ad val.
Rare-earth compounds, individual REO's (excludes cerium compounds)	2846.90.8000	3.7% ad val.	25% ad val.
Ferrocerium and other pyrophoric alloys	3606.90.3000	5.9% ad val.	56.7% ad val.

Depletion Allowance: Percentage method, monazite, 22% on thorium content and 14% on rare-earth content (Domestic), 14% (Foreign); bastnasite and xenotime, 14% (Domestic and Foreign).

Prepared by **James B. Hedrick, (703) 648-7725 [Fax: (703) 648-7722].**

RARE EARTHS

Government Stockpile:

Stockpile Status—9-30-97[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
REO in sodium sulfate	—	455	—	—	—

Events, Trends, and Issues: Domestic demand for rare earths in 1997 was higher than in 1996. The use of rare earths increased as the domestic economy improved with stronger than average growth through the first two quarters of 1997. Imports continued strong going into the third quarter for individual rare-earth metals and compounds, with most import categories slightly behind 1996's record high levels. Exports or rare-earth metals increased primarily to meet overseas demand for permanent magnets. Demand continued to grow for neodymium, used in permanent magnet applications and for cerium, and other rare earths used in automotive catalytic converters. A gadolinium-silicon-germanium-based magnetic refrigerator was demonstrated by scientists from Ames Laboratory and Astronautics Corporation of America.[7] China remained a major source of separated rare-earth compounds and alloys, and is expected to continue as a major world supplier.

The *Third International Conference on f Elements* (lanthanides and actinides) was held in Paris, France, from September 14-19, 1997. The *International Forum on Rare Earths: Technology and Trade*, is scheduled for March 24-26, 1998, in Beijing, China. The conference *Rare Earths '98* is scheduled for October 25-30, 1998, in Freemantle, Western Australia, Australia.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e]		Reserves[8]	Reserve base[8]
	1996	1997		
United States	[9]20,400	20,000	13,000,000	14,000,000
Australia	—	—	5,200,000	5,800,000
Brazil	200	400	280,000	310,000
Canada	—	—	940,000	1,000,000
China	[9]55,000	50,000	43,000,000	48,000,000
Congo (Kinshasa)	5	5	1,000	1,000
India	2,700	2,700	1,100,000	1,300,000
Malaysia	[9]340	300	30,000	35,000
South Africa	—	—	390,000	400,000
Sri Lanka	120	120	12,000	13,000
Former Soviet Union	6,000	6,000	19,000,000	21,000,000
Other countries	5	5	21,000,000	21,000,000
World total (rounded)	84,800	79,500	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 authorized from Molycorp, Inc., personnel.
[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]See Appendix B.
[6]See Appendix C for definitions.
[7]Ames Laboratory, 1997, Next generation of materials advances magnetic refrigeration: Ames, Iowa, Ames Laboratory at Iowa State University press release, June 10, 2 p.
[8]See Appendix D for definitions.
[9]Number reported in published reports or from company representatives.

RHENIUM

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

Domestic Production and Use: During 1997, ores containing rhenium were mined by nine operations. Rhenium compounds are included in molybdenum concentrates derived from porphyry copper deposits in the southwestern United States, and rhenium itself was 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 20% and 60%, 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 1997 was $22 million.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production[1]	12,200	15,500	17,000	14,000	16,000
Imports for consumption	5,900	8,200	12,800	20,800	21,000
Exports			Small		
Consumption: Estimated	6,900	12,900	16,200	24,100	25,000
Apparent	W	W	W	W	W
Price, average value, dollars per kilogram:					
Metal powder, 99.99% pure	1,500	1,560	1,100	900	1,000
Ammonium perrhenate	1,100	1,100	700	500	750
Stocks, yearend, consumer, producer, dealer	W	W	W	W	W
Employment, number			Small		
Net import reliance[2] as a percent of apparent consumption	W	W	W	W	W

Recycling: Small amounts of molybdenum-rhenium and tungsten-rhenium scrap were processed during the past few years by several companies.

Import Sources (1993-96): Chile, 55%; Germany, 19%; the Netherlands, 8%; the United Kingdom, 5%; and other, 13%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Other inorganic acids, other—rhenium, etc.	2811.19.6050	4.2% ad val.	25% ad val.
Salts of peroxometallic acids, other—ammonium perrhenate	2841.90.2000	3.1% ad val.	25% ad val.
Rhenium, etc., (metals) waste and scrap	8112.91.0500	Free	Free.
Rhenium, (metals) unwrought; powders	8112.91.5000	3.3% ad val.	25% ad val.
Rhenium, etc., (metals) wrought; etc.	8112.99.0000	4.6% ad val.	45% ad val.

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

Government Stockpile: None.

Prepared by **John W. Blossom, (703) 648-4964 [Fax: (703) 648-7757].**

RHENIUM

Events, Trends, and Issues: During 1997, the rhenium metal price averaged $1,000 per kilogram for rhenium metal and $750 per kilogram for ammonium perrhenate. Imports of rhenium increased slightly for 1997 compared with those of 1996. Chile and Germany supplied the majority of the rhenium imported. The United States relies on imports for much of its supply of rhenium.

It is estimated that in 1998 U.S. consumption of rhenium will be about 26,000 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[4]	Reserve base[4]
	1996	1997		
United States	14,000	16,000	390,000	4,500,000
Armenia	100	100	95,000	120,000
Canada	1,500	1,500	32,000	1,500,000
Chile	4,000	4,000	1,300,000	2,500,000
Kazakstan	200	200	190,000	250,000
Peru	2,000	2,000	45,000	550,000
Russia	500	500	310,000	400,000
Uzbekistan	300	300	59,000	400,000
Other countries	100	100	91,000	360,000
World total (may be rounded)	22,700	24,700	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 Kazakstan, 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. W Withheld to avoid disclosing company proprietary data.
[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 B.
[4]See Appendix D 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 1997, one company offered 1-gram ampoules of 99.8%-grade rubidium metal at $45.40. The price for 100 grams of the same material from this company was $612.00, or $6.12 per gram. At another company, the price for a 1-gram ampoule of 99.6% pure rubidium was $32.25.

Recycling: None.

Import Sources (1993-96): 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	Most favored nation (MFN) 12/31/97	Non-MFN[1] 12/31/97
Alkali metals, other	2805.19.0000	6.2% ad val.	25% ad val.

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

Government Stockpile: None.

Prepared by **Robert G. Reese, Jr., (703) 648-4981 [Fax: (703) 648-7757].**

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:[2] 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 principle ore of rubidium. Pollucite, the cesium aluminosilicate mineral, may contain up to 1.35% rubidium. The rubidium-bearing minerals are mined as by-products 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 B.
[2]See Appendix D for definitions.

RUTILE[1]

(Data in thousand metric tons of contained TiO_2, unless otherwise noted)

Domestic Production and Use: Rutile was produced at one mine in Florida. At two other mines in Florida, rutile was included in a bulk concentrate containing mostly ilmenite and leucoxene. The major coproduct of these mines is zircon. Synthetic rutile was produced at one plant in Alabama. Domestic ilmenite production data was withheld to avoid revealing company proprietary data. The value of U.S. rutile consumption in 1996, including synthetic rutile, was about $196 million. Two firms, with facilities in Nevada and Oregon, used titanium tetrachloride primarily made from rutile to manufacture titanium. Of 28 consuming firms, mainly in the Eastern United States, 5 companies used 93% of the rutile consumed to produce titanium dioxide (TiO_2) pigment. Welding-rod coatings and miscellaneous applications, which include fiberglass, titanium metal and welding-rod coatings, consumed about 7%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production	W	W	W	W	W
Imports for consumption[2]	349	311	295	305	329
Exports[e]	3	4	6	3	5
Shipments from Government stockpile excesses	1	18	17	—	—
Consumption, reported[2]	436	478	439	365	383
Price, dollars per ton of rutile, yearend:					
Bulk, f.o.b. Australian ports	378	420	600	563	530
Stocks, mine, distributor and consumer, yearend	179	141	52	77	80
Employment, mine and mill,[3] number	395	400	400	400	400
Net import reliance[4] as a percent of apparent consumption	W	W	W	W	W

Recycling: None.

Import Sources (1993-96): Australia, 51%; South Africa, 36%; Sierra Leone, 9%; and other, 4%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Rutile concentrate	2614.00.6040	Free	Free.
Synthetic rutile	2614.00.3000	Free	30% ad val.

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

Government Stockpile: None.

Prepared by **Joseph M. Gambogi, (703) 648-7718 [Fax: (703) 648-7722].**

RUTILE

Events, Trends, and Issues: Based on increased production of titanium pigment, domestic consumption of rutile concentrates was estimated to have increased 5% compared with 1996. In 1997, imports of all rutile concentrates were estimated to have increased 8% compared with 1996. Although imports of natural rutile decreased 2%, imports of synthetic rutile increased 20% compared with 1996. Increased availability of rutile concentrates caused prices to decrease 6% compared with 1996.

Exploration and development of titanium mineral deposits continued in 1997. These activities were most evident in Africa, Australia, Canada, India, Indonesia, Mozambique, Russia, Ukraine, the United States, and Vietnam. Producers continued efforts to develop higher grade concentrates. In Australia, a synthetic producer completed a project to produce an upgraded product lower in uranium and thorium content. Sierra Leone's loss as a major source of natural rutile continued to affect the global market.

Fewer environmental pollution problems are encountered when pigment is produced from rutile rather than ilmenite. The chloride process, using a rutile feed, generates about 0.2 ton of waste per ton of TiO_2 product; the sulfate process, using ilmenite, generates about 3.5 tons of waste per ton of product. Producing synthetic rutile from ilmenite results in about 0.7 ton of waste, mainly iron oxide, per ton of product. Direct chlorination of ilmenite generates about 1.2 tons of waste, mainly ferric chloride, per ton of TiO_2.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1996	1997[e]		
United States	W	W	500	1,800
Australia	171	190	4,300	43,000
Brazil	2	2	40	85,000
India	13	13	6,600	7,700
Italy	—	—	—	8,800
Sierra Leone	—	—	3,100	3,100
South Africa	108	108	8,300	8,300
Sri Lanka	3	2	4,800	4,800
Thailand	3	4	NA	NA
Ukraine	95	95	2,500	2,500
World total (may be rounded)	[7]395	[7]414	30,000	170,000

World Resources: Identified world resources of rutile (including anatase) total about 230 million tons of contained TiO_2. Major rutile resources occur in Australia, India, Italy, Sierra Leone, South Africa, and the United States.

Substitutes: Ilmenite, titaniferous slag, and synthetic rutile made from ilmenite may be used instead of natural rutile for making pigment, metal, and welding-rod coatings.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]See also Ilmenite and Titanium and Titanium Dioxide.
[2]Includes synthetic rutile.
[3]Employment at three sand deposit operations in Florida, which produced either rutile concentrate or a titanium mineral concentrate, where ilmenite and zircon were major coproducts and where employees were not assigned to specific commodities.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix B.
[6]See Appendix D for definitions.
[7]Excludes U.S. production.

SALT

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Domestic production of salt decreased slightly in 1997, with total value estimated at $960 million. Twenty-seven companies operated 67 plants in 14 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 42% of total salt sales, with salt brine representing about 90% of the type of salt used for feedstock. Chlorine and caustic soda manufacture was the main consuming sector within the chemical industry. Salt for highway deicing accounted for 34% of U.S. demand. The remaining markets for salt, in declining order, were distributors, 9%; industrial, 7%; food and agricultural, 3% each; primary water treatment and other, 1% each.

Salient Statistics—United States:[1]	1993	1994	1995	1996	1997[e]
Production	39,200	40,100	42,100	42,200	41,700
Sold or used by producers	38,200	39,700	40,800	42,900	41,400
Imports for consumption	5,870	9,630	7,090	10,600	8,000
Exports	688	742	670	869	675
Consumption: Reported	44,400	47,200	46,500	52,800	48,700
Apparent	43,400	48,600	47,200	52,600	48,700
Price, average value of bulk, pellets and packaged salt, dollars per ton, f.o.b. mine and plant:					
Vacuum and open pan salt	111.97	115.35	118.63	120.54	120.00
Solar salt	34.51	34.77	30.82	39.97	39.00
Rock salt	20.28	22.33	21.80	22.14	21.00
Salt from brine	5.24	5.40	6.91	6.72	6.00
Stocks, producer, yearend[e 2]	1,000	400	1,300	1,400	300
Employment, mine and plant, number	4,150	4,150	4,150	4,150	4,150
Net import reliance[3] as a percent of apparent consumption	12	18	14	19	14

Recycling: None.

Import Sources (1993-96): Canada, 41%; Mexico, 22%; Chile, 17%; The Bahamas, 12%; and other, 8%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Iodized salt	2501.00.0000	Free	26% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: The U.S. Department of Justice in April approved the acquisition of a major U.S. salt company by another large domestic salt producer. The judgement required that the acquired vacuum pan salt plant in Watkins Glen, NY, be divested to maintain competition in the region. The decision also required the divestiture of the mining rights to the Hampton Corners, NY, rock salt project. The mining rights, salt inventories, and certain mining equipment were acquired by a group that formed a new salt company that planned to construct a new rock salt mine. The company was still arranging for the financing of the venture by yearend.

A major U.S. salt company purchased for $195 million a two-thirds interest in a large salt producer in Europe. The remainder of the shares would be acquired later for an additional $95 million. The European company has a combined capacity of more than 2 million tons of rock salt, solar salt, and vacuum pan salt in France and Spain. This is the first salt venture for the U.S. firm outside of the Western Hemisphere.

A Netherlands-based salt company announced it planned to construct a solar salt facility at Onslow, Western Australia. The proposed solar salt plant will have an annual capacity of 2.5 million tons and cost $50 million to build. The demand for high-quality solar salt for chloralkali manufacture in Asia was cited as the main reason for the decision to build the facility.

