

MINERAL COMMODITY SUMMARIES 1994

ADVANCED MATERIALS	FELDSPAR	MANGANESE	SCANDIUM
ALUMINUM	FLUORSPAR	MERCURY	SELENIUM
ANTIMONY	GALLIUM	MICA	SILICON
ARSENIC	GARNET	MOLYBDENUM	SILVER
ASBESTOS	GEMSTONES	NICKEL	SODA ASH
BARITE	GERMANIUM	NITROGEN	SODIUM SULFATE
BAUXITE	GOLD	NONRENEWABLE	STONE
BERYLLIUM	GRAPHITE	ORGANICS	STRONTIUM
BISMUTH	GYP SUM	PEAT	SULFUR
BORON	HAFNIUM	PERLITE	TALC
BROMINE	HELIUM	PHOSPHATE ROCK	TANTALUM
CADMIUM	ILMENITE	PLATINUM	TELLURIUM
CEMENT	INDIUM	POTASH	THALLIUM
CESIUM	IODINE	PUMICE	THORIUM
CHROMIUM	IRON ORE	QUARTZ CRYSTAL	TIN
CLAYS	IRON AND STEEL	RARE EARTHS	TITANIUM
COBALT	KYANITE	RHENIUM	TUNGSTEN
COLUMBIUM	LEAD	RUBIDIUM	VANADIUM
COPPER	LIME	RUTILE	VERMICULITE
DIAMOND	LITHIUM	SALT	YTTRIUM
DIATOMITE	MAGNESIUM	SAND AND GRAVEL	ZINC
			ZIRCONIUM

This report is the earliest Government publication to furnish estimates covering 1993 nonfuel mineral industry data. Most of the estimates are based on at least 6 months data. These data sheets contain information on the domestic industry structure, Government programs, tariffs, and 5-year salient statistics for 90 individual minerals and materials. World resource data appearing in the statements have been provided by the U.S. Geological Survey.

U.S. BUREAU OF MINES THE MINERALS SOURCE

Established in 1910, the U.S. Bureau of Mines conducts research and collects information concerning almost every activity involved in removing minerals from the earth and making them into useful products. The USBM is the U.S. Government's focal agency for matters relating to the technology and economics of minerals and materials. The Bureau collects and analyzes worldwide information covering the mineral/material life cycle, including production, consumption, disposal, and recycling. This information is published and widely used for government policy-making and industrial and financial decisionmaking. The Bureau also conducts basic research in the areas of mining, processing, and materials technology, with special emphasis on health and safety, mining efficiency, environmental concerns, and energy and materials conservation. For additional information, please call the Bureau's Office of Public Information at (202) 501-9649.

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CONTENTS

General:

The Role of Nonfuel Minerals in the U.S. Economy	2
1993 Net Import Reliance of Selected Nonfuel Mineral Materials	3

Significant Events, Trends, and Issues	4
Appendix A—Units of Measure	198
Appendix B—Non-MFN Areas	198
Appendix C—Resource/Reserve Definitions	199

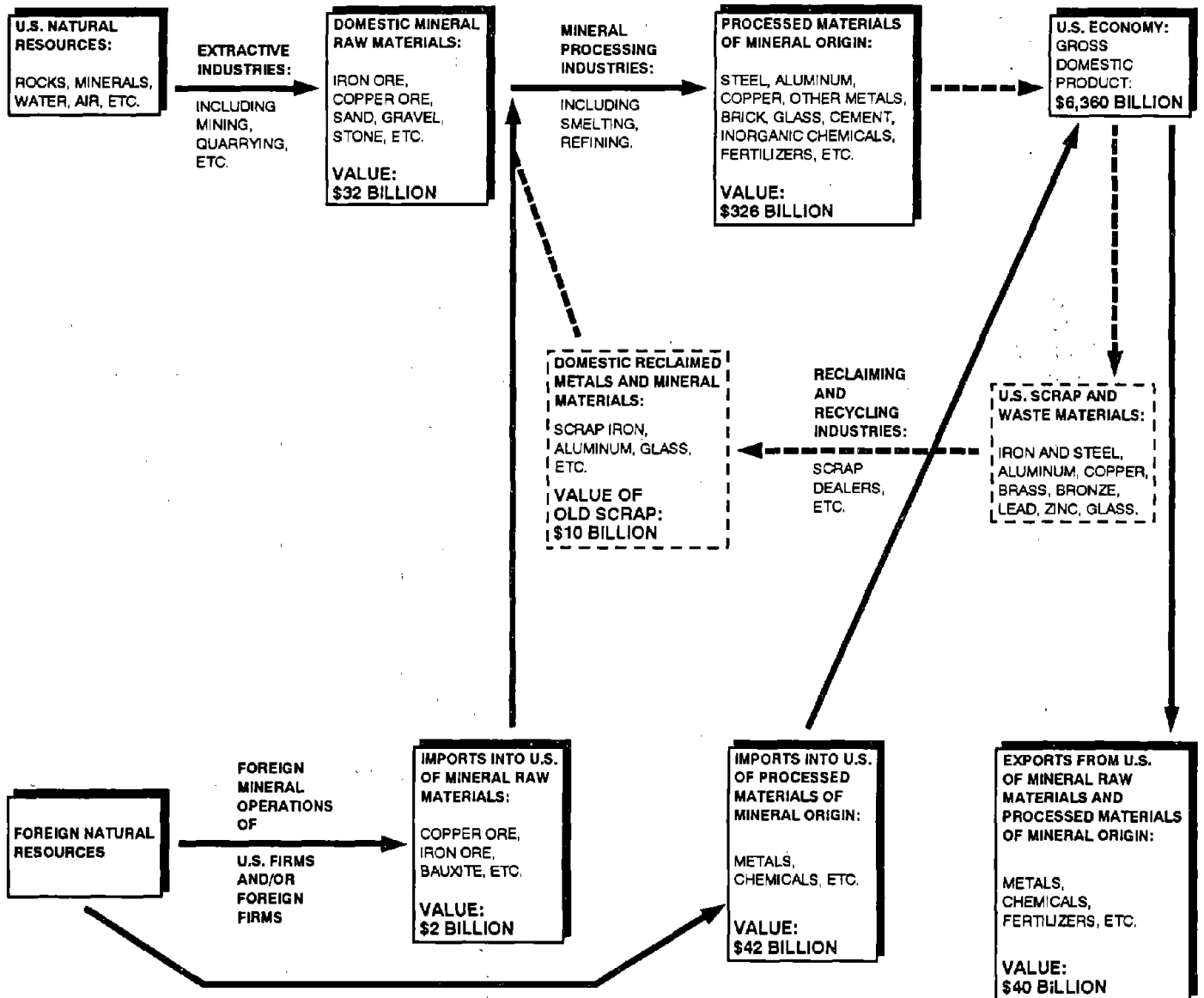
Commodities:

Advanced Materials	18
Aluminum	20
Antimony	22
Arsenic	24
Asbestos	26
Barite	28
Bauxite	30
Beryllium	32
Bismuth	34
Boron	36
Bromine	38
Cadmium	40
Cement	42
Cesium	44
Chromium	46
Clays	48
Cobalt	50
Columbium (Niobium)	52
Copper	54
Diamond (Industrial)	56
Diatomite	58
Feldspar	60
Fluorspar	62
Gallium	64
Garnet (Industrial)	66
Gemstones	68
Germanium	70
Gold	72
Graphite (Natural)	74
Gypsum	76
Hafnium	78
Helium	80
Ilmenite	82
Indium	84
Iodine	86
Iron Ore	88
Iron and Steel	90
Iron and Steel Scrap	92
Iron and Steel Slag	94
Kyanite and Related Minerals	96
Lead	98
Lime	100
Lithium	102
Magnesium Compounds	104
Magnesium Metal	106

Manganese	108
Mercury	110
Mica (Natural), Scrap and Flake	112
Mica (Natural), Sheet	114
Molybdenum	116
Nickel	118
Nitrogen (Fixed), Ammonia	120
Nonrenewable Organics	122
Peat	124
Perlite	126
Phosphate Rock	128
Platinum-Group Metals	130
Potash	132
Pumice and Pumicite	134
Quartz Crystal (Industrial)	136
Rare Earths	138
Rhenium	140
Rubidium	142
Rutile	144
Salt	146
Sand and Gravel (Construction)	148
Sand and Gravel (Industrial)	150
Scandium	152
Selenium	154
Silicon	156
Silver	158
Soda Ash	160
Sodium Sulfate	162
Stone (Crushed)	164
Stone (Dimension)	166
Strontium	168
Sulfur	170
Talc and Pyrophyllite	172
Tantalum	174
Tellurium	176
Thallium	178
Thorium	180
Tin	182
Titanium and Titanium Dioxide	184
Tungsten	186
Vanadium	188
Vermiculite	190
Yttrium	192
Zinc	194
Zirconium	196

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

(ESTIMATED VALUES OF 1993)



BUREAU OF MINES, U.S. DEPARTMENT OF THE INTERIOR
(based in part on U.S. Department of Commerce data)

1993 NET IMPORT RELIANCE^{e 1} OF SELECTED NONFUEL MINERAL MATERIALS AS A PERCENT OF APPARENT CONSUMPTION²

Major Sources (1989-92)

ARSENIC	100	Chile, China, Mexico, France
BAUXITE and ALUMINA	100	Australia, Jamaica, Guinea, Brazil, Guyana
COLUMBIUM (niobium)	100	Brazil, Canada, Fed. Rep. of Germany
GRAPHITE	100	Mexico, China, Canada, Madagascar, Brazil
MANGANESE	100	Rep. of South Africa, France, Australia, Brazil
MICA (sheet)	100	India, Belgium, Brazil, China
STRONTIUM (celestite)	100	Mexico, Fed. Rep. of Germany
THALLIUM	100	Belgium, Canada, United Kingdom (U.K.)
DIAMOND (industrial stones)	98	Ireland, U.K., Zaire, Rep. of South Africa
GEMSTONES (natural and synthetic)	98	Israel, Belgium, India, U.K.
ASBESTOS	95	Canada, Rep. of South Africa
FLUORSPAR	89	Mexico, China, Rep. of South Africa, Canada, Morocco
PLATINUM-GROUP METALS	88	Rep. of South Africa, U.K., former U.S.S.R.
TANTALUM	86	Fed. Rep. of Germany, Australia, Canada, Brazil
TUNGSTEN	84	China, Bolivia, Peru, Fed. Rep. of Germany
CHROMIUM	82	Rep. of South Africa, Turkey, Zimbabwe, Yugoslavia
TIN	81	Brazil, Bolivia, China, Indonesia, Malaysia
COBALT	75	Zambia, Zaire, Canada, Norway
POTASH	71	Canada, Israel, former U.S.S.R., Fed. Rep. of Germany
CADMIUM	66	Canada, Mexico, Australia, France
NICKEL	64	Canada, Norway, Australia, Dominican Republic
BARITE	58	China, India, Mexico
ANTIMONY	57	China, Mexico, Rep. of South Africa, Hong Kong
PEAT	56	Canada
IODINE	51	Japan, Chile
SELENIUM	48	Canada, Japan, Belgium-Luxembourg, U.K.
SILICON	34	Brazil, Canada, Venezuela, Norway
GYPSUM	29	Canada, Mexico, Spain
MAGNESIUM COMPOUNDS	26	China, Canada, Greece, Mexico, Japan
ZINC	26	Canada, Mexico, Peru, Australia, Spain
PUMICE and PUMICITE	25	Greece, Ecuador, Mexico, Turkey
VERMICULITE	16	Rep. of South Africa
NITROGEN	15	Canada, former U.S.S.R., Trinidad and Tobago, Mexico
SULFUR (elemental)	15	Canada, Mexico
IRON and STEEL	12	European Community, Canada, Japan, Brazil, Rep. of Korea
IRON ORE	12	Canada, Brazil, Venezuela, Mauritania, Australia
SALT	12	Canada, Mexico, Bahamas, Chile
LEAD	11	Canada, Mexico, Australia, Peru
MICA (scrap and flake)	11	Canada, India
CEMENT	8	Canada, Mexico, Japan, Spain, Columbia
PERLITE	3	Greece

^eEstimated.

¹Net import reliance = imports - exports + adjustments for Government and industry stock changes.

²Apparent consumption = U.S. primary + secondary production + net import reliance.

SIGNIFICANT EVENTS, TRENDS, AND ISSUES

The U.S. Mineral and Material Industry

The domestic mineral and material industry grew in some key sectors and declined in others during 1993; overall, the industry was poised at yearend for stronger growth in 1994. Metals production is expected to increase with anticipated growth in U.S. motor vehicle sales. There also may be increased demand for industrial minerals in 1994 based on domestic highway and building construction. Additional information on events, trends, and issues in the mineral and material industry is presented below and in the commodity sections that follow.

Overall Industry Performance

The value of processed materials produced from minerals in the United States during 1993 is estimated to have been about \$326 billion, an increase of 5% compared with that of 1992. The estimated value of U.S. raw nonfuel minerals production in 1993 was \$31.6 billion, about 1% less than in the preceding year. The value of domestic minerals production has risen in 28 of the last 33 years.

Total U.S. minerals trade declined in 1993, mirroring weakness in the world economy. The value of raw metal imports declined more than 3% to an estimated \$1.1 billion, while industrial mineral imports decreased by almost 1% to about \$740 million. Exports experienced sharper declines; raw metal exports dropped more than 16% to an estimated \$900 million, and industrial mineral exports decreased nearly 3% to about \$1.1 billion. Exports were expected to increase, however, as the world economy improved and as large metal exports by the former U.S.S.R. declined.