Prepared by **Dennis S. Kostick, (703) 648-7715 [Fax: (703) 648-7722].**

SALT

A project to upgrade a solar salt facility in Israel came on-stream at midyear. New equipment was installed at the plant to modernize its iodized salt products. Solar salt was processed into free flowing, refined table salt with iodine, fluorine, and trace elements added to the salt.

The outlook for the domestic salt industry is favorable for the next few years depending on the severity of this winter's weather. Many weather forecasters were forecasting below-normal temperatures as a result of the El Niño weather phenomenon, which increases the likelihood of adverse conditions requiring large quantities of deicing salt.

World Production, Reserves, and Reserve Base:

	Production		Reserves and reserve base[5]
	1996	1997[e]	
United States[1]	42,200	41,700	Large. Economic and subeconomic deposits of salt are substantial in principal salt-producing countries. The oceans comprise an inexhaustible supply of salt.
Australia	7,905	8,000	
Brazil	5,900	6,000	
Canada	12,289	12,100	
China	28,900	30,000	
France	7,660	7,600	
Germany	10,800	11,000	
India	9,500	9,600	
Italy	3,600	3,600	
Mexico	8,508	8,400	
Poland	4,163	4,000	
Russia	1,600	1,600	
Spain	4,000	4,100	
Ukraine	2,800	2,800	
United Kingdom	6,700	6,700	
Other countries	35,500	34,800	
World total (may be rounded)	192,000	192,000	

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 B.
[5]See Appendix D 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 $4.3 billion was produced by 3,838 companies from 5,562 operations in 49 States. Statistics for Hawaii are excluded from all sand and gravel statistics in 1996 and 1997. Leading States, in order of volume, were California, Michigan, Texas, Ohio, Minnesota, Arizona, Washington, Illinois, Wisconsin, and Colorado, which together accounted for about 52% of the total output. It is estimated that about 41% of the 961 million metric tons of construction sand and gravel produced in 1997 was for unspecified uses. Of the remaining total, about 43% was used as concrete aggregates; 23% 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.; 1% 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 1997 was about 680 million tons, which represents an increase of 2.9% compared with the same period of 1996. 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:	1993	1994	1995	1996	1997[e]
Production	[e]869	891	907	914	961
Imports for consumption	1	1	1	1	1
Exports	1	1	1	1	1
Consumption, apparent	869	891	907	914	961
Price, average value, dollars per ton	4.06	4.20	4.30	4.38	4.46
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e]	42,000	42,500	42,500	42,500	42,500
Net import reliance[3] 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 (1993-96): Canada, 74%; The Bahamas, 15%; Mexico, 3%; and other, 8%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Sand, construction	2505.90.0000	Free	Free.
Gravel, construction	2517.10.0000	Free	30% ad val.

Depletion Allowance: (Domestic and Foreign) Common varieties, 5%.

Government Stockpile: None.

Prepared by **Wallace P. Bolen, (703) 648-7727 [Fax: (703) 648-7722].**

SAND AND GRAVEL (CONSTRUCTION)

Events, Trends, and Issues: Construction sand and gravel output increased 5% in 1997. It is estimated that 1998 domestic production and U.S. apparent consumption will be about 975 million tons each, a 1.5% increase.

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]
	1996	1997[e]	
United States	914	961	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, due to 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 alternative 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]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B.
[5]See Appendix D 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 $512 million was produced by 82 companies from 146 operations in 37 States. Leading States, in order of volume, were Illinois, Michigan, California, New Jersey, and Wisconsin. Combined production from these States represented 44% of the national total. About 37% of the national tonnage was used as glassmaking sand, 23% as foundry sand, 6% as hydraulic fracturing sand, 5% as abrasive sand, and the remainder for many other uses.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production	26,200	27,300	28,200	27,800	28,300
Imports for consumption	44	24	65	7	36
Exports	1,750	1,880	1,870	1,430	800
Consumption, apparent	24,500	25,400	26,400	26,400	27,500
Price, average value, dollars per ton	17.33	17.86	17.82	17.88	18.10
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e]	1,500	1,500	1,450	1,450	1,450
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 (1993-96): Australia, 82%; Guyana, 7%; Canada, 5%; Sweden, 4%; and other, 2%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
95% or more silica and not more than 0.6% iron oxide	2505.10.1000	Free	$1.97/t.

Depletion Allowance: Industrial sand or pebbles, 14% (Domestic and Foreign).

Government Stockpile: None.

Prepared by **Wallace P. Bolen, (703) 648-7727 [Fax: (703) 648-7722].**

SAND AND GRAVEL (INDUSTRIAL)

Events, Trends, and Issues: The United States was the world's largest producer and consumer of industrial sand and gravel based on estimated world production figures. However, 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. Through August 1997, exports of industrial sand and gravel were estimated to have decreased nearly 45%, compared to 1996. Most of this decrease was attributed to a reduction in Canadian demand. 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).

Industrial sand and gravel sold or used increased about 1.8% in 1997 compared with 1996. It is estimated that 1998 domestic production and U.S. 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 1997. Local shortages were expected to continue to increase owing to local zoning regulations and land development alternatives. This is 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[4]
	1996	1997	
United States	27,800	28,300	Large. Silica is abundant in the Earth's crust. The reserves and reserve base are determined by the location of population centers.
Australia	2,500	2,500	
Austria	7,000	6,750	
Belgium	2,300	2,200	
Brazil	2,700	2,700	
Canada	1,670	1,600	
France	6,500	6,800	
Germany	7,500	7,000	
India	1,250	1,280	
Italy	3,000	3,000	
Japan	3,560	3,500	
Mexico	1,470	1,500	
Netherlands	24,000	24,000	
Paraguay	7,000	7,000	
South Africa	2,170	2,000	
Spain	2,800	2,700	
Sweden	1,500	1,500	
United Kingdom	2,000	2,200	
Other countries	10,300	8,500	
World total (rounded)	117,000	115,000	

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 B.
[4]See Appendix D for definitions.

SCANDIUM

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

Domestic Production and Use: Demand for scandium increased in 1997. Although scandium was not mined domestically in 1997, quantities sufficient to meet demand were available from domestic concentrates and tailings. Principal sources were imports from Russia and tailings previously produced from tantalum processing in Muskogee, OK. Companies that processed scandium ores, concentrates, and low-purity compounds to produce refined scandium products were located in Mead, CO; Urbana, IL; and Newport, 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 1997 were metallurgical research, high-intensity metal halide lamps, analytical standards, electronics, and laser research.

Salient Statistics—United States:	1993	1994	1995	1996	1997[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	1,600	1,600	1,500	1,400	1,400
Per kilogram, oxide, 99.9% purity	3,300	3,300	3,300	2,900	2,900
Per kilogram, oxide, 99.99% purity	5,200	5,200	5,100	4,400	4,400
Per kilogram, oxide, 99.999% purity	9,000	9,000	7,650	6,750	6,750
Per gram, powder, metal[1]	372.00	372.00	372.00	372.00	285.00
Per gram, sublimed, metal[2]	312.00	169.00	169.00	169.00	172.00
Per gram, scandium bromide, 99.99% purity[3]	80.00	80.00	80.00	80.00	90.00
Per gram, scandium chloride, 99.9% purity[3]	62.00	37.00	37.00	37.00	38.80
Per gram, scandium fluoride, 99.9% purity[3]	129.00	77.00	77.00	77.00	78.50
Per gram, scandium iodide, 99.999% purity[3]	78.00	78.00	78.00	78.00	148.00
Stocks	NA	NA	NA	NA	NA
Employment, processors, number	12	12	8	5	4
Net import reliance[4] as a percent of apparent consumption	NA	NA	NA	NA	NA

Recycling: Minor, recovered from laser crystal rods.

Import Sources (1993-96): Not available.

Tariff: Item	Number	Most-favored-nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Mineral substances not elsewhere specified or included: Including scandium ores	2530.90.0000	Free	0.3¢/kg.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed including scandium	2805.30.0000	5.0% ad val.	31.3% ad val.
Mixtures of rare-earth oxides except cerium oxide, including scandium oxide mixtures	2846.90.2010	Free	25% ad val.
Rare-earth compounds, including individual rare-earth oxides, hydroxides, nitrates, and other individual compounds, including scandium oxide	2846.90.8000	3.7% ad val.	25% ad val.
Aluminum alloys, other: including scandium-aluminum	7601.20.9090	Free	10.5% ad val.

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

Government Stockpile: None.

Prepared by **James B. Hedrick, (703) 649-7725 [Fax: (703) 648-7722].**

SCANDIUM

Events, Trends, and Issues: Nominal prices for domestically produced scandium compounds were unchanged from the previous year. The supply of domestic and foreign scandium remained strong despite increased demand. Although demand increased in 1997, the total market remained very small. Domestic increases in demand were almost exclusively the result of acquisitions for metallurgical research, and new applications in welding wire and scandium-aluminum baseball bats.

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 1997, 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 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, Kazakstan, and Russia. Foreign mine production data were not available. No scandium was mined in the United States in 1997. Scandium occurs in many ores in trace amounts but has not been found in sufficient quantities to be considered a reserve or reserve base.[6] 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, Kazakstan, 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 Kazakstan 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 for Kobe, Japan. Undiscovered scandium resources are thought to be very large.

Substitutes: In scandium's few applications, such as lighting and lasers, it is generally not subject to substitution.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Less than 250 micron, 99.9% purity, 1993 through 1997 prices converted from 0.5 gram price, from Alfa Aesar.
[2]Lump, sublimed dendritic 99.99% purity, from Alfa Aesar.
[3]Bromide, chloride, and fluoride in crystalline or crystalline aggregate form and scandium iodide as ultradry powder from Alfa Aesar.
[4]Defined as imports - exports + adjustments for Government and industry stock changes.
[5]See Appendix B.
[6]See Appendix D 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. Three copper refineries, one in Utah and two in Texas, accounted for domestic production of primary selenium. The value of production was $2.4 million. 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, 20% (a decrease); and other, including agriculture and metallurgy, 25% (an increase). In glass manufacturing, selenium was used as a decolorant in 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. Selenium was added to copper, lead, and steel alloys to improve their machinability and to replace lead in brasses for plumbing applications. 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 recently manufactured copiers.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, refinery	283	360	373	379	380
Imports for consumption, metal and dioxide	382	411	324	434	330
Exports, metal, waste and scrap	261	246	270	322	135
Consumption, apparent[1]	460	530	517	543	615
Price, dealers, average, dollars per pound, 100-pound lots, refined	4.90	4.90	4.89	4.00	2.90
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	39	31	38	40	41

Recycling: There was no domestic production of secondary selenium. Scrap xerographic materials were exported for recovery of the contained selenium. An estimated 45 tons of selenium metal recovered from scrap was imported in 1997.

Import Sources (1993-96): Canada, 39%; the Philippines, 28%; Belgium, 12%; Japan, 9%; and other, 12%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Selenium metal	2804.90.0000	Free	Free.
Selenium dioxide	2811.29.2000	Free	Free.

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

Government Stockpile: None.

Prepared by **Robert D. Brown, Jr., (703) 648-4984 [Fax: (703) 648-7757].**

SELENIUM

Events, Trends, and Issues: Domestic selenium demand increased moderately in 1997. World selenium demand and production remained at about the 1996 level, so the oversupply situation was not eased significantly. The price continued the steady decline begun in 1996. The use of selenium in glass remained strong. Use in copiers continued to decline, while use as a metallurgical additive increased.

The use of selenium as an additive to no-lead, free-machining brass for plumbing applications began to increase. Ordinary free-machining brass contains up to 7% lead. Industry consortia have tested several lead-free brasses that could be used as substitutes as more stringent regulation of lead in drinking water takes effect. Bismuth is the main replacement additive; however, its supply is limited and selenium reduces the quantity of bismuth needed, without adverse effect on alloy properties.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[4]	Reserve base[4]
	1996	1997[e]		
United States	379	380	10,000	19,000
Belgium	250	250	—	—
Canada	561	560	7,000	15,000
Chile	46	45	19,000	30,000
Finland	30	30	—	—
Germany	120	120	—	—
Japan	610	600	—	—
Peru	21	20	2,000	5,000
Philippines	40	40	2,000	3,000
Serbia and Montenegro	30	30	1,000	1,000
Sweden	30	30	—	—
Zambia	20	20	3,000	6,000
Other countries	13	10	27,000	55,000
World total (rounded)	[5]2,150	[5]2,100	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; and bismuth, lead, and tellurium in free-machining alloys.

[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 B.
[4]See Appendix D for definitions.
[5]In addition to the countries listed, Australia, China, India, Kazakstan, Russia, the United Kingdom, and Zimbabwe are known to produce refined selenium.

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 1997 was about $650 million. Ferrosilicon was produced by five companies in six plants, and silicon metal was produced by five companies in eight 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:	1993	1994	1995	1996	1997[e]
Production	367	390	396	412	424
Imports for consumption	212	255	250	227	256
Exports	31	32	47	44	41
Consumption, apparent	557	616	609	594	637
Price,[1] average, cents per pound Si:					
Ferrosilicon, 50% Si	40.8	43.9	57.9	64.0	55
Ferrosilicon, 75% Si	40.6	40.8	58.1	62.2	48
Silicon metal	66.4	64.1	69.5	89.7	82
Stocks, producer, yearend	48	45	35	35	37
Net import reliance[2] as a percent of apparent consumption	34	37	35	31	34

Recycling: Insignificant.

Import Sources (1993-96): Norway, 24%; Russia, 15%; Brazil, 15%; Canada, 11%; and other, 35%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Ferrosilicon, 55%-80% Si:			
More than 3% Ca	7202.21.1000	1.1% ad val.	11.5% ad val.
Other	7202.21.5000	1.5% ad val.	11.5% ad val.
Ferrosilicon, 80%-90% Si	7202.21.7500	1.9% ad val.	9% ad val.
Ferrosilicon, more than 90% Si	7202.21.9000	5.8% ad val.	40% ad val.
Ferrosilicon, other:			
More than 2% Mg	7202.29.0010	Free	4.4¢/kg Si.
Other	7202.29.0050	Free	4.4¢/kg Si.
Silicon, more than 99.99% Si	2804.61.0000	1.5% ad val.	25% ad val.
Silicon, 99.00%-99.99% Si	2804.69.1000	5.3% ad val.	21% ad val.
Silicon, other	2804.69.5000	6.9% ad val.	45% ad val.

Depletion Allowance: Quartzite, 14% (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 1997 is projected as 7% greater than the average for 1993-96. Of the 1997 total, ferrosilicon is estimated to account for 54% and silicon metal 46%. Growth in demand for ferrosilicon is expected to be at an annual rate in the range of 1% to 2%, in line with trends in domestic steel production. Growth in demand for silicon metal is expected to be greater, with annual growth rates in demand expected to be about 3% from the aluminum industry and 8% from the chemical industry. The chemical industry, principally silicones, may soon overtake the aluminum industry as the largest user of metal.

In terms of contained silicon, domestic production, particularly for silicon metal, continued its upward trend in 1997. Indications were that domestic producers would be increasing their output of metal, possibly at some expense to ferrosilicon production. In the latter part of the year, a domestic producer announced its intention to invest in a Norwegian producer of silicon products, to include partial acquisition of ferrosilicon facilities.

Prepared by **Thomas S. Jones, (703) 648-4973 [Fax: (703) 648-7757].**

SILICON

Prices for silicon materials in the U.S. market declined through at least the first three quarters of the year, especially for 75%-grade ferrosilicon. Prices decreased significantly for ferrosilicon in January; prices for metal began to fall in June. As of the end of September, dealer import prices, in cents per pound of contained silicon, were 53 to 56 for 50%-grade ferrosilicon, 46 to 48 for 75%-grade ferrosilicon, and 76 to 78 for silicon metal.

The domestic industry was operating in an environment whose uncertainties included the outcome of lawsuits and trade actions. The lawsuits were claiming damages from price fixing alleged to have occurred around 1990. Antidumping margins imposed in the 1990's on imported ferrosilicon and/or silicon from China and various Latin American countries and republics of the Former Soviet Union were still subject to review. Especially for silicon metal from Brazil, final determination of margins set by the U.S. Government were going through a complicated process of resolution for annual review periods going back to 1991-92.

World Production, Reserves, and Reserve Base:

	Production[e] 1996	Production[e] 1997
United States	412	424
Australia	29	29
Brazil	318	310
Canada	58	66
China	780	810
Egypt	29	29
France	140	140
Iceland	47	47
India	55	55
Kazakstan	77	78
Norway	408	420
Poland	47	47
Russia	267	260
Slovakia	20	20
South Africa	97	100
Spain	24	31
Ukraine	195	190
Venezuela	32	32
Other countries	130	140
World total (rounded)	3,200	3,200

Reserves and reserve base[4]

The reserves and reserve base in most major producing countries are ample in relation to demand. Quantitative estimates are not available.

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 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 B.
[4]See Appendix D for definitions.

SILVER

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

Domestic Production and Use: Silver, produced by about 76 mines in 16 States, had an estimated value of $238 million in 1997. Nevada (39%), Idaho (15%), and Arizona (12%), were the largest producing States. Precious metal ores accounted for approximately one-half of domestic silver production; the other one-half was recovered as a by-product from copper, lead, and zinc ores. There were 22 principal refiners of commercial-grade silver with an estimated output of approximately 3,900 tons. About 30 fabricators accounted for more than 90% of the silver consumed in arts and industry. The remainder was consumed mostly by small companies and artisans. Aesthetic uses of silver for decorative articles, jewelry, tableware, and coinage were overshadowed by industrial and technical uses. Industrial and technical uses include photographic materials, electrical products, brazing alloys, dental amalgam, bearings, and catalysts.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Mine	1,640	1,490	1,560	1,570	1,600
Refinery: Primary	1,790	1,810	NA	NA	NA
Secondary	2,020	1,700	NA	NA	NA
Imports for consumption[2]	2,500	2,600	3,250	3,010	3,300
Exports[2]	811	967	2,890	2,950	3,000
Shipments from Government stockpile excesses	404	186	220	232	300
Price, average, New York, dollars per troy ounce	4.30	5.29	5.15	5.19	4.62
Stocks, yearend: Treasury Department[3]	912	882	765	740	740
COMEX, CBT[4]	10,500	10,400	6,290	4,550	5,000
Department of Defense	34	15	13	10	10
Employment, mine and mill,[5] number	1,100	1,000	1,200	1,400	1,400

Recycling: About 2,000 tons of silver was recovered from recycled material in 1997.

Import Sources[2] (1993-96): Canada, 26%; Mexico, 23%; Germany, 9%; Peru, 9%; Chile, 7%; and other, 26%.

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

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

Government Stockpile:

Stockpile Status—9-30-97[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Silver	1,220	—	1,220	280	271

Prepared by Henry E. Hilliard, (703) 648-4970 [Fax: (703) 648-7757].

SILVER

Events, Trends, and Issues: Domestic mine production of silver in 1997 increased by about 2% from production in 1996. Domestic consumption of silver was estimated to have increased slightly, owing to increased use in the electronic and photographic sectors.

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 15 years, from 1982 through September 30, 1997, the Government has reduced the quantity of silver held in the stockpile from nearly 4,300 tons to about 1,200 tons.

The average price of silver through the first 9 months of 1997 was $4.628 per ounce, which was down from the average $5.19 per ounce through the first 9 months of 1996. The silver price at the end of 1996 was at about $4.73 per ounce. The price began to rise in January 1997, briefly breaking through the $5.00 mark on January 27 before falling back. The highest price of the year occurred on February 27 at $5.26 per ounce. The price remained above $5.00 until April 1, falling back to $4.74 on April 4. During the next 4 months the price of silver fluctuated between $4.30 and $4.95. The price on September 30, 1997, was $5.21 per ounce.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7]	Reserve base[7]
	1996	1997[e]		
United States	1,570	1,600	31,000	72,000
Australia	1,020	1,100	29,000	33,000
Canada	1,230	1,200	37,000	47,000
Mexico	2,500	2,500	37,000	40,000
Peru	1,970	2,000	25,000	37,000
Other countries	6,910	6,900	120,000	190,000
World total (may be rounded)	15,200	15,300	280,000	420,000

World Resources: Approximately two-thirds of world silver resources are associated with copper, lead, and zinc deposits. The remaining one-third is in vein deposits in which silver 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.

Substitutes: Aluminum and rhodium substitute 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, film with reduced silver content, and xerography are alternatives to some uses of silver in photography.

[e]Estimated. 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]Balance in Mint only.
[4]COMEX: Commodity Exchange Inc., New York. CBT: Chicago Board of Trade.
[5]Source: Mine Safety and Health Administration.
[6]See Appendix C for definitions.
[7]Includes silver recoverable from base metal ores. See Appendix D for definitions.

SODA ASH

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Five companies in Wyoming and one in California composed the U.S. soda ash (sodium carbonate) industry, which was the largest in the world. The six producers, with a combined annual nameplate capacity of 12 million tons, operated at 86% 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 1997 was $822 million.[1]

Based on final 1996 data, the estimated 1997 reported distribution of soda ash by end use was glass, 48%; chemicals, 27%; soap and detergents, 12%; distributors, 5%; pulp and paper, 3%; flue gas desulfurization and other, 2% each; and water treatment, 1%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production[2]	8,960	9,320	10,100	10,200	10,400
Imports for consumption	89	79	83	107	110
Exports	2,800	3,230	3,570	3,840	4,000
Consumption: Reported	6,310	6,260	6,500	6,390	6,480
Apparent	6,350	6,240	6,510	6,470	6,480
Price: Quoted, yearend, soda ash, dense, bulk, f.o.b. Green River, WY, dollars per short ton	98.00	105.00	105.00	105.00	105.00
F.o.b. Searles Valley, CA, same basis	123.00	130.00	130.00	130.00	130.00
Average sales value (natural source), f.o.b. mine or plant, same basis	74.34	70.44	74.50	82.60	79.00
Stocks, producer, yearend	274	203	306	271	300
Employment, mine and plant, number	2,800	2,800	2,800	2,800	2,800
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 (1993-96): Canada, 99%; and other, 1%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Disodium carbonate	2836.20.0000	1.2% ad val.	8.5% ad val.

Depletion Allowance: 14% (Domestic), 14% (Foreign). For natural only.

Government Stockpile: None.

Events, Trends, and Issues: The world's largest soda ash producer, based in Belgium, acquired a 60% share of the Bulgarian soda ash facility, which is the world's largest synthetic soda ash plant for $160 million. A Turkish glass manufacturer obtained 25% of these shares, providing it a 17% ownership in the whole company. This transaction led to an investigation by the Italian antitrust agency that concluded that the Belgian soda ash producer, which also operated a soda ash plant in Italy, represented a quasi monopoly because the Bulgarian purchase would eliminate that company's only competitor in the Italian market. To alleviate the problem, the Belgian company compromised and agreed to withdraw its support of the antidumping investigation conducted by the European Union (EU) Commission, thereby clearing the way for rescinding the antidumping duties on October 13 that were imposed on U.S. soda ash imports into the EU.

A second Japanese synthetic soda ash plant closed in late 1997 that had an annual capacity of 220,000 tons. The company is a co-owner of a Wyoming natural soda ash operation, which was in the process of expanding capacity to offset the loss of the plant in Japan.

Prepared by **Dennis S. Kostick, (703) 648-7715 [Fax: (703) 648-7722].**

SODA ASH

Domestic soda ash consumption for the first half of 1997 increased slightly compared with the previous year despite the low price of electrolytic caustic soda. However, caustic soda prices began to rise in July and continued through yearend causing several customers to switch back to soda ash. To bolster declining soda ash prices, the industry announced an $8 per ton price increase on off-list soda ash effective October 1. Although the export market was strong, a shortage of railcars and late deliveries affected both the soda ash-consuming and soda ash-producing industries. As a result, an inventory buildup began in September and a slowdown in production occurred afterward.

The outlook for soda ash through 1998 is very good. World demand for soda ash is expected to grow 1.5% to 2% annually through the remainder of this century. Domestic demand should be slightly higher than in 1998 when a titanium dioxide producer comes on-stream with new technology that will convert byproduct liquid wastes into a marketable product by using more than 230,000 tons of soda ash annually.

World Production, Reserves, and Reserve Base:

	Production		Reserves[5 6]	Reserve base[6]
	1996	1997[e]		
Natural:				
United States	10,200	10,400	[7]23,000,000	[7]39,000,000
Botswana	100	150	400,000	NA
Chad	NA	NA	NA	NA
Kenya	220	220	7,000	NA
Mexico	—	—	200,000	450,000
Turkey	—	—	200,000	240,000
Uganda	NA	NA	20,000	NA
Other countries	—	—	260,000	220,000
World total, natural (rounded)	10,500	10,800	24,000,000	40,000,000
World total, synthetic (rounded)	19,900	19,200	—	—
World total (rounded)	30,400	30,000	—	—

World Resources: Soda ash is obtained from trona and sodium carbonate-rich brines. The world's largest deposit of trona is in the Green River Basin of Wyoming. About 47 billion 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 and Owens Lakes 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]See Appendix B.
[5]The reported quantities are sodium carbonate only. About 1.8 tons of trona yields 1 ton of sodium carbonate.
[6]See Appendix D for definitions.
[7]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 5% compared with that of the 1996. Approximately 45% of total production was a byproduct from facilities that manufacture rayon and various chemicals. The total value of sodium sulfate sold was an estimated $58 million.

Estimates of U.S. sodium sulfate consumption by end use were soap and detergents, 42%; textiles, 15%; pulp and paper, 12%; glass, 11%; and miscellaneous, 20%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Natural	327	298	327	306	320
Synthetic[1]	210	293	318	246	260
Total	537	591	645	551	580
Imports for consumption	163	190	206	177	160
Exports	89	65	66	86	80
Consumption, apparent (natural and synthetic)	616	724	803	639	659
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	76.53	81.25	84.55	88.90	90.00
Stocks, producer, yearend, natural	42	34	16	19	20
Employment, well and plant, number	240	240	240	240	240
Net import reliance[2] as a percent of apparent consumption	13	18	17	14	12

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 (1993-96): Canada, 95%; Mexico, 4%; and other, 1%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Disodium sulfate:			
Saltcake (crude)	2833.11.1000	Free	Free.
Other	2833.11.5000	0.4% ad val.	3.6% ad val.
Anhydrous	2833.11.5010	0.4% ad val.	3.6% ad val.
Other	2833.11.5050	0.4% ad val.	3.6% ad val.

Depletion Allowance: 14% (Domestic), 14% (Foreign); for natural only.

Government Stockpile: None.

Prepared by **Dennis S. Kostick, (703) 648-7715 [Fax: (703) 648-7722].**

SODIUM SULFATE

Events, Trends, and Issues: The domestic sodium sulfate market remained strong in 1997 as sales to the detergent and textile sectors increased. Sodium sulfate producers situated closer to port facilities took advantage of their strategic location to cater to the export market while inland producers increased product sales to domestic customers. Foreign growth continued in sodium sulfate consumption, especially in Mexico, resulting in a decision by the Mexican sodium sulfate producer to increase capacity by 20%.

A synthetic sodium sulfate demand manufacturer in North Carolina completed its project in June to modify its processing technology to recover high-purity, detergent-grade sodium sulfate. The company anticipated selling material to interested detergent customers beginning in 1998.

The outlook for sodium sulfate in 1998 is forecast to be slightly higher than that estimated for 1997, with detergents remaining the largest sodium sulfate-consuming sector. World production and consumption of sodium sulfate is expected to grow in the next few years, especially in Asia and South America.