Motor vehicle manufacturing helped to support demand in 1993 among industries that consume large quantities of metal and other mineral-based materials. The motor vehicle industry is a large consumer of such materials, particularly steel, aluminum, copper, lead, zinc, platinum-group metals, plastics, and glass. U.S. motor vehicle sales rose during the year for several reasons, including pent-up demand from recent years, low interest rates, and the ever-increasing popularity of light trucks—the motor vehicle segment that is overwhelmingly dominated by the "Big-3" U.S. companies. The rise in motor vehicle

sales was reflected in higher shipments of domestic steel industry products during 1993.

Some sectors of the domestic construction industry also provided a stimulus for mineral production in 1993. For example, highway construction, which consumes large quantities of crushed stone and sand and gravel, increased sharply during the year following reauthorization of the 6-year Federal highway and mass transit program in 1991. Powerplant construction, which had been in decline for a decade, rose steeply in 1993. Electric utilities consume substantial amounts of stone, sand and gravel, steel, and brick for construction of buildings; they also consume steel, copper, aluminum, and other metals for generators, transformers, power lines, supporting structures, and equipment. In addition, apartment construction (a major end-use sector for steel, stone, sand and gravel, cement, and brick) began to show signs of rebounding from its decline of recent years. In response to growth in these construction sectors, the output of stone, clay, and glass products rose slightly.

Key Events and Issues

During 1993, the Administration and Congress proposed changes to the Mining Law of 1872. The Mining Law gives U.S. citizens and businesses the right to prospect for certain minerals on Federal Lands where mining is not prohibited. In addition, the law currently allows citizens and businesses to file claims that permit them to mine and sell the minerals extracted from Federal Lands without paying the Federal Government a royalty or production fee. The claimant may also apply for a patent that transfers ownership of the minerals and the land on which the claim is located from the Federal Government to the claimant. Proposed Mining Law reforms include the establishment of a royalty on minerals extracted from Federal Lands, the elimination of the patenting provision, and the creation of an abandoned mine reclamation fund.

Different Mining Law reform bills were approved by the House and the Senate in 1993. The House bill included an 8% royalty that would be applied to the value of hardrock minerals produced from Federal Lands. Under the Senate bill, the royalty would be 2%. House-Senate negotiations on a compromise bill were underway in late 1993.

TABLE 1.—U.S. MINERAL INDUSTRY TRENDS
(Million dollars unless otherwise specified)

	1989	1990	1991	1992	1993*
Total mine production:					
Metals	11,868	12,442	11,022	11,514	10,876
Industrial minerals	20,357	20,992	20,016	20,487	20,680
Coal	21,399	22,393	21,404	20,931	19,950
Feedstock production, nonrenewable organics ¹	11,548	14,394	13,479	12,698	12,373
Employment: ²					
Coal mining	116	119	110	102	87
Metal mining	44	46	44	42	40
Industrial minerals, except fuels	85	83	78	76	74
Nonrenewable organic materials	207	202	189	180	181
Chemicals and allied products	603	600	580	567	569
Stone, clay, and glass products	444	432	403	395	398
Primary metal industries	589	574	545	524	514
Average weekly earnings of production workers: ³					
Coal mining	706	735	761	755	766
Metal mining	581	601	639	655	654
Industrial minerals, except fuels	513	525	531	551	591
Nonrenewable organic materials	630	649	681	722	728
Chemicals and allied products	555	577	602	625	642
Stone, clay, and glass products	458	467	474	490	509
Primary metal industries	534	552	563	587	614

*Estimated.

¹Nonrenewable organic materials represent all nonfuel uses in physical structure applications. The values shown include those for petrochemicals, lubricants, petroleum coke, coal, asphalt and road oil, in addition to plastic materials, synthetic resins, synthetic rubber, and nonglass fibers (SIC code 282).

²Thousands of production workers.

³Dollars.

U.S. Bureau of Mines; U.S. Department of Energy, Energy Information Administration; U.S. Department of Commerce, Bureau of the Census; U.S. Department of Labor, Bureau of Labor Statistics.

In order to assess royalty options, the Department of the Interior appointed a task force to analyze the implications of a range of feasible royalty alternatives including royalty revenues estimation. The task force conducted a survey, which indicated that \$1.8 billion of domestic hardrock minerals is produced from public domain lands.

Under Mining Law reform proposals, royalties, rental fees, and other revenues would provide funding for an abandoned mine reclamation fund; 50% to 67% of royalty revenues would go to the fund. The gross production royalty would be divided between the reclamation fund, the States, and the Federal Treasury.

A major restructuring of the National Defense Stockpile, which holds many materials of minerals origin, also was underway in 1993. Early in the year, the Department of Defense reported to the Congress that only the following materials were considered essential: beryllium metal, chromium metal, graphite, jewel bearings, mercury, mica, palladium, and platinum. As part of the stockpile revision, Congress authorized the disposal of commodities valued at \$3.5 billion. In the first three-quarters of Fiscal Year 1993, the Department of Defense disposed of more than \$217 million worth of materials. The major disposals included diamonds (\$84 million), tin (\$35 million), ferrochromium (\$22 million), silver (\$14 million), and copper (\$13 million). During the same period, acquisitions were limited to one-half million dollars worth of jewel bearings.

The major Midwest floods in 1993 significantly impaired some mineral production and shipping. Flooding prevented the operation of locks on the Mississippi River, thus halting much mineral fertilizer traffic (i.e., potash and phosphates) by barge. Production of sand and gravel that is dredged from riverbanks also declined as a result of flooding in the Mississippi and Missouri basins.

A comprehensive bill, which emphasized watershed management and pollution prevention, was introduced in the Senate to reauthorize the Clean Water Act in 1993. The bill gives the Environmental Protection Agency (EPA) new authority that enables the agency to require changes in production processes, products, or raw materials in controlling the emission of toxics. Potentially large sectors of the mineral and material industry could be affected by this legislation to reduce or eliminate toxic pollutants. Regulations that would be developed to implement this mandate could take into account factors such as control techniques, age of equipment, process utilized, process flexibility, and compliance costs in determining what is technically or economically achievable. Other provisions of the bill that may affect the mineral and material sector include those that do not allow mixing zones for certain discharges in waters of special Outstanding National Resources areas and that prohibit or limit discharges for certain pollutants.

Also in 1993, a Senate bill introduced to improve wetlands management by Federal Agencies expanded the scope of wetlands activities that could be regulated (e.g., excavation, mechanized land clearing, ditching, and channelization). This expansion of regulated activities could have significant impact on mining projects in wetland areas. Reauthorization of the Clean Water Act also may address other wetlands

issues (such as property rights) important to mining.

The EPA continued to prepare rules for industry sources subject to hazardous air pollutant standards under the Clean Air Act, as amended. The sources, including mineral processors, are those that emit 1 or more of the 189 substances defined as hazardous under the Act. The EPA published a list of these sources in 1992 and has begun the process of defining Maximum Achievable Control Standards which will apply to them. The process includes on-site visits and follow-up questionnaires. Although the timetable for issuing regulatory controls varies, proposed standards for most mineral industries are due by November 15, 1997.

In recent years, Congress and the EPA have been considering several approaches aimed at reducing the amount of lead in the environment and society's exposure to lead. One approach under consideration has been a tax on domestic lead production to reduce lead consumption, raise revenues for a lead abatement program, and encourage lead recycling. In 1993, legislation was introduced in Congress to tax lead production. In order to assist the Congress and the EPA in their decisionmaking, the Department of the Interior assessed the minerals-related implications of a tax on U.S. lead production and imports.

U.S. Industry Outlook

Industry analysts and producers remained cautiously optimistic as the year ended. Growth in U.S. motor vehicle sales and increased highway construction are expected to stimulate mineral and material demand. Some producers expressed concerns about the possibility that royalties on minerals from Federal Lands would increase. Negotiations over expired labor contracts and those due to lapse generated additional concerns.

Polymers and Advanced Materials

New products and expanded markets for polymer materials emerged across major industries. In the transportation industry, automakers found additional uses for nonwoven polymer fabrics in vehicle interiors and in under-the-hood applications. Interior applications included seats, headliners, and sound-proofing components. Under the hood, these fabrics were used as molded hood linings, carburetor air filters, and oil filters. Polymer composites, with and without continuous fibers as reinforcements, continued to replace more conventional materials in

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

	1989	1990	1991	1992	1993*
Gross domestic product (billion dollars)	5,251	5,546	5,723	6,039	6,360
New plant and equipment expenditures (billion dollars):					
All industries	507	533	528	547	585
Manufacturing	184	193	183	174	180
Primary metals	12	12	11	10	10
Stone, clay, and glass	4	3	3	3	4
Mining	9	10	10	9	9
Industrial production (1987 = 100):					
Total index	106	106	104	107	110
Manufacturing	106	106	104	107	111
Stone, clay, and glass products	103	100	93	96	100
Primary metals	107	107	99	101	105
Iron and steel	111	112	101	105	110
Nonferrous metals	102	100	95	96	99
Chemicals and chemical products	109	112	111	115	118
Mining	101	103	102	98	97
Metals	140	153	157	162	164
Coal	107	112	109	105	104
Oil and gas extraction	96	97	96	93	92
Stone and earth minerals	101	102	94	94	94
Capacity utilization (percent): ¹					
Total industry	84	82	79	80	82
Mining	86	89	89	94	87
Metals	84	85	84	86	85
Stone and earth minerals	85	86	80	80	80
Housing starts (thousands of units)	1,376	1,193	1,014	1,200	1,230
Automobile production (thousands of units)	6,823	6,077	5,439	5,663	5,900
Highway construction, all public, expenditures (billion dollars)	27	28	*29	*30	33

*Estimated. ¹Preliminary.

¹1992 estimates based on seasonally adjusted figures.

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

the automotive industry, especially where plastics could meet higher performance criteria and provide lower cost by part(s) consolidation.

In the construction industry, polymers and polymer composites again proved themselves in load bearing applications under diverse environments. Polymers

were used to make polymer concrete for road and bridge overlays, highway safety barriers, and other elements of the infrastructure. These materials were also used in the manufacture of plastic cedar-like roof shingles. In other areas, plastic tubing, rigid containers, and other polymer medical products met demanding requirements of the medical industry. The consumer products industry benefited from an upsurge in new plastics products ranging from home organizing devices to exercise and recreation equipment.

Debates continued over the environmental impact of certain chemicals used in the manufacture of plastics and plastics products. The plastics industry encountered skepticism about its commitment to reduce plastics waste through recycling. Environmentalists have viewed the industry's focus on such issues as source reduction and waste-to-energy incineration as a retreat from plastics recycling. The plastics industry reemphasized its commitment to recycling and its goal to recycle 25% of plastic containers by 1995. Based on its survey of postconsumer recycling, the industry reported improvements in recycling rates for 1992 for most plastics products categories, including bottles and other rigid containers. The plastics industry attributes this recycling growth to an increase in the number of municipal recycling programs and to the industry's investment in recycling, which is projected to reach \$1.2 billion by 1995.

The Advanced Materials and Processing Program (a Federal interagency effort to expand opportunities in advanced materials research and development) had a Fiscal Year 1993 budget projected at \$2.1 billion, a 9% increase over Fiscal Year 1992. The increase reflects the Government's continuing and increasing commitment to enhancing U.S. scientific and technological efforts for global competitiveness.

Company revenues for advanced ceramics, advanced polymer composites, metal matrix composites, and carbon-carbon composites declined. To compensate for the loss of high value-added advanced materials projects in the Department of Defense, companies sought to increase their sales in lower priced products markets. In advanced ceramics markets, for example, the only growth in sales for U.S. companies was in the electronics sector, which reflected increased revenues from the personal computer and telecommunication markets.

The use of metal matrix composites increased in the automotive industry. Metal matrix composites are expected to enter commercial markets more easily

than carbon-carbon composites because their cost is only a factor of 10 above the cost of materials currently used (the cost differential is between 10 and 100 times higher for carbon-carbon composites). Niche markets for carbon-carbon composites, such as golf clubs, tennis rackets, and other recreational products, may not generate a large enough demand for the existing overcapacity in today's industry.

North American Exploration

The Minerals Exploration Statistics Committee of the Society of Economic Geologists interprets data derived from an annual Mineral Exploration Statistics Survey. The survey and supplemental research indicate the current level of international hardrock mineral exploration by Canadian and U.S. companies.

A preliminary evaluation of 1992 survey responses from 36 Canadian and 25 U.S. mineral companies operating in the United States suggests that the average corporate exploration budget was reduced by more than one-half from 1991 levels with most funds going to precious and base metal targets. All categories of exploration activities decreased between 1990 and 1991: geology, land acquisition and airborne geophysics declined by more than 50%; and drilling, geochemistry and general administration each suffered more than a 40% decline. These activities tend to be closely related to basic exploration programs. In addition, the amount of core and rotary drilling declined by 74% and 20%, respectively.

Base and precious metal exploration in the United States during 1992 appears to have decreased, on an average company basis, by more than 60%. Although specific gold and copper deposits continue to command attention, most U.S. programs have been curtailed. Many companies accelerated exploration programs on their existing claims in order to reduce the size of these land packages. The Bureau of Land Management estimated that 75% of these claims were dropped during 1993.

The number of companies that have shifted portions of their exploration budgets to Latin America continues to grow. More than 250 companies, about 10% of the North American exploration industry, are now active in Latin America. Mexico and Chile are the principal countries of choice. However, a major gold discovery during 1992 in Venezuela and continued success of some companies in Bolivia also make these countries attractive. The privatization of world-class mineral deposits by numerous Latin American governments has created a wealth of new

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1993*

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	\$569,698	18	1.81	Stone (crushed and broken), cement (portland), lime, and sand and gravel (construction).
Alaska	420,698	25	1.33	Zinc, gold, sand and gravel (construction), and lead.
Arizona	2,741,503	1	8.69	Copper, sand and gravel (construction), cement (portland), and molybdenum.
Arkansas	364,937	28	1.16	Stone (crushed and broken), bromine, cement (portland), and sand and gravel (construction).
California	2,281,587	3	7.24	Sand and gravel (construction), cement (portland), gold, and boron minerals.
Colorado	432,013	24	1.37	Sand and gravel (construction), cement (portland), stone (crushed and broken), and gold.
Connecticut	86,398	44	.27	Stone (crushed and broken), sand and gravel (construction), sand and gravel (industrial), and stone (dimension).
Delaware	111,200	50	.04	Sand and gravel (construction).
Florida	1,297,305	9	4.11	Phosphate rock, stone (crushed and broken), cement (portland), and sand and gravel (construction).
Georgia	1,691,211	4	5.36	Clays (kaolin), stone (crushed and broken), clays (Fuller's earth), and cement (portland).
Hawaii	1134,583	41	.43	Stone (crushed and broken), cement (portland), cement (masonry), and gemstones.
Idaho	282,568	33	.90	Phosphate rock, gold, sand and gravel (construction), and silver.
Illinois	731,566	16	2.32	Stone (crushed and broken), sand and gravel (construction), cement (portland), and sand and gravel (industrial).
Indiana	501,223	21	1.59	Stone (crushed and broken), cement (portland), sand and gravel (construction), and lime.
Iowa	343,613	31	1.09	Stone (crushed and broken), cement (portland), sand and gravel (construction), and gypsum (crude).
Kansas	383,917	27	1.22	Salt, helium (Grade-A), stone (crushed and broken), and cement (portland).
Kentucky	415,765	26	1.32	Stone (crushed and broken), lime, cement (portland), and sand and gravel (construction).
Louisiana	256,031	35	.81	Salt, sand and gravel (construction), sulfur (Frasch), and stone (crushed and broken).
Maine	60,938	45	.19	Cement (portland), sand and gravel (construction), stone (crushed and broken), and gemstones.

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1993^a—continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Maryland	1360,995	30	1.14	Stone (crushed and broken), cement (portland), sand and gravel (construction), and cement (masonry).
Massachusetts	166,381	39	.53	Stone (crushed and broken), sand and gravel (construction), lime, and stone (dimension).
Michigan	1,407,911	5	4.46	Iron ore (usable), cement (portland), sand and gravel (construction), and stone (crushed and broken).
Minnesota	1,323,370	8	4.19	Iron ore (usable), sand and gravel (construction), stone (crushed and broken), and sand and gravel (industrial).
Mississippi	138,610	40	.44	Sand and gravel (construction), cement (portland), clays (Fuller's earth), and stone (crushed and broken).
Missouri	785,383	15	2.49	Lead, cement (portland), stone (crushed and broken), and lime.
Montana	495,798	22	1.57	Gold, copper, cement (portland), and sand and gravel (construction).
Nebraska	118,417	42	.38	Sand and gravel (construction), cement (portland), stone (crushed and broken), and clays (common).
Nevada	2,734,499	2	8.67	Gold, sand and gravel (construction), silver, and diatomite.
New Hampshire	135,909	47	.11	Sand and gravel (construction), stone (crushed and broken), stone (dimension), and gypsum (crude).
New Jersey	251,700	36	.80	Stone (crushed and broken), sand and gravel (construction), sand and gravel (industrial), and greensand marl.
New Mexico	787,730	14	2.50	Copper, potash, sand and gravel (construction), and stone (crushed and broken).
New York	844,624	12	2.68	Stone (crushed and broken), salt, sand and gravel (construction), and cement (portland).
North Carolina	593,663	17	1.88	Stone (crushed and broken), phosphate rock, lithium minerals, and sand and gravel (construction).
North Dakota	124,994	49	.08	Sand and gravel (construction), lime, sand and gravel (industrial), and clays (common).
Ohio	813,586	13	2.58	Stone (crushed and broken), sand and gravel (construction), salt, and lime.
Oklahoma	282,467	34	.90	Stone (crushed and broken), cement (portland), sand and gravel (construction), and iodine (crude).

See footnotes at end of table.

TABLE 3.—VALUE OF NONFUEL MINERAL PRODUCTION IN THE UNITED STATES AND PRINCIPAL NONFUEL MINERALS PRODUCED IN 1993^a—continued

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Oregon	233,526	37	0.74	Stone (crushed and broken), sand and gravel (construction), cement (portland), and lime.
Pennsylvania	893,353	10	2.83	Stone (crushed and broken), cement (portland), lime, and sand and gravel (construction).
Rhode Island	126,900	48	.09	Sand and gravel (construction), stone (crushed and broken), and sand and gravel (industrial).
South Carolina	361,317	29	1.15	Cement (portland), stone (crushed and broken), gold, and clays (kaolin).
South Dakota	324,349	32	1.03	Gold, cement (portland), sand and gravel (construction), and stone (crushed and broken).
Tennessee	538,318	19	1.71	Stone (crushed and broken), zinc, cement (portland), and sand and gravel (construction).
Texas	1,393,637	6	4.42	Cement (portland), stone (crushed and broken), magnesium metal, and sand and gravel (construction).
Utah	1,349,838	7	4.28	Copper, gold, magnesium metal, and cement (portland).
Vermont	144,804	46	.14	Stone (dimension), stone (crushed and broken), sand and gravel (construction), and talc and pyrophyllite.
Virginia	515,289	20	1.63	Stone (crushed and broken), cement (portland), sand and gravel (construction), and lime.
Washington	480,419	23	1.52	Sand and gravel (construction), magnesium metal, gold, and stone (crushed and broken).
West Virginia	111,421	43	.35	Stone (crushed and broken), cement (portland), sand and gravel (industrial), and sand and gravel (construction).
Wisconsin	200,250	38	.63	Stone (crushed and broken), sand and gravel (construction), lime, and sand and gravel (industrial).
Wyoming	858,004	11	2.72	Soda ash, clays (bentonite), helium (Grade-A), and cement (portland).
Undistributed	51,352	—	.16	
Total ²	31,556,000	XX	100.00	

^aEstimated. XX Not applicable.

¹Partial total, excludes values that must be concealed to avoid disclosing company proprietary data. Concealed values included with "Undistributed" figure.

²Rounded.

opportunities; each contributing to the transformation of U.S. mining companies from a U.S. mineral reserve base to an international one. Additional details on this trend are provided below.

Significant International Developments

In 1993, the global mineral industry was dramatically impacted by several diverse international socioeconomic forces that have been gathering momentum over the last few years:

- More liberal investment climates being created in Latin America and Asia have encouraged international mining companies to focus their attention on these regions.
- The disarray presently existing in Central Eurasia (the former Soviet Union), wherein minerals consumption within this region has decreased significantly without a concomitant cutback in production, has meant that exports from Central Eurasia are now inundating the world's mineral markets. When combined with continued recession in Western Europe and Japan, these exports have resulted in depressed minerals and metals prices worldwide, especially for aluminum, nickel, potash, and magnesium.
- Regional trade blocs are being developed and expanded. The European Community (EC), the North American Free Trade Agreement (NAFTA), the Association of Southeast Asian Nations (ASEAN), the Asia Pacific Economic Cooperation (APEC), and the Latin American Southern Cone Common Market (MERCOSUR), will all contribute to reduced internal tariffs and increased intraregional mineral trade.
- An unprecedented trend toward privatization of previously nationalized or centrally planned mineral industries is occurring throughout the world. Privatization of mineral companies is occurring at an accelerated pace in Western Europe, particularly in France and Italy; throughout Latin America, Central Eurasia, Eastern Europe, Asia, and Africa. The reasons for privatization may vary among regions and countries but the trend appears to be worldwide.

Europe and Central Eurasia

The breakup of the world's most prolific minerals producer, the former Soviet Union, has resulted in a redirection of the trade patterns of some of the newly independent states (NIS) that had comprised the

U.S.S.R. Russia, in particular, is now exporting a far higher amount of aluminum, magnesium, potash, titanium, nickel, and other minerals to Western Europe and the United States than it did before the breakup. This is due to reduced internal consumption in the NIS and the inability of both domestic and former East European customers to pay hard currency for these raw materials. For example, aluminum exports to countries outside those formerly in the Council for Mutual Economic Assistance (CMEA) have increased five-fold in the last few years, to an estimated 1.6 million metric tons in 1993. Coming in the wake of recessions in Western Europe and Japan, these increased exports have caused disruptions in international consumption patterns, helped reduce worldwide minerals prices, and, in general, helped perpetuate the general international economic malaise. In the case of aluminum, the EC established a limit on Russian exports to EC countries of 60,000 metric tons over a 4-month period. This caused strong reaction on the part of U.S. aluminum producers who had sought to minimize the effects of extra Russian material by cutting back on their own production. As a result, meetings were held between the United States, the EC, Russia, and other major producers of minerals and/or metals in an attempt to minimize some of these disruptions.

The trend toward privatization has proliferated in Eastern Europe and the states of the former Soviet Union, and is also prevalent in France, Italy, and other EC countries. In 1993, France announced a privatization program involving 21 large state-controlled enterprises. Italy also plans to privatize several state-controlled companies. In Spain, the country's largest chemicals, fertilizers, mining, and explosives company is in the process of being privatized. With regard to Eastern Europe, modernization, rationalization, and restructuring as well as privatization is ongoing. Germany is continuing to spend on the order of \$100 billion per year to modernize and integrate the eastern German states into a greater Germany. In the process, much of the minerals and metals production in the former Eastern Germany, which went, in part, to supply former CMEA needs, has been cut back significantly. In particular, the steelworks at Brandenburg, and the potash and lignite mines have been greatly affected. The Czech Republic, Hungary, and especially Poland, have attracted a number of foreign investors in the metals and minerals sector.

Latin America and Canada

Congressional approval of the North American Free Trade Agreement was a significant event in late

TABLE 4.—EXPLORATION STATISTICS
(Thousand dollars unless otherwise specified)

	<u>1990</u>	<u>1991</u>	<u>1992</u>
Expenditures in the United States:			
Companies reporting	55	49	61
Total spent	\$164,000	\$149,718	\$80,600
Average spent per company	<u>\$2,982</u>	<u>\$3,395</u>	<u>\$1,321</u>
Expenditures by commodities:			
Precious metals	NA	\$111,488	\$65,170
Base metals	NA	\$33,508	\$10,390
Base and precious metals	\$157,108	\$144,996	\$75,560
Other minerals	NA	\$290	\$601
Uranium	\$383	NA	\$0
Industrial minerals	\$6,509	\$4,432	\$4,080
Unknown	NA	NA	\$359

NA Not available

Source: Society of Economic Geologists.

1993. Because most mineral commodities from Mexico already enter the U.S. market duty free or at preferential rates, NAFTA should generally help increase U.S. mineral exports to Mexico, where the average duty is 10% and certain items have a tariff of 20%.

The United States depends significantly on Canada and many Latin American countries for mineral imports. In 1993, Suriname became the 31st Latin American country to sign a "trade framework agreement" with the United States. The framework agreements create Trade and Investment Councils to discuss bilateral easing of barriers to trade and investment.

A large number of countries in the region are in the process of reducing the role of their governments in the economy through privatization of business operations. Especially notable was the action taken by Argentina to sell control of its state oil company to local and foreign investors. Company shares were made available on the New York Stock Exchange in the form of American Depository Receipts. Privatization programs were also active in Bolivia, Chile, Brazil, Mexico, and Peru.

Foreign investment in Latin America has been stimulated by more open economies and less

intervention by governments, but more particularly by liberalized investment and mining laws offering incentives and equal treatment to the foreign investor. In some countries, like Mexico, incentives include reduction in corporate taxes. Chile, Bolivia, and Mexico have been particular beneficiaries of increased foreign investment. Foreign investors have targeted precious metals in their exploration and development projects. Large investments by U.S. and Canadian mining companies in Chile have enabled that country to obtain record-high gold and copper production and become the largest world producer and exporter of copper. Increased gold output in Bolivia, Uruguay, and Venezuela is also the result of foreign investment. Changes in the petroleum laws of Argentina, Bolivia, Chile, and Peru have also increased interest and exploration by foreign oil companies.

The overall change in investment climate and the issuance of new liberalized mining laws and regulations have led to an increase in mineral exploration in Latin America, especially Mexico. It has been estimated that since 1990, there has been an influx of more than 100 U.S. and Canadian exploration companies into Mexico. In 1993, more than 50 active exploration and development programs were ongoing in Chile.

Asia and the Pacific

Japan, China and Taiwan, with whom the United States has large trade deficits, import large quantities of raw materials for the production of finished goods for export.

Due to the strength of the yen, Japan's purchases of foreign minerals, metals, and fuels continued to cause contraction of its relatively small domestic mining sector. Japan has intensified its overseas mineral exploration and development projects for copper, gold, lead, silver, and zinc since 1992. Significant joint exploration and development projects were undertaken in Australia, Chile, China, Mexico, Mongolia, the Republic of South Africa, and the United States. In 1992, Japan successfully launched its first geological observation satellite with the world's most advanced sensor and radar equipment to aid in the worldwide search for copper, gold, iron, lead, silver, zinc, and other metals. The satellite began transmitting data in 1993 covering 10 portions of the earth's surface, including 2 targeted areas in the United States.