World Production, Reserves, and Reserve Base:

	Production		Reserves[4]	Reserve base[4]
	1996	1997[e]		
Natural:				
United States	306	320	860,000	1,400,000
Argentina	10	10	NA	NA
Canada	315	300	84,000	270,000
China	650	650	NA	NA
Iran	280	280	NA	NA
Mexico	525	550	170,000	230,000
Spain	650	650	180,000	270,000
Turkey	300	300	100,000	NA
Turkmenistan[5]	100	50	NA	200
Other countries	104	160	100,000	200,000
World total, natural (rounded)	3,200	3,300	[6]3,300,000	[7]4,600,000
World total, synthetic (rounded)	1,700	1,800	—	—
World total (rounded)	4,900	5,100	—	—

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. NA Not available.

[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.

[3]See Appendix B.

[4]See Appendix D for definitions.

[5]Part of the Former Soviet Union. Data are inadequate to formulate reliable estimates for individual countries of the Former Soviet Union.

[6]Excludes Argentina, Iran, and Turkmenistan. Includes nonproducing nations.

[7]Excludes Argentina, Iran, and Turkey. Includes nonproducing nations.

STONE (CRUSHED)[1]

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

Domestic Production and Use: Crushed stone valued at $7.7 billion was produced by 1,500 companies operating 3,700 active quarries in 48 States. Leading States, in order of production, were Pennsylvania, Texas, Florida, Missouri, Illinois, Ohio, Georgia, Virginia, Kentucky, and North Carolina, together accounting for about 51% of the total output. It is estimated that, of the 1.39 billion tons of crushed stone produced in 1997, about 42% was for unspecified uses. Of the remaining total, about 83% was used as construction aggregates mostly for highway and road construction and maintenance; 14% for chemical and metallurgical uses, including cement and lime manufacture; 2% for agricultural uses; and 1% for special uses and products. To provide a more accurate estimate of the consumption patterns for crushed stone, the "unspecified uses" are not included in the above percentages. Of the total crushed stone produced in 1997, about 72% was limestone and dolomite; 15%, granite; 7%, traprock; and the remaining 6%, was shared, in descending order of quantity, by sandstone and quartzite, miscellaneous stone, marble, calcareous marl, slate, volcanic cinder and scoria, and shell.

The estimated output of crushed stone in the 48 conterminous States shipped for consumption in the first 9 months of 1997 was 1.03 billion tons, which represents an increase of about 6.5% compared with the same period of 1996. 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:	1993	1994	1995	1996	1997[e]
Production	1,120	1,230	1,260	1,330	1,390
Imports for consumption	8	9	11	11	11
Exports	5	5	6	3	4
Consumption, apparent	1,123	1,234	1,265	1,338	1,397
Price, average value, dollars per metric ton	5.30	5.39	5.36	5.40	5.55
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill, number[e 3]	76,000	77,000	77,200	77,500	78,000
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 (1993-96): Canada, 53%; Mexico, 27%; The Bahamas, 10%; and other, 10%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Crushed and broken stone	2517.10.0000	Free	30% ad val.

Depletion Allowance: (Domestic and Foreign) 14% for chemical and metallurgical uses; 5% if used for riprap, ballast, road material, concrete aggregate, and similar purposes.

Government Stockpile: None.

Prepared by **Valentin V. Tepordei, (703) 648-7728 [Fax: (703) 648-7722].**

STONE (CRUSHED)

Events, Trends, and Issues: Crushed stone output increased 4.5% in 1997. It is estimated that 1998 domestic production and U.S. apparent consumption will be about 1.45 billion tons each, a 4% increase.

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. This is 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]
	1996	1997[e]	
United States	1,330	1,390	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 chemical and metallurgical use are limited in many geographical 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 aggregate 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]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 B.
[6]See Appendix D for definitions.

STONE (DIMENSION)[1]

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Dimension stone totaling 1.16 million tons (1.28 short tons) valued at $235 million was produced by 139 companies at 228 quarries in 35 States. Dimension stone was used in rough blocks in building, 26%; ashlar, 12%; rough blocks for monuments, 12%; dressed monumental, 4%; and other, 46%. Leading producing States were Georgia, Indiana, Texas, Vermont, and Wisconsin, which together accounted for 50% of the output. Of the total, 44% was granite; 30%, limestone; 13%, sandstone; 2%, slate; 2%, marble; and 9%, other.

Salient Statistics—United States:[2]	1993	1994	1995	1996	1997[e]
Production: Tonnage	1,280	1,190	1,160	1,150	1,160
Value, million dollars	226	218	233	234	235
Imports for consumption, value, million dollars	398	440	478	462	470
Exports, value, million dollars	53	53	52	50	50
Consumption, apparent, value, million dollars	571	605	659	646	655
Price	Variable, depending on type of product				
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill,[3] number	3,000	3,000	3,000	3,000	3,000
Net import reliance[4] as a percent of apparent consumption (based on value)	60	64	64	64	64
Granite only:					
Production	624	499	495	501	500
Imports for consumption	494	NA	NA	NA	NA
Exports (rough and finished)	143	170	158	137	140
Consumption, apparent	975	NA	NA	NA	NA
Price	Variable, depending on type of product				
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill,[3] number	1,500	1,500	1,500	1,500	1,500
Net import reliance[4] as a percent of apparent consumption (based on tonnage)	36	NA	NA	NA	NA

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

Import Sources (1993-96) (based on value): Dimension stone: Italy, 42%; India, 17%; Brazil, 14%; Canada, 14%; and other, 13%. Granite only: Italy, 44%; Spain, 11%; India, 10%; and other, 35%.

Tariff: Dimension stone tariffs ranged from free to 6.6% ad valorem for most favored nations in 1997 according to type, size, value, and degree of preparation.

Prepared by **Lloyd E. Antonides, (703) 648-7710 [Fax: (703) 648-7722].**

STONE (DIMENSION)

Depletion Allowance: 14% (Domestic and Foreign); 5% if used for rubble and other nonbuilding purposes.

Government Stockpile: None.

Events, Trends, and Issues: Wider applications in residential markets, 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. Furthermore, current high commercial vacancy rates and increased competition have caused an increased use of stone to upgrade the appearance of buildings.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base[5]
	1996	1997[e]	
United States[2]	1,150	1,160	Adequate except for certain
Other countries	NA	NA	special types and local
World total	NA	NA	shortages.

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

Substitutes: Substitutes for dimension stone include concrete, steel, aluminum, resin agglomerated stone, and plastics.

[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 D 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, 73%; ferrite ceramic magnets, 9%; pyrotechnics and signals, 9%; and others, 9%.

Salient Statistics—United States:	**1993**	**1994**	**1995**	**1996**	**1997[e]**
Production, strontium minerals	—	—	—	—	—
Imports for consumption:					
Strontium minerals	11,600	16,000	12,700	11,600	12,000
Strontium compounds	15,300	20,000	20,800	20,500	20,500
Exports, compounds	260	1,120	1,160	712	800
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent, celestite and compounds	W	W	W	W	W
Price, average value of mineral imports at port of exportation, dollars per ton	73	68	71	67	70
Stocks, consumer, yearend, celestite only	W	W	W	W	W
Net import reliance[2] as a percent of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1993-96): Strontium minerals: Mexico, 100%. Strontium compounds: Mexico, 87%; Germany, 12%; and other, 1%. Total imports: Mexico, 90%, and Germany, 10%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Mexico 12/31/97	Non-MFN[3] 12/31/97
Celestite	2530.90.0010	Free	Free	0.3¢/kg.
Strontium metal	2805.22.1000	3.7% ad val.	Free	25% ad val.
Compounds:				
Strontium nitrate	2834.29.2000	4.2% ad val.	Free	25% ad val.
Strontium carbonate	2836.92.0000	4.2% ad val.	Free	25% ad val.
Strontium oxide, hydroxide, peroxide	2816.20.0000	4.2% ad val.	Free	25% ad val.

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

Government Stockpile:

Stockpile Status—9-30-97[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Celestite	5,100	—	5,100	—	—

Prepared by **Joyce A. Ober, (703) 648-7717 [Fax: (703) 648-7722].**

STRONTIUM

Events, Trends, and Issues: 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 1998 Annual Materials Plan, announced at the end of September 1997 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.

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

	Mine production		Reserves[6]	Reserve base[6]
	1996	1997[e]		
United States	—	—	—	1,360,000
Algeria	5,400	5,400		
Argentina	9,300	9,000		
China	35,000	35,000		
Iran	20,000	20,000		
Mexico	144,000	150,000	Other:	Other:
Pakistan	2,500	2,500	6,800,000	10,600,000
Spain	91,000	90,000		
Tajikistan	NA	NA		
Turkey	25,000	25,000		
World total (may be rounded)	[7]330,000	[7]340,000	6,800,000	12,000,000

World Resources: Resources in the United States are several times the reserve base. World resources, although not thoroughly evaluated, are thought to exceed 1 billion tons.

Substitutes: 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. W Withheld to avoid disclosing company proprietary data.
[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.
[4]See Appendix C for definitions.
[5]Metric tons of strontium minerals.
[6]See Appendix D for definitions.
[7]Excludes Tajikistan.

SULFUR

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

Domestic Production and Use: In 1997, elemental sulfur and byproduct sulfuric acid were produced at 152 operations in 30 States, Puerto Rico, and the U.S. Virgin Islands. Total shipments were valued at about $450 million. Elemental sulfur production was 10.5 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 58 companies at 137 plants in 26 States, Puerto Rico, 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. Byproduct sulfuric acid, representing 12% of sulfur in all forms, was recovered at 14 nonferrous smelters in 8 States by 10 companies. Domestic elemental sulfur provided 73% of domestic consumption and byproduct acid 10%. The remaining 17% of sulfur consumed was imported sulfur and sulfuric acid. About 90% of sulfur was consumed in the form of sulfuric acid. Agricultural chemicals (primarily fertilizers) comprised 70% of sulfur demand; petroleum refining, 11%; chemicals, organic and inorganic, 7%; and metal mining, 6%. Other uses, accounting for 6% of demand, were widespread because a multitude of industrial products require sulfur in one form or another during some stage in their manufacture.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Frasch	[1]1,900	[e]2,960	[e]3,150	[e]2,900	2,900
Recovered elemental	[2]7,720	7,160	7,250	7,470	7,600
Other forms	1,430	1,380	1,400	1,430	1,400
Total	11,100	11,500	11,800	11,800	11,900
Shipments, all forms	10,500	11,700	12,100	11,800	12,000
Imports for consumption:					
Recovered, elemental	2,040	1,650	2,510	1,620	1,610
Sulfuric acid, sulfur content	797	696	628	678	620
Exports:					
Frasch and recovered elemental	656	899	906	855	690
Sulfuric acid, sulfur content	46	46	56	38	40
Consumption, apparent, all forms	12,600	13,100	14,300	13,200	13,500
Price, reported average value, dollars per ton of elemental sulfur, f.o.b., mine and/or plant	31.86	28.60	43.74	34.48	38.00
Stocks, producer, yearend	1,380	1,160	583	639	600
Employment, mine and/or plant, number	3,100	3,100	3,100	3,100	3,100
Net import reliance[3] as a percent of apparent consumption	12	12	21	10	11

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

Import Sources (1993-96): Frasch and recovered: Canada, 68%; Mexico, 31%; and other, 1%. Sulfuric acid: Canada, 71%; Germany, 10%; Japan, 5%; Mexico, 5%; and other, 9%. Total sulfur imports: Canada, 70%; Mexico, 18%; Germany, 5%; Japan, 3%; and other, 4%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Sulfur, crude or unrefined	2503.00.0010	Free	Free.
Sulfur, all kinds, other	2503.00.0090	Free	Free.
Sulfur, sublimed or precipitated	2802.00.0000	Free	Free.
Sulfuric acid	2807.00.0000	Free	Free.

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

Government Stockpile: None.

Prepared by **Joyce A. Ober, (703) 648-7717 [Fax: (703) 648-7722].**

SULFUR

Events, Trends, and Issues: Domestic sulfur demand was reasonably strong and prices increased slightly over the year. Operating rates at domestic Frasch operations continued below capacity. The parent company of the remaining U.S. Frasch sulfur producer expected to merge with a major fertilizer producer. The two companies participated in joint venture projects in the past. The sulfur mining, marketing, transportation, and the oil and gas portions of the parent were to be spun off as a debt-free independent entity. Regulatory, board of directors, and shareholder approvals were expected by yearend.

The merger of two U.S. railroad companies resulted in logistical problems that effected sulfur availability. Delays in the movement of railcars to oil refineries because engines were unavailable prompted sulfur deliveries by truck, rather than rail, to move sulfur from refineries with no storage facilities. Truck deliveries were not capable of completely remedying the problem. By the end of the third quarter, some refineries were considering temporary shutdowns because the transportation problems were so severe.

Elemental sulfur imports from Canada remained at low levels because some Canadian producers withheld product from the United States market rather than face the possibility of antidumping penalties. The U.S. Department of Commerce (DOC) once again levied antidumping duties against several Canadian sulfur producers for shipments made in 1994 and 1995. Significant in this decision was that DOC established that the cost of sulfur production should be determined at the point where sulfur is separated from hydrogen, not at the wellhead or when the raw material reaches the processing plant.

Discrepancies between trade data published by the Bureau of the Census and information provided by sulfur consumers in the United States and sulfur producers in Canada have raised questions concerning the quantity of elemental sulfur imported by the United States in 1996 and 1997. Solutions to the data problem were being sought.

Domestic sulfur production is expected to increase slightly for the next few years, with Frasch production remaining relatively stable at reduced levels as long as both mines continue to operate. Recovered production should continue its consistent growth. Apparent consumption of sulfur is projected to be 13.8 million tons in 1998.

World Production, Reserves, and Reserve Base:

	Production—All forms		Reserves[5]	Reserve base[5]
	1996	1997[e]		
United States	11,800	11,900	140,000	230,000
Canada	9,010	9,200	160,000	330,000
China	5,470	5,200	100,000	250,000
France	1,200	1,100	10,000	20,000
Iraq	475	475	130,000	500,000
Japan	2,802	2,800	5,000	15,000
Mexico	2,890	2,900	75,000	120,000
Poland	1,769	1,700	130,000	300,000
Russia	4,000	4,000	NA	NA
Saudi Arabia	2,000	2,000	100,000	130,000
Spain	752	700	50,000	300,000
Other countries	10,200	12,000	500,000	1,300,000
World total (may be rounded)	52,400	54,000	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.