In contrast to Japan, China is experiencing a period of rapid economic growth and consuming an increasing amount of raw materials. Thus, although China has continued to increase its minerals production significantly, it continues to import increasing amounts of copper, iron and steel products and other raw materials, and has been one of the few regions in the world exerting a positive force on world mineral demand.

An important Roundtable Conference on Regulations for Foreign Investment in the Mineral Industry, organized by the Ministry of Geology and Mineral Resources, was held in Beijing in May 1993. The Conference provided the opportunity for representatives of international companies to comment on the proposed regulations on foreign investment and enter into discussions with high-level Government officials.

India issued a new National Mineral Policy (NMP) in March 1993. The NMP repeals the ban on foreign and private investment in the mining of 13 mineral commodities—chromium, copper, diamond, gold, iron, lead, manganese, molybdenum, nickel, platinum group metals, sulfur, tungsten, and zinc. The NMP allows foreign equity up to 50% in joint venture mining projects promoted by Indian companies. Enhanced equity holdings above 50% will be considered on a case-by-case basis. India has considerable mineral potential that can be exploited. One of the objectives

of the NMP is to attract foreign investment for mineral exploration.

Australia's mineral industry was strained by the Australian High Court's "MABO Decision" ruling against the concept of Terra Nullius, the principle that Australia was legally uninhabited before the arrival of Europeans in the 18th century. The decision paves the way for a profusion of land rights conflicts and claims that could significantly impact the mining industry. Australia managed to sustain its gold output despite dire predictions of decreased production resulting from the 1991 gold tax.

After a series of intense negotiations with the major foreign investors in the country, the Papua New Guinea Government's joint venture equity ownership in the huge Ok Tedi copper mine and Porgera gold mine, as well as at Lihir, the world's largest undeveloped gold prospect, was settled during the year. In an action counter to the trend in most other nations, the Government's equity stake increased from 20% to 30% at Ok Tedi; from 10% to 25% at Porgera and from zero to 50% at Lihir, raising further concerns about development financing for Lihir.

In Indonesia, access to low-cost hydroelectric energy allowed aluminum and nickel operations to maintain production levels despite depressed world prices. Coal production increased 16% to 26 million metric tons, and coal exports increased 20% to 18 million metric tons because of strong demand from Asian markets. A new mine in West Irian came on-line, single-handedly helping Indonesia maintain its place as one of the largest copper producers in the world and substantially increasing gold output.

The Middle East

The dissolution of the former Soviet Union has opened up vast opportunities for Turkey, Iran, and Saudi Arabia to advance their influence in the newly independent Islamic republics. Turkish private concerns and the state oil company signed agreements to help develop some of the enormous oil and gas resources in this region. Turkish interests also negotiated access to gold and other minerals as well. Iranian and Saudi Arabian interests continued negotiations on developing hydrocarbons and other minerals in the newly independent Islamic states.

Iraqi mineral production facilities damaged during the Gulf War in late 1990 and early 1991 reportedly have been restored to at least 50% of pre-war capacity in crude oil and natural gas and even more in petroleum

and petrochemical products, phosphate, sulfur, cement, and construction material. However, production was essentially limited to what was consumed internally because of the United Nations trade embargo.

Oil and gas provided more than 80% of the Middle East's foreign exchange. Most mineral commodity production facilities, including hydrocarbons, were still under government control through various parastatal companies. Although most of the governments continued to promote privatization of the sector, progress was slow.

Africa

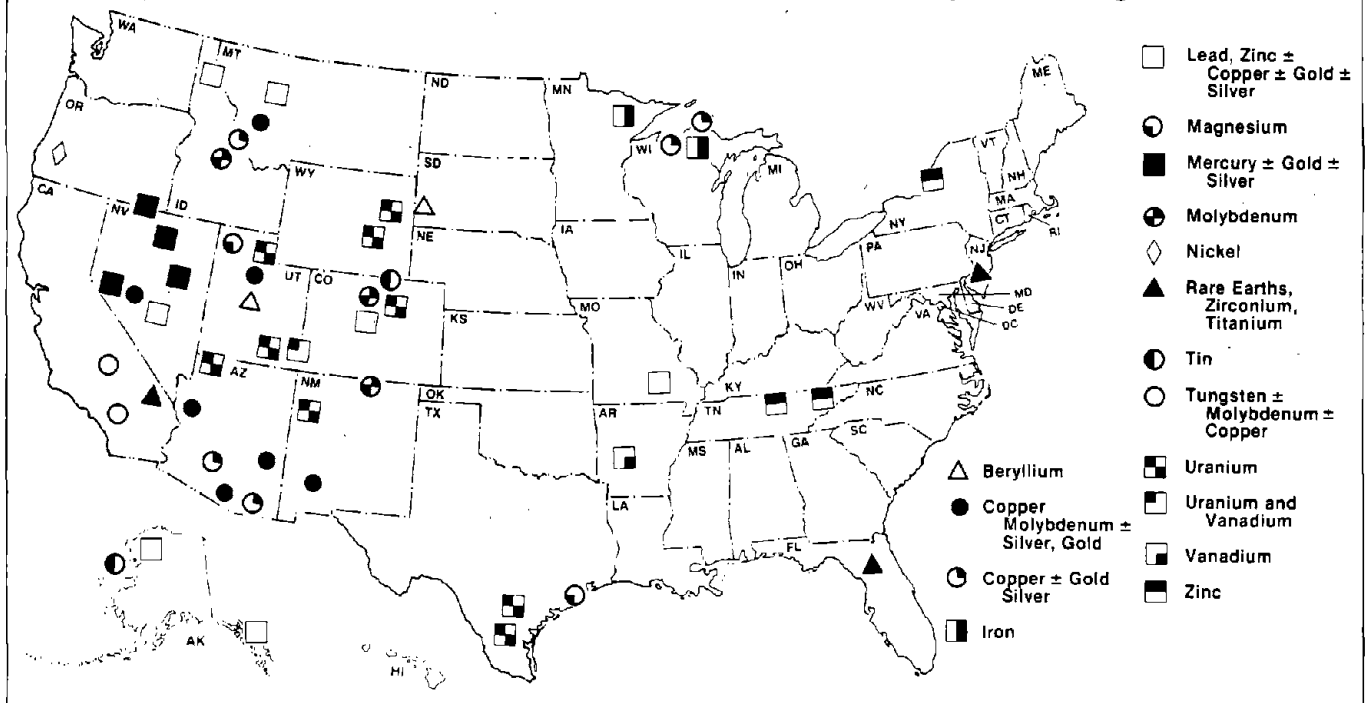
Political unrest dominated daily life in many African countries during 1993. Most of the countries in Africa have some existing or potential mineral production and are looking for increased foreign investment. Many African governments have adopted internally painful International Monetary Fund and World Bank structural adjustment programs to facilitate foreign investments, but these programs have been slow in enticing new foreign investment to the region. In 30 of the countries with ongoing adjustment programs, only a handful, such as the Ghanaian mineral sector, can tell a success story. Political instability and poor infrastructure have deterred growth in mining and other foreign investments. However, enhanced development of mineral resources is occurring in several African countries. Gold continued to be of international interest in Botswana, Zimbabwe, Ghana and other west African countries, including Guinea, Niger, and Nigeria. Gold is produced in 24 African countries, led

by South Africa, which remained the world's largest producer in 1993. In Ghana, second to South Africa in African gold production, construction began on initial components of a new gold bio-oxidation facility.

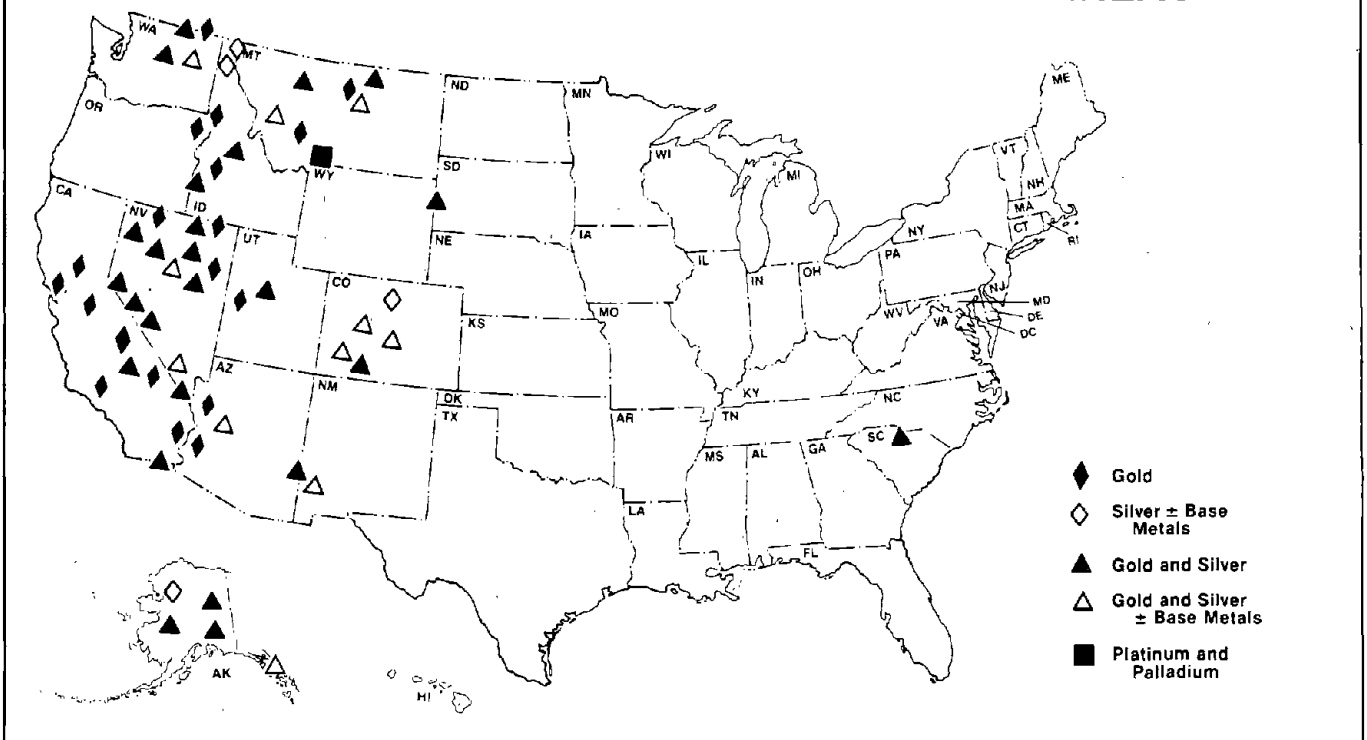
In Nigeria, the Government revised investment laws to attract new investors in the oil and gas sectors, allowing joint ventures between local and foreign participants. The foreign partners are permitted to have as much as 70% equity. This and other policy changes have led to an increase in the nation's oil and natural gas reserves. In addition, the Nigerian Government began rewriting its mining laws to become more attractive to foreign investors. Ethiopia's transitional Government adopted new mining laws in 1993 to follow up the Investment Law of 1992. Newly independent Eritrea also drafted new mining and investment laws.

In the Republic of South Africa, a new Minerals, Mining and Exploration Act came into effect. It provides for a standard licensing regime with special provisions to promote investment by foreign and domestic enterprises in minerals exploration and extraction. Further mining legislation was introduced in the South African Parliament to increase the responsibility of mine owners to rehabilitate environmental damage and to increase the environmental planning requirements of new mines. The formal ending of apartheid laws and of economic sanctions against the Republic of South Africa during the year opens the country for renewed foreign investment. However, most investors are awaiting the outcome of elections in April 1994 and subsequent new policies that could impact mining investment.

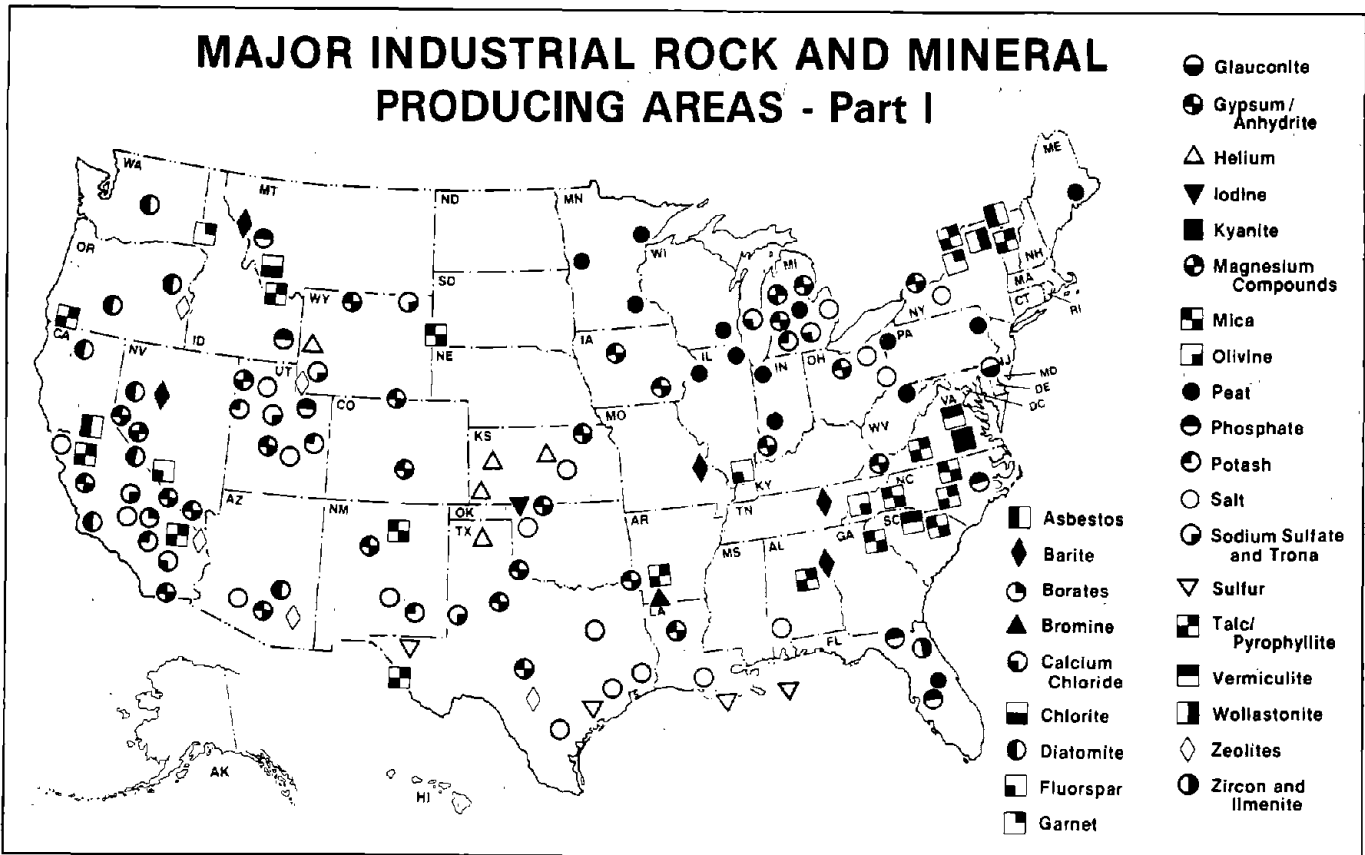
MAJOR BASE METAL PRODUCING AREAS



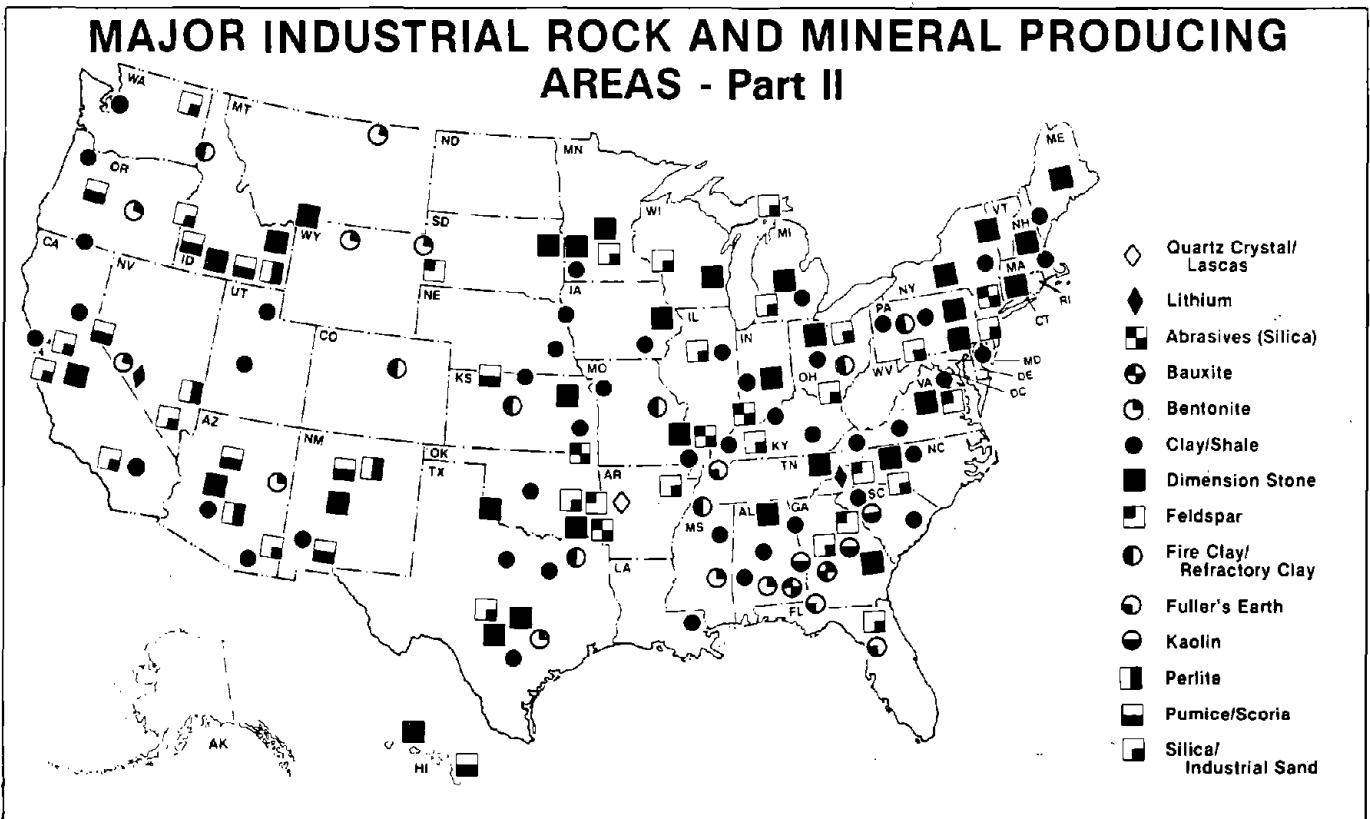
MAJOR PRECIOUS METAL PRODUCING AREAS



MAJOR INDUSTRIAL ROCK AND MINERAL PRODUCING AREAS - Part I



MAJOR INDUSTRIAL ROCK AND MINERAL PRODUCING AREAS - Part II



ADVANCED MATERIALS

(Data in thousand metric tons, unless noted)

Domestic Production and Use: U.S. shipments of polymer composites¹ are estimated to reach 1.2 million metric tons in 1993, an increase of approximately 5% over 1992. Dollar values for these shipments are not available for public release. These figures represent more than 450 U.S. firms in the polymer composites industry. The 5% shipment increase reflects optimism for the economy and the continued substitution of polymer composites for other materials. The U.S. Bureau of Mines estimates U.S. shipments of advanced polymer composites at 7,500 metric tons in 1993, with a dollar value of \$2.3 billion. These estimates indicate advanced polymer composites shipments equal to approximately 0.6% of the total shipments of polymer composites. The average dollar value for advanced polymer composites is about \$139.00 per kilogram (\$63.00 per pound). The majority of applications using advanced polymer composites are in the military and commercial aircraft industries. Advanced polymer composites shipments and dollar value have remained virtually unchanged for 1991 through 1993, reflecting the current worldwide recession.

Advanced ceramics revenues for 1993, as estimated by the Bureau, are expected to reach about \$3.2 billion, a 2% increase over 1992. This estimate is based on the 1993 projected growth in the U.S. gross domestic product. The data source for these revenues has changed.² U.S. advanced ceramics submarkets for 1993 include electronic ceramics, ceramic coatings, and engineering ceramics.

Metal matrix composites revenues for 1993 are projected to be \$30 million for the following applications (in percent of total revenue): aerospace, 83%; automotive, 13%; recreational, 2.6%; and industrial-other, 1.4%. The estimated \$30 million in sales is 3.8% above the 1992 level but below that for 1991 (\$33 million) and 1990 (\$36 million). The automotive segment appears to be growing relative to the other segments.

Carbon carbon composites revenues for 1993 are projected to be \$115 million for the following applications (in percent of total revenue): aerospace ablative, 50%; aircraft brakes, 26%; rocket nozzles, 17%; and industrial-other, 7%. The estimated \$115 million in sales is 4.3% lower than the 1992 level and lower still than that for 1991 (\$125 million) and 1990 (\$152 million).

Salient Statistics—United States:

U.S. percentage of advanced polymer composites revenues worldwide is estimated at 51% or \$2,300 million.*

U.S. percentage of advanced ceramics revenues worldwide is estimated at 22% or \$3,235 million.*

U.S. percentage of metal matrix composites revenues worldwide is estimated at 55% or \$30 million.*

U.S. percentage of carbon carbon composites revenues worldwide is estimated at 68% or \$115 million.*

Recycling: Besides some 1993-model production vehicles featuring polymer composite components manufactured with recycled materials, U.S. automakers are adding "design for recycle" concepts to their total quality manufacturing themes based on "design for manufacture." Proposed German recycling laws intend that German automakers buy back their products at the end of useful service. Existing German law requires automakers to conduct R&D on full auto recycling. Some U.S. auto and chemical companies have started similar programs in anticipation of auto recycling laws in the United States.

Import Sources: Not available.

Tariff: Not available.

Depletion Allowance: Not available.

Government Stockpile: None.

Events, Trends, and Issues: The current worldwide recession has generally restrained any revenue increases for advanced materials in the past 2 years. The few bright areas economically are related to the communications and computer industries. Revised 1992 data for engineered ceramics showed a decrease in 1992 revenues, but, for 1993, estimated revenues were closer to the 1990 level. The monetary and industrial policies of the past decade for most countries in the Northern Hemisphere are adjusting to the inherent downcycling of the world economy coupled with the end of the cold war.

The technology issues of how to increase competitiveness for U.S. companies through improved manufacturing have been accelerated by the Clinton administration. More funding was added in 1993 to many "competitiveness" bills introduced and/or pending in Congress, and executive branch policymaking study panels have been empowered. The following three agencies will be the lead agencies: the Department of Commerce

ADVANCED MATERIALS

with its Advanced Technology Programs, the Department of Defense with its "Dual Use" Manufacturing Programs, and the Department of Energy with its Energy Efficiency Programs. For 1993, the joint agency Technology Reinvestment Program is providing \$500 million to start reinvestment in U.S. manufacturing know-how. The three aforementioned agency programs are funded at approximately \$100 million each for 1993 and are expected to have annual funding approaching \$700 million each by a 1996 to 1998 timeframe.

World Production: Worldwide revenues for five technical categories under the designation of advanced materials are shown in the table below.

Worldwide revenues for advanced materials

	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>
Advanced polymer composites: ³				
Shipments, thousand metric tons	15.9	14.1	13.7	13.8
Revenue, million dollars	4,000	4,500	4,300	4,500
Advanced ceramics: ⁴				
Revenue, million dollars	13,594	15,341	14,816	15,000
Engineered ceramics: ⁴				
Revenue, million dollars	1,359	1,688	1,185	1,300
Metal matrix composites: ³				
Shipments, thousand metric tons	0.55	0.44	0.56	0.54
Revenue, million dollars	60	54	56	55
Carbon carbon composites: ³				
Shipments, thousand metric tons	0.31	0.24	0.23	0.22
Revenue, million dollars	200	175	171	170

World Resources: Not available.

Substitutes: Polymer composites and advanced polymer composites use both petroleum and natural gas as feedstocks. The amount of both feedstocks consumed in nonfuel applications is between 6% and 8% of the total pumped out of the earth. Since these feedstocks are nonrenewable, small efforts at their recycling have demonstrated an economic return. Current studies indicate that recycling polymer-base products may be feasible with a minimum of cost once "economies of scale" for polymer recycling begin to operate. Recycling polymer materials would allow the world continued use of these most readily available products.

Advanced ceramics are fabricated from abundant, low-cost earth materials. Aluminum oxide, silicon oxide, oxygen, carbon, and nitrogen are common feedstocks for advanced ceramics. The technical issues of today revolve around processing costs at elevated temperatures and the brittleness of the finished product. Heat engines of the future may be made of these plentiful feedstock materials. The tradeoffs will be sufficiently increased fuel efficiency offset by the cost of using composite materials to control or negate the brittleness problem.

Metal matrix composites portend many new industrial and market applications. These composites, uniqueness in severe environments for today's applications makes it difficult to find material substitutes for them. The full utilization of metal matrix composites may depend on the economies of their recyclability.

Carbon carbon composites are attractive for their low density and ablative attributes in nonoxidizing environments. These composites rely on petroleum and natural gas feedstocks, and their recyclability is not proven. Therefore, long-term reliance on critical applications requiring these composites may be costly until new material substitutions become available. For instance, a technology very similar to carbon carbon is in its R&D infancy. The material is high-purity silicon carbide (SiC). SiC continuous fibers in SiC matrix composites are fabricated by the very same technologies that produce carbon carbon components. The uniqueness of SiC over carbon is SiC's ability to resist oxidation at elevated temperatures. Today, SiC is the material used as glow bars or heaters in most chemical, metal, and ceramic processing furnaces and annealing or curing lines.

*Estimated.

¹Source: Society of Plastics Industry's Composite Institute.

²In 1992, Ceramic Industry Magazine's annual U.S. survey changed to an annual worldwide survey. For 1992 and onward, the Bureau will also use Kline & Co. data, which estimates both quantity of shipment and dollar value.

³Source: Kline & Co.

⁴Source: Ceramic Industry Magazine.