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]Includes 10 months of Frasch sulfur data. Two remaining months of Frasch data included with recovered sulfur data to conform with proprietary data requirements.
[2]Includes corresponding Frasch sulfur data for November and December.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B.
[5]See Appendix D for definitions.

TALC AND PYROPHYLLITE

(Data in thousand metric tons, unless noted)

Domestic Production and Use: The total estimated crude ore value of 1997 domestic production was $33 million. There were 17 talc-producing mines in 8 States in 1997. Companies in Montana, New York, Texas, and Vermont accounted for most of the domestic production. Ground talc was consumed in ceramics, 34%; paper, 23%; paint, 19%; plastics, 5%; roofing, 5%; cosmetics, 2%; and other, 12%. Two firms in North Carolina and one firm in California accounted for 100% of domestic pyrophyllite production, which increased slightly from that of 1996. Consumption was in ceramics, refractories, and insecticides, in decreasing order of tonnage.

Salient Statistics—United States:[1]	1993	1994	1995	1996	1997[e]
Production, mine	968	935	1,060	994	1,060
Sold by producers	900	923	901	909	968
Imports for consumption	100	155	146	187	92
Exports	135	154	183	192	197
Shipments from Government stockpile excesses	—	—	—	—	([2])
Consumption, apparent	933	936	1,020	989	955
Price, average, processed dollars per ton	116	126	111	111	122
Stocks, producer, yearend	80	80	80	NA	NA
Employment, mine and mill	800	750	750	750	750
Net import reliance[3] as a percent of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1993-96): China, 39%; Japan, 23%; Canada, 19%; and other, 19%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Crude, not ground	2526.10.0000	0.02¢/kg	0.6¢/kg.
Ground, washed, powdered	2526.20.0000	1% ad val.	35.0% ad val.
Cut or sawed	6815.99.2000	Free	2.2¢/kg.

Depletion Allowance: Block steatite talc: 22% (Domestic), 14% (Foreign). Other: 14% (Domestic), 14% (Foreign).

Government Stockpile:

Stockpile Status—9-30-97[5]
(Metric tons)

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Talc, block and lump	911	—	911	911	64
Talc, ground	988	—	988	988	—

Prepared by **Robert L. Virta, (703) 648-7726 [Fax: (703) 648-7722].**

TALC AND PYROPHYLLITE

Events, Trends, and Issues: Production and sales increased 7% and 6%, respectively, from those of 1996. Apparent consumption decreased 4% and exports increased 3% from those of 1996. Canada was the major importer of U.S. talc. Imports for consumption decreased slightly from those of 1996. Although imports in 1996 were reported to be 187,000 tons, actual imports were estimated to be near 100,000 tons. Canada, China, and Japan supplied approximately 74% of the imported talc.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[6]	Reserve base[6]
	1996	1997[e]		
United States[1]	994	1,060	136,000	544,000
Brazil	510	520	14,000	54,000
China	2,400	2,400	Large	Large
India	580	600	4,000	9,000
Japan	965	965	132,000	200,000
Korea, Republic of	820	820	14,000	18,000
Other countries	1,920	1,900	Large	Large
World total (may be rounded)	8,190	8,270	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 clay and pyrophyllite in ceramics; calcium carbonate, diatomite, kaolin, and mica in paint; calcium carbonate and kaolin in paper; clays, feldspar, mica, silica, and wollastonite in plastics; and calcium carbonate, kaolin, and silica 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.
[6]See Appendix D 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 four companies; tantalum units were obtained from imported concentrates and metal, and from foreign and domestic scrap. Tantalum was consumed mostly in the form of metal powder, ingot, fabricated forms, compounds, and alloys. The major end use for tantalum was in the production of electronic components, more than 60% of use, mainly in tantalum capacitors. The value of tantalum consumed in 1997 was estimated at around $145 million.

Salient Statistics—United States:	1993	1994	1995	1996	1997[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]	170	190	220	290	300
Consumption: Reported, raw material	NA	NA	NA	NA	NA
Apparent	410	430	515	490	500
Price, tantalite, dollars per pound[2]	26.41	26.24	26.98	27.75	28.80
Stocks, industry, processor, yearend	NA	NA	NA	NA	NA
Employment	NA	NA	NA	NA	NA
Net import reliance[3] as a percent of apparent consumption	85	80	80	80	80

Recycling: Combined prompt industrial and obsolete scrap consumed represented about 20% of apparent consumption.

Import Sources (1993-96): Australia, 28%; Thailand, 14%; Germany, 12% (majority of imports of unknown origin); Brazil, 9%; and other, 37%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Synthetic tantalum-columbium concentrates	2615.90.3000	Free	30% ad val.
Tantalum ores and concentrates	2615.90.6060	Free	Free.
Tantalum oxide	2825.90.9000	3.7% ad val.	25% ad val.
Potassium fluotantalate	2826.90.0000	3.1% ad val.	25% ad val.
Tantalum, unwrought:			
Waste and scrap	8103.10.3000	Free	Free.
Powders	8103.10.6030	3% ad val.	25% ad val.
Alloys and metal	8103.10.6090	3% ad val.	25% ad val.
Tantalum, wrought	8103.90.0000	4.8% ad val.	45% ad val.

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

Government Stockpile: For fiscal year (FY) 1997, ending September 30, 1997, the Defense Logistics Agency (DLA) sold about 1 ton of tantalum contained in tantalum carbide valued at about $135,000 and about 9 tons of tantalum contained in tantalum oxide valued at about $1.1 million. For FY 1998, in October 1997, the DLA sold an additional 1 ton of tantalum contained in tantalum carbide valued at about $131,000 and 9 tons of tantalum contained in tantalum oxide valued at about $1.3 million. The sales exhausted the Annual Materials Plan quantity for tantalum carbide and tantalum oxide disposals for each of fiscal years 1997 and 1998. Additionally, the Department of Defense planned to dispose of about 45 tons of tantalum contained in tantalum minerals from the National Defense Stockpile (NDS) in FY 1998. The NDS uncommitted inventories shown below include a small quantity in nonstockpile-grade tantalum capacitor-grade metal powder and about 454 tons of tantalum contained in nonstockpile-grade minerals.

Prepared by **Larry D. Cunningham, (703) 648-4977 [Fax: (703) 648-7757].**

TANTALUM

Stockpile Status—9-30-97[5]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Tantalum:					
Carbide powder	12	—	2	1	1
Metal:					
Capacitor-grade	73	—	—	—	—
Ingots	111	—	—	—	—
Minerals	1,130	—	340	—	—
Oxide	65	—	9	—	9

Events, Trends, and Issues: Overall consumption of tantalum improved in 1997, with continued strong demand for tantalum capacitor-grade powder in the electronics sector. 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 1996. For the same period, imports for consumption of tantalum mineral concentrates were down, with Australia supplying almost 50% of quantity and more than 60% of value. Exports continued to rise with increased shipments of tantalum concentrates to Brazil and China, and tantalum waste and scrap to China. In late October the published spot price for tantalite ore was quoted in the range of $32 to $34 per pound of contained pentoxide. The most recent industry source on tantalum prices indicated that the average selling prices for some tantalum products were as follows (per pound of contained tantalum): powder, $100 to $180; wire, $170 to $250; and sheet, $100 to $150. Tantalum oxide was selling at an average of $40 to $90 per pound of oxide, and the average selling price for tantalum carbide was $45 to $60 per pound.

It is estimated that in 1998 domestic mine production will be zero and U.S. apparent consumption will be around 500 tons.

World Mine Production, Reserves, and Reserve Base:

	Mine production[e 6] 1996	Mine production[e 6] 1997	Reserves[e 7]	Reserve base[e 7]
United States	—	—	—	Negligible
Australia	276	290	4,500	9,100
Brazil	55	50	900	1,400
Canada	48	50	1,800	2,300
Congo (Kinshasa)[8]	—	—	1,800	4,500
Nigeria	2	2	3,200	4,500
Zimbabwe	2	2	NA	NA
Other countries[9]	—	1	1,400	1,800
World total (may be rounded)	383	395	14,000	24,000

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)[8], and Nigeria. The United States has about 1,400 tons of tantalum resources in identified deposits, most of which were considered uneconomic at 1997 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; glass, titanium, zirconium, columbium, and platinum in corrosion-resistant equipment; and tungsten, rhenium, molybdenum, iridium, hafnium, and columbium in high-temperature applications.

[e]Estimated. NA Not available.
[1]Metal, alloys, and synthetic concentrates; exclusive of waste and scrap.
[2]Average value, contained tantalum pentoxides, 60% basis.
[3]Defined as imports - exports + adjustments for Government and industry stock changes.
[4]See Appendix B.
[5]See Appendix C for definitions.
[6]Excludes production of tantalum contained in tin slags.
[7]See Appendix D 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 1997, 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, 10%; and other uses, 5%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, refinery	W	W	W	W	W
Imports for consumption:					
Unwrought, waste and scrap[1]	45	27	46	74	68
Exports	NA	NA	NA	NA	NA
Consumption, apparent	NA	NA	NA	NA	NA
Price, dollars per pound, 99.7% minimum[2]	32	26	23	21	19
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 (1993-96): The United Kingdom, 23%; the Philippines, 22%; Canada, 17%; Japan, 15%; and other, 23%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[4] 12/31/97
Metal	2804.50.0000	Free	25.0% ad val.

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

Government Stockpile: None.

Prepared by **Robert D. Brown, Jr., (703) 648-4984 [Fax: (703) 648-7757].**

TELLURIUM

Events, Trends, and Issues: Domestic and world tellurium demand decreased in 1997, but world production remained steady, resulting in continued oversupply. Detailed information on the world tellurium market was not available.

Cadmium telluride remains one of the most promising thin-film photovoltaic (PV) module compounds for power generation, achieving some of the highest power conversion ratios yet obtained. The most promising application is in Remote Area Power Supplies, mainly in developing countries, where the largest increases in power consumption will occur in the next century.

Smaller, lighter imaging devices based on cadmium-zinc-telluride crystal chips for use in the medical and military areas, specifically cancer detection and nuclear weapons monitoring, are being developed in California. Sharper images result from direct readings of the signals produced without the need for the analog-to-digital conversion required by the conventional gamma cameras currently in use.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves[5]	Reserve base[5]
	1996	1997[e]		
United States	W	W	3,000	6,000
Canada	62	60	700	1,500
Japan	39	40	—	—
Peru	28	30	500	1,600
Other countries[6]	NA	NA	16,000	29,000
World total (may be rounded)	[7]129	[7]130	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 undeveloped or 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 Code System; 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 B.
[5]See Appendix D for definitions. Tellurium contained in copper resources only.
[6]In addition to the countries listed, Australia, Belgium, China, France, Germany, Kazakstan, the Philippines, Russia, and the United Kingdom produce refined tellurium, but output is not reported and available information is inadequate for formulation of reliable production estimates.
[7]Excludes refinery production from the United States 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 1997. The estimated value of thallium consumed in 1997 was $380,000. Research and development in the use of thallium-base superconductor materials accounted for a significant portion of domestic consumption in 1997. Thallium also was used in electronics, alloys, glass manufacturing, and pharmaceuticals.

Salient Statistics—United States:	**1993**	**1994**	**1995**	**1996**	**1997[e]**
Imports for consumption[1]	273	630	1,180	166	200
Exports	NA	NA	NA	NA	NA
Consumption[e]	300	630	700	300	300
Price, metal, dollars per kilogram[2]	800	950	1,100	1,200	1,280
Net import reliance[3] as a percent of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1993-96): Belgium, 42%; Mexico, 31%; and Canada, 27%.

Tariff: Item	Number	Most favored nation (MFN)[4] 12/31/97	Non-MFN[5] 12/31/97
Unwrought; waste and scrap; powders	8112.91.6000	4.6% ad val.	25% ad val.

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

Government Stockpile: None.

Prepared by **Gerald R. Smith, (703) 648-4983 [Fax: (703) 648-7757].**

THALLIUM

Events, Trends, and Issues: Research and development activities of both a basic and applied nature were conducted during 1997 to improve and expand the use of thallium. These experimental activities concerned essentially all existing uses of thallium as well as its potential use in superconductor alloys.

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. The Occupational Safety and Health Administration and the American Conference of Governmental Industrial Hygienists each has set an exposure limit of 0.1 milligram per cubic meter for thallium in workplace air. Thallium, thallium compounds, and metal waste consisting of alloys of thallium are included on the list of materials to which export restrictions are expected to be applied, according to the United Nations Environment Program's Basel Convention currently under discussion.

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

	Mine production		Reserves[7]	Reserve base[7]
	1996	1997		
United States	([8])	([8])	32,000	120,000
Other countries	15,000	15,000	350,000	530,000
World total (may be rounded)	15,000	15,000	380,000	650,000

World Resources: World resources of thallium contained in zinc resources total about 17 million kilograms; most are located in Europe, Canada, 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]See Appendix B.
[6]Estimates, based on thallium content of zinc ores.
[7]See Appendix D for definitions.
[8]Thallium contained in mined base-metal ores, estimated at 450 to 500 kilograms per year, is separated from the base metals but not extracted for commercial use.