ALUMINUM¹

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

Domestic Production and Use: In 1993, 13 companies operated 22 primary aluminum reduction plants. Montana, Oregon, and Washington accounted for 35% of the production; Kentucky, North Carolina, South Carolina, and Tennessee, 20%; other States, 45%. Based on published market prices, output of primary metal in 1993 was valued at \$4.3 billion. Aluminum consumption, by an estimated 25,000 firms, was centered in the East Central United States. Packaging accounted for an estimated 33% of domestic consumption in 1993; transportation, 23%; building, 17%; electrical, 9%; consumer durables, 8%; and other uses, 10%.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Production: Primary	4,030	4,048	4,121	4,042	3,700
Secondary (from old scrap)	1,011	1,359	1,317	1,612	1,600
Imports for consumption	1,470	1,514	1,490	1,725	2,400
Exports	1,615	1,659	1,762	1,453	1,200
Shipments from Government stockpile excesses ²	—	—	—	(55)	—
Consumption, apparent ³	4,957	5,264	5,043	5,725	6,300
Price, ingot, average U.S. market (spot), cents per pound	87.8	74.0	59.5	57.5	53.0
Stocks: Aluminum industry, yearend	1,822	1,820	1,775	1,875	2,100
LME, U.S. warehouses, yearend	—	—	168	214	200
Employment: Primary reduction ^a	19,900	19,500	19,900	20,000	18,800
Secondary smelter ^a	3,600	3,600	3,600	3,600	3,600
Net import reliance ⁴ as a percent of apparent consumption	E	E	E	1	16

Recycling: Aluminum recovered in 1993 from purchased scrap was about 2.8 million tons, of which about 40% came from new (manufacturing) scrap and 60% from old scrap (discarded aluminum products). Aluminum recovered from old scrap was equivalent to about 25% of apparent consumption.

Import Sources (1989-92): Canada, 79%; Venezuela, 6%; Mexico, 2%; Brazil, 2%; and other, 11%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁵ 1/1/94
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—9-30-93**

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Aluminum	57	—	—	—

Events, Trends, and Issues: Domestic primary aluminum production decreased significantly in 1993 to its lowest level in 6 years. In response to rising world inventories and falling prices, more than one-half of the domestic primary aluminum smelters announced temporary shutdowns in production capacity during the year. By the end of the year, domestic smelters had closed 769,000 tons of annual capacity and were operating at about 80% of engineered or rated capacity.

U.S. imports for consumption increased dramatically in 1993. Total imports increased almost 40% compared with those of the previous year and reached an alltime high. Although there were increased imports from several different countries, one of the most significant increases was the rise in the level of imported primary ingot from the former U.S.S.R. Total imports of primary metal and alloys from the former U.S.S.R. in 1992 was 16,384 tons. By August 1993, imports from these same countries amounted to almost 256,000 tons. While total U.S. imports were increasing dramatically, total exports in 1993 declined to their lowest level since 1987.

ALUMINUM

The price of primary aluminum ingot trended downward during the first 10 months of 1993. In January, the average monthly U.S. spot price for primary ingot quoted by Metals Week was 56.1 cents per pound, the high for the year. By October, the price had decreased to 51.1 cents per pound, a historic low in terms of constant dollars, and showed no sign of rebounding during the remainder of the year. Prices on the London Metal Exchange (LME) followed the trend of U.S. spot prices. The monthly average LME cash price for October was 49.3 cents per pound. Prices in the aluminum scrap markets paralleled the general trend of primary ingot prices. The buying prices for aluminum used beverage can scrap, as quoted by the American Metal Market, decreased from a 40- to 42-cent-per-pound range in January to a 30- to 37-cent-per-pound range at the beginning of November.

World inventories of metal continued to rise during the year. Inventories on the LME exceeded 2 million tons, and inventories held by producers, as reported by the International Primary Aluminium Institute, approached 2 million tons by the end of September. The flow of metal from the former U.S.S.R. to Western markets continued. In August, the European Community (EC) unilaterally imposed import restrictions on metal from the former U.S.S.R. into the EC at 60,000 tons for the period August 1 to November 30, 1993. This prompted the U.S. industry to seek assistance from the U.S. Government in solving the crisis facing not only the domestic aluminum industry but also the industry worldwide. At the invitation of the Russian Government, delegations from the EC and the Governments of Australia, Canada, Norway, Russia, and the United States met in Moscow to discuss the world aluminum situation. A followup meeting was scheduled for December in the United States.

World Smelter Production and Capacity:

	Production		Yearend capacity	
	1992	1993 ^a	1992	1993 ^a
United States	4,042	3,700	4,163	4,163
Australia	1,216	1,350	1,240	1,380
Azerbaijan	25	20	58	58
Brazil	1,200	1,170	1,156	1,196
Canada	1,950	2,200	2,265	2,265
France	417	450	472	472
Russia	2,700	2,700	2,970	2,970
Tajikistan	300	300	517	517
Ukraine	90	80	110	110
Venezuela	600	570	610	640
Other countries	6,679	6,460	7,931	8,266
World total (may be rounded)	19,200	19,000	21,500	22,000

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.

^aEstimated. E Net exporter.

¹See also Bauxite.

²Data in parentheses denote stockpile acquisitions.

³Domestic primary metal production + recovery from old aluminum scrap + net import reliance.

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

⁵See Appendix B.

ANTIMONY

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

Domestic Production and Use: Primary antimony metal and oxide were produced by six companies operating six plants utilizing both foreign and domestic material. Two plants were in Texas, and there was one each in Idaho, Montana, Nebraska, and New Jersey. A very small amount of antimony was recovered as a byproduct from the smelting of lead and silver-copper ores. Virtually all antimony metal and oxides produced domestically originated from imports. The estimated value of primary antimony metal and oxides produced in 1993 was \$40 million. The estimated distribution of antimony uses was flame retardants, 74%; transportation, including batteries, 11%; chemicals, 9%; ceramics and glass, 2%; and other, 4%.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Production: Mine	W	W	W	W	W
Refinery: Primary	18,954	20,070	16,032	19,675	18,000
Secondary	19,501	20,351	19,294	17,736	19,000
Imports for consumption	25,165	29,403	28,833	31,204	30,000
Exports of metal, alloys, and oxide	2,143	7,730	4,446	5,764	5,000
Consumption, apparent ¹	41,499	38,963	41,988	44,603	44,600
Price, average, cents per pound ²	94.3	81.8	82.0	79.0	80.0
Stocks, yearend	6,270	8,175	10,170	8,743	9,000
Employment, plant ^a	100	110	115	115	110
Net import reliance ³ as a percent of apparent consumption	56	51	53	60	57

Recycling: Approximately 18,700 tons or 97% of secondary antimony was recovered as antimonial lead, most of which was consumed by the battery industry.

Import Sources (1989-92): Metal: China, 84%; Hong Kong, 5%; Mexico, 3%; Thailand, 3%; and other, 5%. Ore and concentrate: China, 38%; Mexico, 23%; Bolivia, 14%; Guatemala, 10%; and other, 15%. Oxide: China, 33%; Republic of South Africa, 22%; Mexico, 16%; Bolivia, 7%; and other, 22%. Total: China, 60%; Mexico, 10%; Republic of South Africa, 10%; Hong Kong, 4%; and other, 16%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁴
			1/1/94	1/1/94
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—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Antimony	34,736	680	2,597	1,273

ANTIMONY

Events, Trends, and Issues: In 1993, antimony production from domestic source materials was mainly derived from recycling of lead-antimony batteries. Recycling plus U.S. mine output supplied less than one-half of the estimated domestic demand.

Government stockpile sales of antimony began for the first time since 1988. Public Laws 99-661 and 102-484 provided authorization for additional antimony sales once a month through 1994 or until the authorized 3,507 short tons is disposed of. Antimony sales were conducted on a sealed bid basis and started on May 20, 1993. Sales were held on the third Thursday of each month. Each month, a maximum of 1 million pounds of antimony, Grade A or Grade B, were offered generally in the form of ingots or cakes. Antimony was stockpiled in Government warehouses in 13 locations, with the Somerville, New Jersey, depot holding the largest amount.

Environmental and ecological problems associated with the treatment of antimony metal and ores were minimal because emissions and effluents were controlled at the processing plants.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁵	Reserve base ⁵
	1992	1993 ⁶		
United States	W	W	80,000	90,000
Bolivia	6,500	6,000	310,000	320,000
Mexico	1,800	2,000	180,000	230,000
South Africa, Republic of	4,000	4,000	240,000	250,000
Other countries	63,700	58,000	3,400,000	3,800,000
World total (may be rounded)	⁶ 76,000	⁶ 70,000	4,200,000	4,700,000

World Resources: U.S. resources are mainly in Idaho, Nevada, Alaska, and Montana. Principal identified world resources, estimated at 5.1 million tons, are in China, Bolivia, Russia, the Republic of South Africa, and Mexico. Additional antimony resources may occur in "Mississippi Valley Type" lead deposits in the Eastern United States.

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

⁶Estimated. W Withheld to avoid disclosing company proprietary data.

¹Domestic mine production + secondary production from old scrap + net import reliance (see footnote 3).

²New York dealer price for 99.5% to 99.6% metal, c.i.f. U.S. ports.

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

⁴See Appendix B.

⁵See Appendix C for definitions.

⁶Excludes U.S. production.

ARSENIC

(Data in metric tons, unless noted)

Domestic Production and Use: Arsenic trioxide was imported and converted to arsenic acid for use in the production of arsenical wood preservatives by three major companies, one headquartered in the United States and the other two in the United Kingdom. Nearly all arsenic was consumed in compound form mainly by two producers of agricultural chemicals and three producers of wood preservative chemicals. Metallic arsenic was used in nonferrous alloys and in the electronics industry for semiconductor materials. The estimated end-use distribution of arsenic in 1993 was 75% in wood preservatives, 16% in agricultural chemicals (principally herbicides and desiccants), 4% in glass, 3% in nonferrous alloys, and 2% in other uses. The total value of arsenic metal and compounds consumed was estimated to be about \$19 million.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Imports for consumption:					
Metal	928	796	1,008	740	700
Arsenic trioxide ¹	28,348	26,256	27,142	30,671	31,000
Arsenic compounds ²	50	21	374	40	—
Exports, arsenic metal	126	149	233	94	230
Consumption, apparent, arsenic content	22,300	20,500	21,600	23,900	23,900
Price, cents per pound, average: ³					
Trioxide, Mexican	27	23	25	29	33
Metal, Chinese	47	180	68	56	54
Stocks, yearend, refinery, arsenic content	100	100	—	—	—
Net import reliance ⁴ as a percent of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1989-92): Chile, 21%; China, 19%; Mexico, 15%; France, 13%; and other, 32%.

Tariff:	Item	Number	Most favored nation(MFN)	Non-MFN⁵
			1/1/94	1/1/94
	Metal	2804.80.0000	Free	13.2¢/kg.
	Trioxide	2811.29.1000	Free	Free.
	Sulfide	2813.90.1000	Free	Free.
	Acid ⁶	2811.19.1000	3.1¢/kg	6.6¢/kg.

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

Government Stockpile: None.

ARSENIC

Events, Trends, and Issues: The Food and Drug Administration announced the availability of four guidance documents on elemental contaminants in shellfish, including one entitled "Guidance Document for Arsenic in Shellfish." Others dealt with cadmium, chromium, and nickel.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base ⁷
	1992	1993 [*]	
United States	—	—	World reserves and reserve base are believed to be about 20 and 30 times, respectively, annual world production.
Belgium	2,000	2,000	
Chile	6,500	6,500	
China	17,000	17,000	
Kazakhstan	3,000	3,000	
Mexico	4,900	5,000	
Namibia	2,300	2,000	
Philippines	5,000	5,000	
Russia	3,000	3,000	
Sweden	1,000	500	
Other countries	2,900	3,000	
World total (rounded)	47,600	47,000	

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 exist in most major end uses, although arsenic may be the preferred material because of its lower cost and superior qualities. In agricultural uses, synthetic organic compounds such as paraquat may be substituted for arsenical pesticides, herbicides, and desiccants. The wood preservatives pentachlorophenol and creosote may be substituted for chromated copper arsenate where odor and paintability are not problems. Nonwood alternatives such as concrete and steel may be substituted for arsenical pressure-treated wood.

^{*}Estimated.

¹Arsenic trioxide (As₂O₃) contains 75.7% arsenic by weight.

²Almost entirely arsenic acid.

³Calculated from Bureau of the Census import data using customs value.

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

⁵See Appendix B.

⁶Tariff is free for Israel, Caribbean Basin Countries, and designated Beneficiary Developing Countries. For Canada, the tariff is 1.8¢/kg.

⁷See Appendix C for definitions. Contained in nonferrous ores, principally in copper-zinc-lead ores and copper ores.

ASBESTOS

(Data in thousand metric tons, unless noted)

Domestic Production and Use: Two firms, one each in California and Vermont, accounted for 100% of domestic production. Asbestos was consumed in roofing products, 50%; friction products, 30%; packing and gaskets, 10%; asbestos-cement pipe, 5%; and other, 5%.

Salient Statistics—United States:	1989	1990	1991	1992	1993^c
Production (sales), mine	17	W	20	16	15
Imports for consumption	55	41	35	32	33
Exports	27	28	26	25	32
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent	55	41	35	33	33
Price: average value, dollars per ton, f.o.b.	W	W	W	W	W
Stocks, producer, yearend	7	5	W	W	W
Employment, mine and mill	70	70	70	70	70
Net import reliance ¹ as a percent of apparent consumption	90	90	95	95	95

Recycling: Insignificant.

Import Sources (1989-92): Canada, 98%; Republic of South Africa, 1%; and other, 1%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN² 1/1/94
	Asbestos	2524.00.0000	Free	Free.

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

Government Stockpile:

Stockpile Status—9-30-93 (Metric tons)

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Amosite	30,849	—	30,850	—
Chrysotile	9,706	62	9,706	—
Crocidolite	33	—	33	—

ASBESTOS

Events, Trends, and Issues: Domestic sales of asbestos declined slightly from that of 1992. Imports increased slightly from those of 1992. Exports increased to 32,000 tons in 1993, according to the Bureau of the Census. It is likely that a large percentage of the exports were either reexports, asbestos-containing products, or nonasbestos products. Exports of asbestos fiber are estimated to be less than 15,000 tons. Apparent consumption was unchanged from 1992. Approximately 99% 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 ³	Reserve base ³
	1992	1993 [*]		
United States	16	15	Large	Large
Brazil	233	230	Moderate	Moderate
Canada	585	580	40,000	47,000
China	240	240	Large	Large
South Africa, Republic of	124	120	5,000	8,000
Zimbabwe	140	140	Moderate	Moderate
Other countries	1,783	1,785	Large	Large
World total	3,121	3,110	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 fiber, polyethylene fiber, polypropylene fiber, and polytetrafluoroethylene fiber. 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.

^{*}Estimated. W Withheld to avoid disclosing company proprietary data.

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

²See Appendix B.

³See Appendix C for definitions.

BARITE

(Data in thousand metric tons, unless noted)

Domestic Production and Use: Barite production in 1993 decreased to 300,000 tons valued at \$18 million. Production came from five States, with about 80% of the total coming from Nevada. The second largest producing State was Georgia. About 860,000 tons of ground barite from both domestic production and imports was sold in 1993. Nearly 90% of the barite sold in the United States in 1992 was used as a weighing agent in oil- and gas-well-drilling fluids mostly in the Gulf of Mexico and Pacific coast areas. Barite was also used in the production of paint, rubber, glass, and barium chemicals.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Production, mine	290	430	448	326	300
Imports for consumption:					
Crude barite ¹	987	988	841	323	400
Ground barite ²	47	57	46	31	30
Other ³	11	10	10	12	10
Exports	10	9	43	12	20
Consumption, apparent ⁴	1,325	1,476	1,302	680	720
Consumption ⁵ (ground and crushed)	1,277	1,434	1,267	999	860
Price, average value, dollars per ton, mine	43.53	37.21	47.57	60.22	59.80
Stocks, producer, year end	NA	NA	NA	NA	NA
Employment, mine and mill ⁶	400	400	400	350	330
Net import reliance ⁷ as a percent of apparent consumption	77	69	70	52	58

Recycling: None.

Import Sources (1989-92): China, 76%; India, 19%; Mexico, 1%; and other, 4%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁷
			1/1/94	1/1/94
	Crude barite ^{1 8}	2511.10.5000	\$1.25/mt	\$3.94/mt.
	Ground barite ^{2 8}	2511.10.1000	\$3.20/mt	\$7.38/mt.
	Witherite ⁹	2511.20.0000	3% ad val	30% ad val.
	Oxide, hydroxide, and peroxide ⁹	2816.30.0000	2% ad val	10.5% ad val.
	Other chlorides ⁹	2827.38.0000	4.2% ad val	28.5% ad val.
	Other sulfates ^{3 9}	2833.27.0000	0.4¢/kg	2.8¢/kg.
	Other nitrates ⁹	2834.29.5000	3.5% ad val	10% ad val.
	Carbonate ⁹	2836.60.0000	0.9¢/kg	3.3¢/kg.

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

Government Stockpile: None.

Events, Trends, and Issues: The demand for barite, as indicated by the ground and crushed barite consumption figure, declined from that recorded in 1992. The decrease resulted from petroleum prices declining to a level that discouraged oil well drilling in the United States. However, drilling for natural gas was increasing because of rising prices and the transfer of leases to independent operators. The drill rig count in the United States for June 25 was 702 rigs, up from the 596 of last year. After that, the count rose strongly and was reported at 856 for the week of October 8. The Administration encouraged natural gas consumption as an environmentally benign fuel. This includes natural-gas-powered automobiles.

BARITE

Imports for consumption of lower cost foreign barite exceeded domestic production by nearly 45%. Major sources of imported barite are China, India, and Mexico. One of the factors allowing the lower cost of foreign barite is the cheaper (per ton-mile) cost of ocean transportation as compared to 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.

The principal environmental impact of chemically inert barite is the land disturbance normally associated with mining. Mud pits at petroleum drilling sites that contain some barite are treated differently according to 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.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ¹⁰	Reserve base ¹⁰
	1992	1993*		
United States	326	300	30,000	60,000
Algeria	40	50	2,000	8,000
Brazil	50	65	1,000	2,000
China	1,800	1,800	38,000	150,000
France	80	90	2,000	2,500
Germany	160	170	1,000	1,500
India	620	525	30,000	32,000
Ireland	80	100	1,000	1,500
Italy	85	50	2,000	2,000
Mexico	200	200	7,000	8,500
Morocco	433	350	10,000	11,000
Poland	25	30	NA	NA
Romania	25	30	NA	NA
Russia	400	400	10,000	75,000
Slovakia	80	60	14,700	20,000
Thailand	100	100	9,000	15,000
Turkey	280	300	4,000	20,000
United Kingdom	80	70	NA	NA
Other countries	593	400	21,000	111,000
World total (may be rounded)	5,436	5,200	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 is identified.

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

*Estimated. NA Not available.

¹Bureau of the Census title is "Natural Barium Sulfate-Other."

²Bureau of the Census title is "Natural Barium Sulfate-Ground."

³Bureau of the Census title is "Other Sulfates of Barium."

⁴Sold or used by domestic mines - exports + imports.

⁵Domestic and imported crude barite sold or used by domestic grinding establishments.

⁶Defined as imports - exports + adjustments for Government and industry stock changes.

⁷See Appendix B.

⁸Per metric ton.

⁹Ad valorem per kilogram.

¹⁰See Appendix C for definitions.

BAUXITE¹

(Data in thousand metric dry tons, unless noted)

Domestic Production and Use: In 1993, three companies operated surface bauxite mines in Alabama and Georgia. Virtually all domestic ore was consumed in the production of nonmetallurgical products such as abrasives, chemicals, proppants, and refractories. Approximately 93% of the total bauxite consumed in the U.S. during 1993 was utilized for the production of alumina. Primary aluminum smelters received 85% of the alumina supply. Annual alumina capacity was 5.7 million tons, with five Bayer refineries in operation at yearend.

Salient Statistics—United States:²	1989	1990	1991	1992	1993^c
Production, mine	W	W	W	W	W
Imports of bauxite for consumption ^{3 4}	11,603	12,987	12,305	11,372	11,860
Imports of alumina ⁵	4,312	4,069	4,592	4,701	4,470
Exports of bauxite ⁴	57	64	58	68	90
Exports of alumina ⁵	1,328	1,263	1,351	1,143	1,215
Shipments from Government stockpile excesses	—	—	—	437	557
Consumption, apparent, bauxite and alumina ⁶	4,517	4,570	4,609	4,863	4,500
Price, dollars per ton, f.o.b. mine	15-20	15-20	15-18	15-18	15-18
Stocks, industry, yearend, bauxite	2,500	2,300	2,600	2,300	2,600
Employment, mine	50	40	35	35	35
Net import reliance ⁷ as a percent of apparent consumption	96	98	100	100	100

Recycling: None.

Import Sources (1989-92):⁸ Bauxite: Guinea, 33%; Jamaica, 28%; Brazil, 13%; Guyana, 10%; Australia, 7%; and other, 9%. Alumina: Australia, 80%; Jamaica, 7%; Suriname, 5%; and other, 8%. Total: Australia, 40%; Jamaica, 19%; Guinea, 18%; Brazil, 8%; Guyana, 5%; and other, 10%.

Tariff: Import duties on bauxite and alumina were abolished in 1971 by Public Law 92-151. Only imports from non-most-favored nations, as defined by the 1979 Tokyo Round tariff agreements, were dutiable. Countries that supplied commercial quantities of bauxite or alumina to the United States during the first 8 months of 1993 had most-favored-nation status.

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

Government Stockpile:**Stockpile Status—9-30-93**

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Bauxite, metal grade:				
Jamaica-type	11,876	508	11,876	508
Suriname-type	4,977	—	4,977	—
Bauxite, refractory-grade, calcined	231	49	161	49

BAUXITE

Events, Trends, and Issues: As in 1992, reduced levels of primary aluminum production and rising aluminum inventories on international markets led to declines in world bauxite and alumina output in 1993.

U.S. alumina plant capacity remained essentially unchanged from that of yearend 1992; however, apparent capacity utilization decreased by the close of 1993.

Prices for smelter-grade alumina remained below the \$200 per metric ton level throughout 1993 in response to continued stagnation in worldwide demand. Increased demand by China and several former Eastern bloc nations provided some support for near-term alumina prices.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁶	Reserve base ⁶
	1992	1993 ⁶		
United States	W	W	20,000	40,000
Australia	39,950	41,000	5,620,000	7,860,000
Brazil	10,800	9,400	2,800,000	2,900,000
Greece	2,100	1,700	600,000	650,000
Guinea	13,773	14,000	5,600,000	5,900,000
Guyana	2,300	2,000	700,000	900,000
Hungary	1,721	1,500	300,000	300,000
India	4,475	5,400	1,000,000	1,200,000
Jamaica	11,302	10,800	2,000,000	2,000,000
Suriname	3,250	3,200	575,000	600,000
Venezuela	1,052	1,000	320,000	350,000
Other countries	12,902	11,383	3,450,000	5,050,000
World total (may be rounded)	¹⁰ 104,000	¹⁰ 101,000	23,000,000	28,000,000

World Resources: Bauxite resources (reserves plus subeconomic and undiscovered deposits) 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.

*Estimated. W Withheld to avoid disclosing company proprietary data.

¹See also Aluminum. As a general rule, four tons of bauxite are required to produce two tons of alumina which in turn provide one ton of primary aluminum metal.

²Includes U.S. Virgin Islands.

³Includes abrasive-grade bauxite consumed in Canada.

⁴Includes all forms of bauxite, expressed as dry equivalent weights.

⁵Calcined equivalent weights.

⁶The sum of the aluminum equivalents of U.S. bauxite production and net import reliance.

⁷Defined as imports - exports + adjustments for Government and industry stock changes (all in aluminum equivalents).

⁸Aluminum equivalents.

⁹See Appendix C for definitions.

¹⁰Excludes U.S. production.

BERYLLIUM

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

Domestic Production and Use: One company in Utah mined bertrandite ore and recovered beryllium hydroxide from this ore and from imported and 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 from Asia 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 165 tons was valued at approximately \$58 million, based on the producer price for beryllium-copper master alloy. Beryllium was used as an alloy and oxide in electronic components, 52%; as an alloy and oxide in electrical components, 18%; as an alloy, oxide, and metal in aerospace and defense applications, 17%; and as an alloy, metal, and oxide in other applications, 13%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production, mine	184	182	174	193	159
Imports for consumption, ore and metal	38	25	55	6	6
Exports	34	45	33	41	16
Shipments from Government stockpile excesses ¹	(6)	(21)	—	² 15	² (15)
Consumption, apparent	187	175	203	174	165
Price, dollars:					
Domestic, metal, vacuum-cast ingot, per pound	225	225	308	308	295
Domestic, metal, powder blend, per pound	261	269	280	280	280
Domestic, beryllium-copper master alloy, per pound of contained beryllium	160	160	160	160	160
Domestic, beryllium oxide, powder, per pound	65.65	72.50	72.50	72.50	72.50
Imported ore, per stu (20 pounds) BeO	90	101	113	NA	NA
Stocks, consumer, yearend	153	119	112	111	110
Employment:					
Mine, full-time equivalent employees*	25	25	25	25	25
Primary refineries*	400	400	400	400	400
Net import reliance ³ as a percent of apparent consumption	2	E	14	E	4

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

Import Sources (1989-92): Beryl ore: Brazil, 91%; China, 3%; Italy, 3%; and other, 3%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁴ 1/1/94
	Ore and concentrates	2617.90.0030	Free	Free.
	Unwrought beryllium	8112.11.6000	8.5% ad val.	25.0% ad val.
	Beryllium, wrought	8112.19.0000	5.5% ad val.	45.0% ad val.
	Beryllium-copper master alloy	7405.00.6030	6.0% ad val.	28.0% ad val.
	Beryllium oxide or hydroxide	2825.90.1000	3.7% ad val.	25.0% ad val.

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

Government Stockpile:

Stockpile Status—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Beryl ore (11% BeO)	534	—	534	—
Beryllium-copper master alloy	268	—	—	—
Beryllium metal	347	—	—	—

BERYLLIUM

Events, Trends, and Issues: Total U.S. beryllium consumption declined slightly in 1993 mostly because of a continued decline in beryllium metal demand. Declines in defense-related applications were cited as the reason for declining metal consumption. Despite the downturn in defense market, an increase in consumption for beryllium-copper strip was reported in computer applications, and increases in beryllium oxide consumption were reported in automotive electronics and lasers.

Because of the decline in defense applications for beryllium, producers were developing new alloys for use in commercial applications. A new temper version of a lower cost beryllium alloy was developed during 1993 and was directed toward automotive applications. The largest beryllium-copper alloy producer also announced that it signed a multiyear contract to supply beryllium-copper components for undersea fiber optics telecommunications systems. This company also is conducting research to improve a newly developed beryllium aluminum alloy that is used in some computer disk drives.