THORIUM

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

Domestic Production and Use: Monazite, a rare-earth and thorium phosphate mineral, is the primary source of the world's thorium. It was not mined domestically in 1997. 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 ceramics, magnesium-thorium alloys, and welding electrodes. The value of thorium metal, alloys, and compounds used by the domestic industry was estimated to be about $1 million.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, refinery[1]	—	—	—	—	—
Imports: Thorium ore and concentrates (monazite), gross weight	—	—	40	101	5
Compounds	18	3	20	26	12
Exports: Thorium ore and concentrates (monazite), gross weight	—	33	—	2	—
Compounds	(2)	(2)	(2)	(2)	(2)
Shipments from Government stockpile excesses (thorium nitrate)	—	—	—	—	0.9
Consumption, reported[e]	8.3	3.6	5.4	4.9	NA
Price, yearend, dollars per kilogram:					
Nitrate, welding-grade[3]	5.46	5.46	5.46	5.46	5.46
Nitrate, mantle-grade[4]	22.25	23.30	23.30	14.32	27.00
Oxide, yearend: 99.0% purity[5]	65.00	63.80	NA	64.45	65.55
99.9% purity[5]	NA	NA	88.50	90.00	90.00
99.99% purity	107.00	107.25	107.25	107.25	107.25
Stocks, industrial, yearend	NA	NA	NA	NA	NA
Employment, mine	—	—	—	—	—
Net import reliance[6] as a percent of apparent consumption	NA	NA	NA	NA	NA

Recycling: None.

Import Sources (1993-96): Monazite: Australia, 80%, and France, 20%. Thorium compounds: France, 100%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[7] 12/31/97
Thorium ores and concentrates (monazite)	2612.20.0000	Free	Free.
Thorium compounds	2844.30.1000	6.4% ad val.	35% ad val.

Depletion Allowance: Percentage method: Monazite, 22% on thorium content, 14% on rare-earth and yttrium content (Domestic); 14% (Foreign).

Government Stockpile:

Stockpile Status—9-30-97[8]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Thorium nitrate	3,218	—	2,969	—	—

Events, Trends, and Issues: Domestic mine production of thorium-bearing monazite ceased at the end of 1994 as world demand for thorium-bearing ores declined. Imports and existing stocks supplied essentially all thorium consumed in the United States in 1997. Imports of thorium compounds decreased from the previous year. Overall, domestic demand for thorium metal, alloys, and compounds continues to decline. Thorium consumption in the United States declined in 1996 and remained small at 4.9 tons. Worldwide demand for thorium remained low.

Prepared by **James B. Hedrick, (703) 648-7725 [Fax: (703) 648-7722].**

THORIUM

Based on data through July 1997, the average value of thorium compounds was $25.77 per kilogram gross weight. A theory developed by Italian physicist and past director of the European Laboratory for Particle Physics (CERN) to create a fuel cycle using subatomic particles and thorium gained support in Europe. The theory advanced that thorium should produce 140 times more energy than uranium using accelerated subatomic particles. The process would involve accelerating the subatomic particles to speeds of several million kilometers per hour in particle accelerators and then firing them at thorium.[9] Fission would occur based on a nuclear cascade generated by the particle accelerator instead of the conventional chain reaction generated from the neutron bombardment from uranium or plutonium fuel. The process reportedly creates much less hazardous waste than uranium fuels and would generate energy equivalent to 3 million tons of crude oil per ton of thorium fuel. Several European industrial companies were reportedly preparing to fund a prototype of the energy amplifier needed to demonstrate the process.[10]

The use of thorium in the United States has decreased significantly since 1990. 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 thorium's 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[11]	Reserve base[11]
	1996	1997		
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]Less than ½ unit.
[3]Source: U.S. Department of Defense, Defense Logistics Agency. Based on sales from the National Defense Stockpile.
[4]Source: Rhône-Poulenc Basic Chemicals Co., f.o.b. port of entry, duty paid, ThO_2 basis, f.o.b. Ontario, Canada, duty unpaid, 1993. Rhône-Poulenc Basic Chemicals Co., Shelton, CT, 1994-97.
[5]Source: Rhône-Poulenc Basic Chemicals Co., f.o.b. port of entry, duty paid.
[6]Defined as imports - exports + adjustments for Government and industry stock changes.
[7]See Appendix B.
[8]See Appendix C for definitions.
[9]The Washington Post, Reuters, 1993, In theory, a new route to nuclear energy: November 24, p. A18.
[10]Sacks, Tony, 1997, Nuclear nirvana?: Electrical Review, v. 230, no. 12, June 10, p. 24-26.
[11]See Appendix D for definitions.

TIN

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

Domestic Production and Use: In 1997, 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 85% of the primary tin. The major uses were as follows: cans and containers, 30%; electrical, 20%; construction, 10%; transportation, 10%; and other, 30%. The estimated value of primary metal consumed in 1997, based on the New York composite price, was $310 million.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Mine	([1])	([1])	—	—	—
Secondary (old scrap)	6,900	7,400	7,720	7,580	7,500
Secondary (new scrap)	5,100	4,300	3,880	3,460	3,500
Imports for consumption: Refined tin	33,700	32,400	33,200	30,200	34,000
Exports: Refined tin	2,600	2,560	2,790	3,670	4,500
Shipments from Government stockpile excesses	6,020	5,620	11,450	11,760	11,000
Consumption reported: Primary	34,600	33,700	35,200	36,500	37,000
Secondary	11,900	8,530	10,800	8,180	9,000
Consumption, apparent	44,200	43,300	47,000	48,400	49,000
Price, average, cents per pound:					
New York market	239	255	295	288	265
New York composite	350	369	416	412	385
London	233	248	282	279	255
Kuala Lumpur	232	245	278	275	255
Stocks, consumer and dealer, yearend	10,800	10,400	11,700	11,800	11,000
Employment, mine and primary smelter, number[e]	5	—	—	—	—
Net import reliance[2] as a percent of apparent consumption	84	83	84	83	85

Recycling: About 11,000 tons of tin from old and new scrap was recycled in 1997. Of this, about 7,500 tons was recovered from old scrap at 7 detinning plants and 110 secondary nonferrous metal processing plants.

Import Sources (1993-96): Brazil, 30%; Bolivia, 22%; Indonesia, 21%; China, 12%; and other, 15%.

Tariff: Most major imports of tin, including unwrought metal, waste and scrap, and unwrought tin alloys, enter duty free.

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

Government Stockpile:

Stockpile Status—9-30-97[3]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Pig tin	104,000	—	97,800	12,000	12,000

Prepared by **James F. Carlin, Jr., (703) 648-4985 [Fax: (703) 648-7757].**

TIN

Events, Trends, and Issues: The Defense Logistics Agency (DLA) made a major change in its tin sales program for fiscal year 1997, now emphasizing its long-term sales program and reducing its spot sales effort. DLA allocated 2,000 tons of tin to sell on the spot market at monthly sales. Two long-term sales were planned for fiscal year 1997.

Public Law 104-201 provided for continued tin disposals from the National Defense Stockpile. DLA announced that its Annual Materials Program for fiscal year 1997 called for sales of up to 12,000 tons of stockpile tin. Stockpile tin is warehoused at 10 depots, with the largest holdings at Hammond, IN, and Point Pleasant, WV.

A major domestic tinplate producer completed construction of a new joint-venture tinplate mill in Belmont County, OH. The cost was estimated at $80 million. It was the first domestic tinplating facility built since the early 1960's and replaced that producer's current 50-year-old tin mill.

The Steel Recycling Institute (SRI), Pittsburgh, PA, announced that the domestic steel can recycling rate reached 58% in 1996, compared with a 56% rate in 1995. SRI observed that 1996's figures represented more than 1.6 million tons of steel cans. 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 third 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 was 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[4]	Reserve base[4]
	1996	1997[e]		
United States	—	—	20,000	40,000
Australia	8,830	9,000	210,000	600,000
Bolivia	15,200	16,000	450,000	900,000
Brazil	19,500	20,000	1,200,000	2,500,000
China	60,000	60,000	2,100,000	3,400,000
Indonesia	38,500	40,000	750,000	820,000
Malaysia	5,170	5,000	1,200,000	1,400,000
Peru	27,000	29,000	300,000	400,000
Portugal	4,800	6,000	70,000	80,000
Russia	8,000	8,000	300,000	350,000
Thailand	1,450	1,000	940,000	1,000,000
Other countries	7,000	7,000	180,000	200,000
World total (may be rounded)	196,000	201,000	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]Negligible.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix C for definitions.
[4]See Appendix D for definitions.

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 companies produced titanium forgings, mill products, and castings. In 1997, an estimated 65% of the titanium metal used was in aerospace applications. The remaining 35% was used in the chemical process industry, power generation, marine, ordnance, medical, and other nonaerospace applications. The value of sponge metal consumed was about $308 million, assuming an average selling price of $9.70 per kilogram ($4.40 per pound).

In 1997, titanium dioxide (TiO_2) pigment, valued at about $2.73 billion, was produced by 5 companies at 11 plants in 9 States. TiO_2 was used in paint, varnishes, and lacquers, 48%; plastics, 19%; and other, 33%. Other uses of TiO_2 included catalysts, ceramics, coated fabrics and textiles, floor coverings, paper, printing ink, and roofing granules.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Titanium metal:					
Production, sponge	W	W	W	W	W
Imports for consumption, sponge	2,160	6,470	7,560	10,100	15,300
Exports, all metal forms	7,890	9,660	10,800	12,100	15,200
Shipments from Government stockpile excesses	—	—	—	—	227
Consumption of sponge metal, reported	15,100	17,200	21,500	28,400	31,800
Price, sponge, dollars per pound, yearend	3.75	4.00	4.40	4.40	4.40
Stocks, sponge, industry yearend[e]	2,905	5,570	5,270	4,390	5,460
Employment, reduction plants, number[e]	350	300	300	300	300
Net import reliance,[2] sponge only, as a percent of apparent consumption	W	W	W	W	W
Titanium dioxide:					
Production	1,160,000	1,250,000	1,250,000	1,230,000	1,330,000
Imports for consumption	172,000	176,000	183,000	167,000	196,000
Exports	290,000	352,000	342,000	332,000	368,000
Consumption, apparent	1,030,000	1,090,000	1,080,000	1,070,000	1,150,000
Price, rutile, list, dollars per pound, yearend	0.94	0.93	1.01	1.09	0.93
Stocks, producer, yearend	123,000	106,000	120,000	107,000	108,000
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 26,500 tons in 1997. In addition, estimated use of titanium as scrap and in the form of ferrotitanium made from scrap by the steel industry was about 5,300 tons; by the superalloy industry, 750 tons; and in other industries, 1,200 tons. Old scrap reclaimed was about 200 to 400 tons. Minor amounts of TiO_2 were recycled.

Import Sources (1993-96): Sponge metal: Russia, 60%; Japan, 25%; China, 6%; Kazakstan, 4%; and other, 5%. Titanium dioxide pigment: Canada, 40%; Germany, 13%; France, 11%; the United Kingdom, 6%; Spain, 4%; and other, 26%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Waste and scrap metal	8108.10.1000	Free	Free.
Unwrought metal	8108.10.5000	15.0% ad val.	25.0% ad val.
Wrought metal	8108.90.6000	15.0% ad val.	45.0% ad val.
Titanium dioxide pigments	3206.10.0000	6.0% ad val.	30.0% ad val.
Titanium oxides	2823.00.0000	5.8% ad val.	30.0% ad val.

Depletion Allowance: Not applicable.

Prepared by **Joseph M. Gambogi, (703) 648-7718 [Fax: (703) 648-7722].**

TITANIUM AND TITANIUM DIOXIDE

Government Stockpile: In addition to the quantities shown below, the stockpile contained 9,860 tons of nonstockpile-grade sponge metal.

Stockpile Status—9-30-97[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Titanium sponge	33,156	—	—	—	227

Events, Trends, and Issues: In 1997, domestic production of titanium pigment reached a record level and increased an estimated 10% compared with 1996. Exports of titanium pigment increased 11%. Apparent consumption of titanium pigment increased 7% and published prices of rutile-grade pigment decreased 15%. According to company press releases, the world's largest producer of titanium pigment plans to acquire nearly all of the pigment facilities of the second largest pigment producer. This would increase its share of global capacity from 23% to about 37%.

Demand for titanium metal products was at record levels in 1997. Domestic production of titanium ingot and mill products were expected to reach 58,000 tons and 33,500 tons, respectively. In response to strong demand from commercial aerospace markets, domestic producers of titanium ingot announced plans for significant capacity expansions. In midyear 1998, a 9,000-ton-per-year furnace is scheduled for start-up in Morgantown, PA , and a new 10,000-ton-per-year facility is being constructed in Richland, WA. In 1999, a 3,000-ton-per-year expansion is expected somewhere in Ohio. A new 340-ton-per-year titanium sponge facility completed its first year of operation at Salt Lake City, UT. The new facility uses the Hunter-process to produce a feedstock for electronic grade titanium metal. At yearend an agreement was reached whereby one of the two domestic producers of titanium sponge will be acquired by a major producer of ingot and mill products.

World Sponge Metal Production and Sponge and Pigment Capacity:

	Sponge production		Capacity 1997	
	1996	1997[e]	Sponge	Pigment
United States	W	W	[5]29,800	1,360,000
Australia	—	—	—	164,000
Belgium	—	—	—	80,000
Canada	—	—	—	91,000
China[e]	2,000	2,000	7,000	45,000
Finland	—	—	—	80,000
France	—	—	—	225,000
Germany	—	—	—	350,000
Italy	—	—	—	80,000
Japan	21,100	24,100	25,800	326,000
Kazakstan[e]	10,000	12,000	35,000	1,000
Russia[e]	18,000	20,000	35,000	20,000
Spain	—	—	—	65,000
Ukraine[e]	—	—	—	120,000
United Kingdom[e]	—	—	—	275,000
Other countries	—	—	—	585,000
World total (may be rounded)	[6]51,000	[6]58,000	130,000	3,900,000

World Resources: Resources of titanium minerals are discussed in the sections on ilmenite and rutile. Most titanium for domestic sponge production was obtained from rutile or rutile substitutes. The sources for pigment production were ilmenite, slag, 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. There is no cost-effective substitute for TiO_2 pigment.

[e]Estimated. E Net exporter. W Withheld to avoid disclosing company proprietary data.
[1]See also Ilmenite and Rutile.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B.
[4]See Appendix C for definitions.
[5]Current operating capacity is 22,600 tons per year.
[6]Excludes U.S. production.

TUNGSTEN

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

Domestic Production and Use: In 1997, little if any tungsten concentrate was produced from U.S. mines. 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. More than 70 industrial consumers were surveyed on a monthly or annual basis. Based on data reported by these consumers, approximately 80% of 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, 7%; tool steels, 6%; other steels, superalloys, and wear-resistant alloys, 6%; and chemicals for catalysts and pigments, 1%. The total estimated value of primary tungsten materials consumed in 1997 was $280 million.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, mine shipments	W	W	W	W	W
Imports for consumption, concentrate	1,720	2,960	4,660	4,190	4,700
Exports, concentrate	63	44	20	72	20
Government stockpile shipments, concentrate	—	—	—	—	—
Consumption: Reported, concentrate	[1]2,870	[1]3,630	6,320	5,420	7,100
Apparent, all forms	7,100	7,900	10,000	10,700	11,400
Price, concentrate, dollars per mtu WO_3,[2] average:					
U.S. spot market, Platt's Metals Week	42	45	62	66	66
European market, Metal Bulletin	35	42	64	53	47
Stocks, producer and consumer, yearend concentrate	636	955	675	613	600
Employment, mine and mill, number	33	35	46	58	60
Net import reliance[3] as a percent of apparent consumption	81	95	90	90	85

Recycling: During 1997, the quantity of scrap reprocessed into intermediates was about 2,400 tons, representing approximately 21% of apparent consumption of tungsten in all forms.

Import Sources (1993-96): China, 35%; Russia, 20%; Germany, 7%; Bolivia, 6%; and other, 32%.

Tariff: Item	Number	Most favored nation (MFN)[4] 12/31/97	Non-MFN[5] 12/31/97
Ore	2611.00.3000	Free	$1.10/kg W cont.
Concentrate	2611.00.6000	37.5¢/kg W cont.	$1.10/kg W cont.
Ferrotungsten	7202.80.0000	5.6% ad val.	35.0% ad val.
Tungsten powders	8101.10.0000	8.4% ad val.	58.0% ad val.
Ammonium tungstate	2841.80.0010	7.3% ad val.	49.5% ad val.
Tungsten carbide	2849.90.3000	9.0% ad val.	55.5% ad val.

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

Government Stockpile: In addition to the data shown below, the stockpile contained the following quantities of nonstockpile-grade tungsten materials (tons of tungsten content): ores and concentrates, 7,010; ferrotungsten, 533; metal powder, 151; and carbide powder, 51.

Stockpile Status—9-30-97[6]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Carbide powder	871	—	—	—	—
Ferrotungsten	385	—	—	—	—
Metal powder	710	—	—	—	—
Ore and concentrate	27,600	—	—	—	—

Prepared by **Kim B. Shedd, (703) 648-4974 [Fax: (703) 648-7757].**

TUNGSTEN

Events, Trends, and Issues: World demand for tungsten was strong in 1997 and was expected to be higher than that of 1996. Continued exports of tungsten materials from China and Russia have sustained an oversupply situation, kept prices low, and resulted in a significant decrease in mine production. The amount of tungsten concentrates remaining in stockpiles in China and Former Soviet Union countries and how long they will continue to contribute to world supply are concerns for the tungsten industry. Once the stockpiles are depleted, world mine production will have to increase to meet demand. How quickly mines can be brought back on line and whether mine production can meet demand once stockpiles are depleted will influence the future tungsten supply/demand balance.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[7]	Reserve base[7]
	1996	1997[e]		
United States	W	W	140,000	200,000
Australia	—	—	1,000	63,000
Austria	360	360	10,000	15,000
Bolivia	580	580	53,000	100,000
Brazil	100	100	20,000	20,000
Burma	330	330	15,000	34,000
Canada	—	—	260,000	490,000
China	24,000	24,000	920,000	1,300,000
France	—	—	20,000	20,000
Kazakstan	220	220	—	38,000
Korea, North	900	900	—	35,000
Korea, Republic of	—	—	58,000	77,000
Portugal	1,340	1,340	25,000	25,000
Russia	3,000	3,000	250,000	420,000
Tajikistan	50	50	—	23,000
Thailand	50	50	30,000	30,000
Turkmenistan	—	—	—	10,000
Uzbekistan	300	300	—	20,000
Other countries	680	680	280,000	360,000
World total (may be rounded)	32,000	32,000	2,100,000	3,300,000

World Resources: More than 90% of the world's estimated tungsten resources are outside the United States. Approximately 40% of these resources are in China, 15% are in Canada, and 13% are 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. W Withheld to avoid disclosing company proprietary data.
[1]Excludes 3 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.
[6]See Appendix C for definitions.
[7]See Appendix D 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, or vanadium-bearing chemicals or specialty alloys. 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 33%; full alloy steel 21%; high-strength low-alloy steel 22%; tool steel 11%; and other 3%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production:					
Mine, recoverable basis	W	W	W	W	W
Mill, recovered basis[1]	W	W	W	W	W
Petroleum residues, recovered basis	2,870	2,830	1,990	3,730	NA
Imports for consumption:					
Ash, residues, slag,	1,450	1,900	2,530	2,270	2,200
Vanadium pentoxide, anhydride	70	294	547	485	700
Oxides and hydroxides, other	19	3	36	11	200
Aluminum-vanadium master alloys (gross weight)	19	38	36	2	—
Ferrovanadium	1,630	1,910	1,950	1,880	1,800
Exports:					
Vanadium pentoxide, anhydride	126	335	229	241	800
Oxides and hydroxides, other	895	1,050	1,010	2,670	400
Aluminum-vanadium master alloys (gross weight)	866	1,030	660	310	700
Other compounds	989	—	—	—	—
Ferrovanadium	219	374	340	479	400
Shipments from Government stockpile	—	—	416	201	260
Consumption: Reported	3,970	4,280	4,650	4,650	4,500
Apparent	W	W	W	W	W
Price, average, dollars per pound V_2O_5	1.45	2.95	2.80	3.19	3.90
Stocks, producer and consumer, yearend	900	1,110	1,100	1,070	1,000
Employment, mine and mill, number	430	400	390	390	400
Net import reliance[2] as a percent of apparent consumption	W	W	W	W	W

Recycling: Vanadium was recycled as a minor component of scrap iron and steel alloys, which were recycled principally for their iron content. 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 (1993-96): Ferrovanadium: Russia, 36%; Canada, 32%; Belgium, 7%; Austria, 6%; and other, 19%. Vanadium pentoxide: South Africa, 79%; China 10%; Russia, 9%; and other, 2%.

Tariff: Aluminum-vanadium master alloys (except from non-most-favored nations), ash, residues, slag, and waste and scrap enter duty-free.

Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Vanadium pentoxide anhydride	2825.30.0010	12.8% ad val.	40% ad val.
Vanadium oxides and hydroxides, other	2825.30.0050	12.8% ad val.	40% ad val.
Vanadates	2841.90.1000	9.5% ad val.	40% ad val.
Ferrovanadium	7202.92.0000	4.2% ad val.	25% ad val.
Aluminum-vanadium master alloys	7601.20.9030	Free	10.5% ad val.

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

Prepared by **Robert G. Reese, Jr., (703) 648-4981 [Fax: (703) 648-7757].**

VANADIUM

Government Stockpile:

Stockpile Status—9-30-97[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Vanadium pentoxide (Gross weight)	—	180	—	—	372

Events, Trends, and Issues: In 1994, the Defense Department decided that vanadium pentoxide was no longer needed in the National Defense Stockpile (NDS), and authorized the disposal of its entire holdings, with sales beginning in fiscal year 1995. At yearend 1994, the NDS held 651 tons of vanadium pentoxide. On September 30, 1997, the Defense Logistics Agency (DLA), which has operational control of the NDS, completed the disposal of the vanadium pentoxide held in the NDS.

Vanadium consumption in the United States in 1997 was essentially unchanged from that in 1996. Although total consumption was essentially unchanged, preliminary data indicated the following changes among the major uses for vanadium during the first 8 months of 1997: carbon steel decreased 15%; full alloy steel decreased 17%; high-strength low-alloy steel increased 10%; and tool steel increased 36%.

World Mine Production, Reserves, and Reserve Base:

	Mine production 1996	Mine production 1997[e]	Reserves[5]	Reserve base[5]
United States	W	W	45,000	4,000,000
China	7,000	7,000	2,000,000	3,000,000
Russia	11,000	11,000	5,000,000	7,000,000
South Africa	16,000	16,000	3,000,000	12,000,000
Other countries	1,100	1,000	—	1,000,000
World total (may be rounded)	[6]35,100	[6]35,000	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. Among various metals that are to some degree interchangeable with vanadium as alloying elements in steel are columbium, manganese, molybdenum, titanium, and tungsten. 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]Produced from domestic materials.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B.
[4]See Appendix C for definitions.
[5]See Appendix D for definitions.
[6]Excludes U.S. mine production.

VERMICULITE

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: Two companies, with mining and processing facilities, produced vermiculite concentrate. One company had its operation in South Carolina, and the other company had an operation in Virginia and an operation in South Carolina run by its subsidiary company. Most of the vermiculite concentrate was shipped to 19 exfoliating plants in 11 States. The end uses for exfoliated vermiculite were estimated to be agriculture, 56%; insulation, 20%; and lightweight concrete aggregates (including concrete, plaster, and cement premixes) and other, 24%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production[1]	190	177	171	W	W
Imports for consumption[e]	30	30	30	48	50
Exports[e]	7	7	6	8	8
Consumption, apparent, concentrate	213	200	195	W	W
Consumption, exfoliated	140	130	130	130	135
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	11	11	12	W	W

Recycling: Insignificant.

Import Sources (1993-96):[e] South Africa, 94%; China, 5%; and other, 1%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Mineral substances not specifically provided for	2530.10.0000	Free	Free.
Exfoliated vermiculite as mixtures and articles of heat-insulating, sound-insulating, or sound-absorbing materials	6806.20.0000	2% ad val.	30% ad val.

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

Government Stockpile: None.

Prepared by **Michael J. Potter, (703) 648-7723 [Fax: (703) 648-7722].**

VERMICULITE

Events, Trends, and Issues: With the retirement of the owners of one of the three U.S. producers of vermiculite concentrate, located in South Carolina, some of the company's mining and plant activities were taken over by one of the remaining concentrate producers and by another company which exfoliates vermiculite.

The largest end use of vermiculite in recent years has been horticulture, composing over one-half of the output. Vermiculite is used to loosen and aerate soil, and improve water retention and fertilizer release. Vermiculite is used also in lightweight concrete for roof and floor slabs. Fireproofing uses of vermiculite include furnace insulation; with molten metals as a mold lining; and sprayed or trowelled as a premixed plaster on structural steel. Vermiculite is used also to enhance sound absorption properties in acoustical panels, ceiling tiles, and texturized ceiling coatings.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves[4]	Reserve base[4]
	1996	1997[e]		
United States[1]	W	W	25,000	100,000
Russia	30	35	NA	NA
South Africa	186	190	20,000	80,000
Other countries[5]	50	50	5,000	20,000
World total	[6]266	[6]275	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. Total world resources are estimated to be up to three times the reserve amount.

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 B.
[4]See Appendix D for definitions.
[5]Excludes the United States and countries for which information is not available.
[6]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 by one company 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 by one company 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 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 1996 by end use was as follows: lamp and cathode ray tube phosphors, 98%; oxygen sensors, laser crystals, and miscellaneous, 2%.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production, mine	W	W	—	—	—
Imports for consumption:					
In monazite	—	—	0.4	1	—
In xenotime and yttrium concentrate[2]	NA	NA	NA	NA	NA
Exports, in ore and concentrate	NA	NA	NA	NA	NA
Consumption, estimated	NA	344	365	207	315
Price, dollars:[4]					
Monazite concentrate, per metric ton	204-238	233-272	222-259	244-285	224-262
Yttrium oxide, per kilogram, 99.0% to 99.99% purity	16-116	20-116	17-110	17-85	17-85
Yttrium metal, per kilogram, 99.0% to 99.9% purity	135-350	135-350	150-200	95-200	80-100
Stocks, processor, yearend	NA	NA	NA	NA	NA
Net import reliance[e 3] as a percent of apparent consumption	100	100	100	100	100

Recycling: Small quantities, primarily from laser crystals and synthetic garnets.

Import Sources (1996):[e] Yttrium compounds: China, 81%; and Japan, 19%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[5] 12/31/97
Thorium ores and concentrates (monazite)	2612.20.0000	Free	Free.
Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed	2805.30.0000	5.0% ad val.	31.3% ad val.
Yttrium bearing materials and compounds containing by weight >19% but <85% Y_2O_3	2846.90.4000	Free	25% ad val.
Rare-earth compounds, including yttrium oxide, yttrium nitrate, and other individual compounds	2846.90.8000	3.7% ad val.	25% ad val.

Depletion Allowance: Percentage method: Monazite: 22% on thorium content and 14% on yttrium and rare-earth content (Domestic), 14% (Foreign). Xenotime: 14% (Domestic and Foreign).

Government Stockpile: None.

Prepared by **James B. Hedrick, (703) 648-7725 [Fax: (703) 648-7722].**

YTTRIUM

Events, Trends, and Issues: Yttrium demand which decreased in 1996, rebounded in 1997 as prices were stable to slightly lower. Yttrium markets continued to be competitive, although China was the source of most of the world's supply. The U.S. economy showed strong growth in the first half of 1997, and demand for yttrium in most uses increased.

Yttrium was consumed primarily in the form of high-purity compounds, especially the oxide and nitrate.

World Mine Production, Reserves, and Reserve Base:

	Mine production[6]		Reserves[7]	Reserve base[7]
	1996	1997[e]		
United States	—	—	120,000	130,000
Australia	—	—	100,000	110,000
Brazil	5	5	400	1,500
Canada	—	—	3,300	4,000
China	1,400	1,300	220,000	240,000
Congo (Kinshasa)[8]	1	1	570	630
India	55	55	36,000	38,000
Malaysia	7	6	13,000	21,000
South Africa	—	—	4,400	5,000
Sri Lanka	2	2	240	260
Thailand	—	—	600	600
Former Soviet Union[9]	120	120	9,000	10,000
World total (rounded)	1,600	1,500	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 may be substituted with calcia or magnesia.

[e]Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]See also Rare-Earths and Scandium.
[2]This import category typically includes yttrium concentrates.
[3]Essentially all yttrium consumed domestically was imported or refined from imported ores and concentrates.
[4]Monazite concentrate price derived from Metals Bulletin; yttrium oxide and metal prices from Elements (a TradeTech publication), and Rhône-Poulenc Basic Chemicals Co.
[5]See Appendix B.
[6]Includes yttrium contained in rare-earth ores.
[7]See Appendix D for definitions.
[8]Formerly Zaire.
[9]As constituted before Dec. 1991.

ZINC

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

Domestic Production and Use: The value of zinc mined in 1997, based on contained zinc recoverable from concentrate, was about $1.1 billion. It was produced in 8 States, at 21 mines operated by 8 mining companies. Alaska, Tennessee, New York, and Missouri accounted for 94% of domestic mine output; Alaska alone accounted for more than one-half. Three primary and five secondary smelters refined zinc metal of commercial grade in 1997. Of zinc metal consumed, about 75% was used in Illinois, Indiana, Michigan, New York, Ohio, and Pennsylvania. Of the total zinc consumed, about 54% was used in galvanizing, 19% in zinc-base alloys, 13% in brass and bronze, and 14% 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:	1993	1994	1995	1996	1997[e]
Production: Mine, recoverable[1]	488	570	614	600	607
Primary slab zinc	240	217	232	226	235
Secondary slab zinc	141	139	131	140	145
Imports for consumption:					
Ore and concentrate	33	27	10	15	30
Refined zinc	724	793	856	827	861
Exports: Ore and concentrate	311	389	424	425	425
Refined zinc	1	6	3	2	2
Shipments from Government stockpile	18	39	14	15	40
Consumption: Apparent, refined zinc	1,120	1,180	1,230	1,210	1,280
Apparent, all forms	1,340	1,400	1,460	1,450	1,500
Price, average, cents per pound:					
Domestic producers	46.2	49.3	55.8	51.1	81.0
London Metal Exchange, cash	43.6	45.3	46.8	46.5	75.0
Stocks, slab zinc, yearend	77	80	78	74	78
Employment: Mine and mill, number[e]	2,500	2,700	2,700	2,700	2,700
Smelter primary, number[e]	1,300	1,000	1,000	1,000	1,000
Net import reliance[2] as a percent of apparent consumption of:					
Refined zinc	67	70	71	70	70
All forms of zinc	36	35	35	33	35

Recycling: In 1997, an estimated 380,000 tons of zinc was recovered from waste and scrap; more than one-third was recovered in the form of slab zinc and the remainder in alloys, oxide, and chemicals. Of the total amount of zinc recycled, 265,000 tons from new scrap and 115,000 tons from old scrap. About 45,000 tons of scrap was exported, mainly to Taiwan, and 31,000 tons imported.

Import Sources (1993-96): Ore and concentrate: Mexico, 59%; Peru, 35%; Australia, 5%; and other, 1%. Metal: Canada, 59%; Mexico, 12%; Spain, 9%; Peru, 4%; and other, 16%. Combined total: Canada, 60%; Mexico, 14%; Spain, 10%; and other, 16%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Canada 12/31/97	Mexico 12/31/97	Non-MFN[3] 12/31/97
Ore and concentrate	2608.00.0030	0.7¢/kg on lead content	0.1¢/kg on lead content	Free	3.7¢/kg on zinc content.
Unwrought metal	7901.11.0000	1.5% ad val.	0.1% ad val.	Free	5.0% ad val.
Alloys, casting-grade	7901.12.1000	9.4% ad val.	1.9% ad val.	11.4% ad val.	45.0% ad val.
Alloys	7901.20.0000	9.4% ad val.	1.9% ad val.	Free	45.0% ad val.
Waste and scrap	7902.00.0000	Free	Free	Free	11.0% ad val.
Hard zinc spelter	2620.11.0000	0.6% ad val.	0.1% ad val.	0.9% ad val.	5.0% ad val.
Zinc oxide	2817.00.0000	Free	Free	Free	5.5% ad val.

Prepared by **Jozef Plachy, (703) 648-4982 [Fax: (703) 648-7757].**

ZINC

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

Government Stockpile:

Stockpile Status—9-30-97[4]

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Zinc	221	7	221	45	38

Events, Trends, and Issues: Domestic mine production increased slightly in 1997, 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 correspondingly to increased mine production. The United States is the world's largest exporter of zinc concentrates; it is also the largest importer of zinc metal, because of inadequate refinery production capacity. Expansion of refinery capacity at Clarksville, TN, and Sauget, IL, is anticipated. Available primary annual capacity in 1997 was 231,000 tons.

After a slight decrease in 1996, domestic consumption of zinc metal increased in 1997, 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 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 low tariffs.

After stagnant metal prices during the previous years, the price for zinc metal started to increase at the end of 1996 and continued its rapid increase in 1997.

World Mine Production, Reserves, and Reserve Base:

	Mine production[5]		Reserves[6]	Reserve base[6]
	1996	1997[e]		
United States	628	635	19,000	60,000
Australia	1,071	1,100	39,000	100,000
Canada	1,235	1,200	15,000	40,000
China	1,010	1,000	33,000	80,000
Mexico	378	380	6,000	8,000
Peru	761	780	7,000	12,000
Other countries	2,357	2,700	72,000	130,000
World total (may be rounded)	7,440	7,800	190,000	430,000

World Resources: Identified zinc resources of the world are about 1.9 billion tons.

Substitutes: Aluminum, steel, and plastics substitute for galvanized sheet. Aluminum, plastics, and magnesium are major competitors as diecasting materials. Plastic coatings, paint, and cadmium and aluminum alloy coatings replace zinc for corrosion protection; aluminum alloys are used in place of brass. Many elements are substitutes for zinc in chemical, electronic, and pigment uses.

[e]Estimated.
[1]Zinc recoverable after smelting and refining.
[2]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B.
[4]See Appendix C for definitions.
[5]Zinc content of concentrate and direct shipping ore.
[6]See Appendix D 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, and 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 as an addition in superalloys.

Salient Statistics—United States:	1993	1994	1995	1996	1997[e]
Production: Zircon (ZrO_2 content)[1]	W	W	W	W	W
Imports:					
Zirconium, ores and concentrates (ZrO_2 content)	45,500	53,300	60,800	60,100	41,600
Zirconium, alloys, waste and scrap (ZrO_2 content)	798	837	884	830	993
Zirconium oxide (ZrO_2 content)	1,990	2,400	4,370	5,240	3,870
Hafnium, unwrought, waste and scrap	3	5	5	8	8
Exports:					
Zirconium ores and concentrates (ZrO_2 content)	23,400	20,800	26,200	22,780	24,900
Zirconium, alloys, waste and scrap (ZrO_2 content)	2,020	1,640	1,680	1,480	1,690
Consumption, zirconium ores and concentrates, apparent, (ZrO_2 content)	W	W	W	W	W
Prices:					
Zircon, dollars per ton:					
Domestic	NA	278	319	419	400
Imported, f.o.b. U.S. east coast	200	220	325	411	400
Zirconium sponge, dollars per pound	9-12	9-12	9-12	9-12	9-12
Hafnium sponge, dollars per kilogram	165-210	165-210	165-210	165-210	165-210
Net import reliance[2] 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 (1993-96): Zirconium ores and concentrates: Australia, 53%; South Africa, 46%; and other, 1%. Zirconium, wrought, unwrought, waste and scrap: France, 53%; Canada, 17%; Germany, 12%; Japan, 10%; and other, 8%. Hafnium, unwrought, waste and scrap: France, 91%; Germany, 5%; the United Kingdom, 3%; and Hong Kong, 1%.

Tariff: Item	Number	Most favored nation (MFN) 12/31/97	Non-MFN[3] 12/31/97
Zirconium ores and concentrates	2615.10.0000	Free	Free.
Germanium oxides and ZrO_2	2825.60.0000	3.7 ad val.	25% ad val.
Ferrozirconium	7202.99.1000	4.2% ad val.	25% ad val.
Zirconium, waste and scrap	8109.10.3000	Free	Free.
Zirconium, other unwrought, powders	8109.10.6000	4.2% ad val.	25% ad val.
Zirconium, other wrought, alloys	8109.90.0000	4.4% ad val.	45% ad val.
Unwrought hafnium, waste and scrap	8112.91.2000	Free	25% ad val.

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

Government Stockpile: In addition to 14,500 tons of baddeleyite ore 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.

Prepared by **Joseph M. Gambogi, (703) 648-7718 [Fax: (703) 648-7722].**

ZIRCONIUM AND HAFNIUM

	Stockpile Status—9-30-97[4]				
Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposal plan FY 1997	Disposals FY 1997
Baddeleyite	15,800	—	—	—	—

Events, Trends, and Issues: The global supply and demand of zirconium mineral concentrates was largely in balance in 1997 and 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 decreased 31% while exports increased 10% compared with 1996. A new mining operation was commissioned at the Old Hickory deposit near Richmond, VA. Initial capacity was expected to include up to 30,000 tons per year of zircon with a mine life of 16 years. Availability of hafnium continued to exceed supply. Surpluses were stockpiled in the form of hafnium oxide. The demand for nuclear-grade zirconium metal, the production of which necessitates hafnium's removal, produces more hafnium than can be consumed by the metal's uses.

Zirconium and hafnium exhibit nearly identical properties and are not separated for most applications. However, zirconium and hafnium are separated for certain nuclear applications. Zirconium-clad fuel rods in nuclear reactors are hafnium-free to improve reactor efficiency because hafnium is a strong absorber of thermal neutrons. At the same time, hafnium is used in reactor control rods to regulate the fission process through neutron absorption.

World Mine Production, Reserves, and Reserve Base: World primary hafnium production statistics are not available. Hafnium occurs with zirconium in the minerals zircon and baddeleyite.

	Zirconium				Hafnium	
	Mine production[e] (thousand metric tons)		Reserves[5] (million metric tons, ZrO_2)	Reserve base[5] (million metric tons, ZrO_2)	Reserves[5] (thousand metric tons, HfO_2)	Reserve base[5] (thousand metric tons, HfO_2)
	1996	1997[e]				
United States	W	W	1.7	5.3	32	97
Australia	462	500	6.3	27.0	114	484
Brazil	17	17	.4	.4	7	7
China[e]	15	15	.5	1.0	NA	NA
India	19	21	3.4	3.8	42	46
South Africa	260	265	14.3	14.3	259	259
Ukraine[e]	55	55	4.0	6.0	NA	NA
Other countries	29	30	.9	4.1	NA	NA
World total (rounded)	[6]857	[6]903	32	62	450	890

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]Defined as imports - exports + adjustments for Government and industry stock changes.
[3]See Appendix B.
[4]See Appendix C for definitions.
[5]See Appendix D for definitions.
[6]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

Non-Most-Favored-Nation Trade Areas

The countries or areas for which non-most-favored-nation (Non-MFN) rates apply are the following:

Afghanistan
Cambodia
Cuba
Laos
North Korea
Vietnam

Most favored nation (MFN), Non-MFN, and special tariff rates including the U.S. Generalized System of Preferences are given in the "Harmonized Tariff Schedule of the United States" published by the United States International Trade Commission, Washington, DC 20436. It is available in many public libraries or can be purchased from the United States Government Printing Office, Washington, DC 20402.

APPENDIX C

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 1997 refers the Defense Logistics Agency's Annual Materials Plan for the fiscal year. Fiscal year 1997 is the period 10/1/96 through 9/30/97.

Disposals FY 1997 refers to material sold or traded from the stockpile in fiscal year 1997; it may or may not have been removed by the buyers.

APPENDIX D

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). The term "geologic reserve" has been applied by others

[1]Based on U.S. Geological Survey Circular 831, 1980.

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*

<table>
<tr><td rowspan="3">Cumulative Production</td><td colspan="3">IDENTIFIED RESOURCES</td><td colspan="2">UNDISCOVERED RESOURCES</td></tr>
<tr><td colspan="2">Demonstrated</td><td rowspan="2">Inferred</td><td colspan="2">Probability Range</td></tr>
<tr><td>Measured</td><td>Indicated</td><td>Hypothetical</td><td>(or) Speculative</td></tr>
<tr><td>ECONOMIC</td><td colspan="2">Reserves</td><td>Inferred Reserves</td><td colspan="2" rowspan="3"></td></tr>
<tr><td>MARGINALLY ECONOMIC</td><td colspan="2">Marginal Reserves</td><td>Inferred Marginal Reserves</td></tr>
<tr><td>SUBECONOMIC</td><td colspan="2">Demonstrated Subeconomic Resources</td><td>Inferred Subeconomic Resources</td></tr>
<tr><td>Other Occurrences</td><td colspan="5">Includes nonconventional and low-grade materials</td></tr>
</table>

FIGURE 2.--*Reserve Base* and *Inferred Reserve Base* Classification Categories

<table>
<tr><td rowspan="3">Cumulative Production</td><td colspan="3">IDENTIFIED RESOURCES</td><td colspan="2">UNDISCOVERED RESOURCES</td></tr>
<tr><td colspan="2">Demonstrated</td><td rowspan="2">Inferred</td><td colspan="2">Probability Range</td></tr>
<tr><td>Measured</td><td>Indicated</td><td>Hypothetical</td><td>(or) Speculative</td></tr>
<tr><td>ECONOMIC</td><td colspan="2" rowspan="3">Reserve Base</td><td rowspan="3">Inferred Reserve Base</td><td colspan="2" rowspan="4"></td></tr>
<tr><td>MARGINALLY ECONOMIC</td></tr>
<tr><td rowspan="2">SUBECONOMIC</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td>Other Occurrences</td><td colspan="5">Includes nonconventional and low-grade materials</td></tr>
</table>