Under provisions of the Defense Authorization Act in 1992, the entire quantity of beryl in the National Defense Stockpile (NDS) was authorized for disposal. No beryl ore was sold in 1993; instead, it was used as a part of the beryl upgrading program. The Utah beryllium producer, under a contract with the Defense Logistics Agency, was producing hot-pressed beryllium powder billets for the NDS from beryl that was in the NDS. Contract deliveries were scheduled to continue through June 1994.

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		Reserves and reserve base ⁵
	1992	1993 ⁶	
United States	193	159	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 20,000 tons of beryllium. The world reserves and reserve base are not adequately delineated.
Argentina	3	3	
Brazil	34	30	
China ^a	55	55	
Kazakhstan ^a	4	3	
Russia ^a	44	40	
Zimbabwe	1	1	
Other countries	1	(⁶)	
World total	335	291	

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.

^aEstimated. E Net exporter. NA Not available.

¹Data in parentheses denote stockpile acquisitions.

²Data represent the net difference between the beryllium content of beryl shipped for upgrading and stockpile receipts of beryllium metal.

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

⁴See Appendix B.

⁵See Appendix C for definitions.

⁶Less than ½ unit.

BISMUTH

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

Domestic Production and Use: One refinery in Nebraska produced primary bismuth as a byproduct of lead refining. Forty-two companies in the Northern and Eastern United States accounted for 97% of the bismuth consumed in 1993. Based on the average annual price, reported consumption was valued at \$8.3 million. Bismuth was used in pharmaceuticals and chemicals, 52%; metallurgical additives, 26%; fusible alloys and solder, 20%; and other, 2%.

Salient Statistics—United States:

	1989	1990	1991	1992	1993*
Production, refinery	W	W	W	W	W
Imports for consumption	1,880	1,612	1,411	1,621	1,500
Exports ¹	122	122	75	90	70
Shipments from Government stockpile excesses	—	59	57	91	90
Consumption, reported	1,352	1,274	1,427	1,473	1,450
Price, average, domestic dealer, dollars per pound	5.76	3.56	3.00	2.66	2.50
Stocks, yearend, consumer	440	344	325	254	300
Employment, plant ^a	30	30	30	30	30
Net import reliance ² 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 (1989-92): Belgium, 36%; Mexico, 29%; Peru, 12%; China, 7%; and other, 16%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN ³ 1/1/94
Articles thereof, including waste and scrap		8106.00.0000	Free	7.5% ad val.

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

Government Stockpile:

Stockpile Status—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Bismuth	649	—	649	—

Events, Trends, and Issues: Domestic consumption of bismuth has remained relatively unchanged for the last 3 years despite the development of several new applications. Bismuth has been used in nontoxic ceramic glazes and pigments, replacing lead. Other uses under development include shot for hunting waterfowl, fishing sinkers, lead-free solders, as an additive to brass plumbing fixtures to aid in machining, and in lubricating greases.

World production of bismuth has declined slightly since 1989 owing to low prices and slow demand. China, Belgium, Peru, and Mexico have been the largest producers of refined bismuth during the same period. World refinery production capacity was 8,300 metric tons. In Mexico, one of the country's lead producers closed its Monterrey refinery because of environmental problems associated with the accumulation of waste material at the site. The refinery produced impure bismuth bullion that was shipped elsewhere for refining. This was expected to have a small effect on total world production.

The Defense Logistics Agency was authorized to dispose of 136 metric tons of bismuth from the National Defense Stockpile in Fiscal Year 1994.

BISMUTH

World Mine Production, Reserves, and Reserve Base:

	Mine production [*]		Reserves ⁴	Reserve base ⁴
	1992	1993		
United States	W	W	9,000	14,000
Australia	—	—	18,000	27,000
Bolivia	—	—	5,000	10,000
Canada	100	100	5,000	30,000
China	1,200	1,100	20,000	40,000
Kazakhstan	55	80	5,000	10,000
Japan	153	150	9,000	18,000
Mexico	700	700	10,000	20,000
Peru	650	500	11,000	42,000
Other countries	145	100	15,000	35,000
World total (may be rounded)	⁵ 3,000	⁵ 2,700	110,000	250,000

World Resources: Bismuth is recovered in the United States during processing of domestic and imported lead ore and concentrates. Other potential domestic sources include byproduct recovery from molybdenum and tungsten processing, though most domestic reserves are subeconomic. World reserves of bismuth are usually associated with lead deposits, except for China and the Republic of Korea, where it is found with tungsten ores, and 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.

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 in holding jigs used in machining. Glycerine-filled glass bulbs replace bismuth alloys as triggering devices for fire sprinklers. Except when used in solder, these substitutes are not competitive with bismuth on the basis of quality or cost.

^{*}Estimated. W Withheld to avoid disclosing company proprietary data.

¹Includes bismuth, bismuth alloys, and waste and scrap.

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

³See Appendix B.

⁴Most of reserves and reserve base represent bismuth recoverable from the lead reserve base. See Appendix C for definitions.

⁵Excludes U.S. production.

BORON

(Data in thousand metric tons of boric oxide (B₂O₃), unless noted)

Domestic Production and Use: The estimated value of boric oxide contained in minerals and compounds produced in 1993 was \$320 million. Domestic production of boron minerals by two companies, primarily as sodium borates, 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 at two plants accounted for the remaining output. A third company shipped borates from inventories, updated reclamation plans, and continued to process small amounts of calcium and calcium sodium borates. Principal consuming firms were in the North Central and Eastern States. The reported end-use distribution pattern for boron compounds consumed in the United States in 1992 was glass products, 62%; soaps and detergents, 11%; fire retardants, 3%; and other, 24%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production ¹	562	608	626	554	526
Imports for consumption: Borax	2	2	4	6	6
Boric acid	2	3	3	3	3
Colemanite	6	5	7	12	12
Ulexite	11	12	6	17	17
Exports, gross weight of boric acid and refined borates	688	624	601	579	580
Consumption: Apparent	284	287	348	272	244
Reported	315	320	262	345	NA
Price, dollars per ton, granulated pentahydrate borax in bulk, f.o.b. mine ³	272	272	247	276	276
Stocks, yearend ⁴	NA	NA	NA	NA	NA
Employment	1,100	1,100	1,100	900	900
Net import reliance ⁵ as a percent of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1989-92): Boric acid: Italy, 33%; Chile, 23%; and other, 44%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁶ 1/1/94
Borates:				
Refined borax:				
Anhydrous	2840.11.0000		0.07¢/kg	0.28¢/kg.
Other	2840.19.0000		0.07¢/kg	0.28¢/kg.
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:				
Calcium	2528.90.0010		Free	Free.
Sodium	2528.10.0000		Free	Free.
Other	2528.90.0050		Free	Free.

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

Government Stockpile: None.

BORON

Events, Trends, and Issues: The United States was the world's largest producer of boron compounds during 1993 and exported about one-half of domestic production. Exported materials competed with borax, boric acid, colemanite, and ulexite primarily from Turkey, the second largest producer of boron compounds and minerals in the world.

The Turkish Government announced that the state-owned mining and banking giant is to split into two separate divisions to begin the privatization of the banking business. At present, boron minerals are the property of the state and cannot be sold to private investors.

Imports of borates from northern Chile continued. About 150,000 tons per year of ulexite is mined in Chile for the production of boric acid; synthetic colemanite; and ulexite for use in ceramics, insulating and reinforcing fiberglass, and agriculture. Shipments are from the Port of Arica.

The U.S. Department of Health and Human Services ordered a review of research to determine if fiberglass insulation is a carcinogen. Any health threat would be to workers involved in insulation manufacturing, not to homeowners or construction workers. The National Toxicology Program planned to review the data, and the carcinogen report will not be published until the fiberglass issue is resolved.

The Bureau of Land Management issued a draft Environmental Impact Report concerning the a project in Newberry Springs, CA. A final report and decision were expected to be made by the end of the year. The major environmental concern is the effect of in situ mining on the desert tortoise population. The project would employ about 65 workers and would be the largest manufacturing employer in the area.

World Production, Reserves, and Reserve Base⁷:

	Production—all forms		Reserves ⁸	Reserve base ⁸
	1992	1993 ^c		
United States	1,009	1,010	57,000	210,000
Argentina	250	260	2,000	9,000
Bolivia	11	11	4,000	19,000
Chile	100	150	8,000	41,000
China	77	75	27,000	36,000
Iran	1	1	1,000	1,000
Peru	30	30	4,000	22,000
Turkey	1,000	1,000	30,000	150,000
U.S.S.R. ^a	<u>2,800</u>	<u>2,800</u>	<u>28,000</u>	<u>140,000</u>
World total (may be rounded)	5,300	5,300	160,000	630,000

World Resources: Large domestic resources of boron materials occur in California, chiefly in sediments and their contained brines. Extensive resources also occur in Turkey. 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 and other enzymes. Some enamels use other glass producing substances, such as phosphates. Insulation substitutes include foams and mineral wools.

^aEstimated. E Net exporter. NA Not available.

¹Minerals and compounds sold or used by producers; includes both actual mine production and marketable products.

²Source: The Journal of Commerce Port Import/Export Reporting Service. Includes crude borates.

³Chemical Marketing Reporter.

⁴Stocks data are not available and are assumed to be zero for net import reliance and apparent consumption calculations.

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

⁶See Appendix B.

⁷Gross weight of ore in thousand metric tons.

⁸See Appendix C for definitions.

⁹As constituted before Dec. 1991.

BROMINE

(Data in million kilograms of bromine content, unless noted)

Domestic Production and Use: The quantity of bromine sold or used in the United States from companies operating in Arkansas and Michigan accounted for 100% of elemental bromine production valued at an estimated \$110 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 in 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 combinations with other chemicals.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production ¹	175	177	170	171	168
Imports for consumption, elemental bromine and compounds ²	30	20	24	15	14
Exports, elemental bromine and compounds	33	17	17	22	25
Consumption, apparent	183	176	169	172	157
Price, cents per kilogram, bulk, purified bromine	79.4	74.1	73.2	73.3	65.6
Stocks, producer, yearend, elemental bromine ³	—	—	—	—	—
Employment, plant	1,200	1,200	1,200	1,600	1,600
Net import reliance ³ as a percent of apparent consumption	E	E	—	—	E

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

Import Sources (1989-92): Israel, 77%; Netherlands, 15%; France, 5% and other, 3%.

Tariff:⁴	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁴ 1/1/94
	Bromine	2801.30.2000	4.4¢/kg.	22¢/kg.
	Ammonium bromide	2827.59.0500	3.1% ad val.	25% ad val.
	Calcium bromide	2827.59.2000	Free	25% ad val.
	Decabromodiphenyl oxide	2909.30.0700	20% ad val.	15.4¢/kg. + 70.5% ad val.
	Ethylene dibromide	2903.30.0500	1.5¢/kg. + 3.5% ad val.	13.2¢/kg. + 30% ad val.
	Hydrobromic acid	2811.19.5050	4.2% ad val.	25% ad val.
	Potassium bromate	2829.90.1000	3.1% ad val.	25% ad val.
	Potassium bromide	2827.51.2000	3.3¢/kg.	22¢/kg.
	Methyl bromide	2903.30.1520	3.7% ad val.	25% ad val.
	Sodium bromate	2829.90.5000	3.7% ad val.	25% ad val.
	Sodium bromide	2827.51.1000	6.6¢/kg.	22¢/kg.
	Tetrabromobisphenol A	2908.10.2500	1.5¢/kg. + 19.4% ad val.	15.4¢/kg. + 62% ad val.

BROMINE

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

Government Stockpile: None.

Events, Trends, and Issues: One company intended to spin off its specialty chemicals segment, which included the bromine operations, into a publicly traded company. The spinoff will affect about 155 salaried employees primarily in the company's Richmond, VA, headquarters and operations in Baton Rouge, LA.

The U.S. Environmental Protection Agency was reviewing comments in response to a proposal that methyl bromide be added to the Clean Air Act list of class I ozone-depleting substances. The proposal freezes U.S. methyl bromide production in 1994 at 1991 levels and halts U.S. production and imports by 2000. Worldwide methyl bromide production was 65,000 metric tons. Five thousand tons of European consumption of 14,000 metric tons was provided by one French company, and the remainder was imports from the United States and Israel. Israel produces about 20,000 metric tons of the world's production and the United States produces about 30,000 metric tons.

Israel continued steps to the privatization of the large state-owned chemical company that owned the bromine chemical plants. The Government now owns 75%; 4.7% of the shares were acquired by several financial institutions during 1993. Israel announced plans to spend \$500 million during the next 5 years to expand production of bromine and bromine compounds. Production will increase from 140,000 to 200,000 metric tons per year of bromine and bromine compounds.

World Mine Production, Reserves, and Reserve Base:⁶

	Mine production		Reserves ⁵	Reserve base ⁵
	1992	1993 [*]		
United States ¹	171.0	168	11,000	11,000
China	—	—	NA	NA
France	2.5	2.5	1,600	1,600
Germany	1.5	1.5	36	36
India	1.3	1.3	(⁶)	(⁶)
Israel	135.0	135.0	(⁷)	(⁷)
Italy	0.3	0.3	(⁶)	(⁶)
Japan	15.0	15.0	(⁸)	(⁸)
Spain	0.2	0.2	1,400	1,400
U.S.S.R. ⁹	19.0	19.0	1,400	1,400
United Kingdom	28.0	28.0	(⁶)	(⁶)
World total (rounded)	370.0	370.0	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.

*Estimated. E Net exporter. NA Not available.

¹Sold or used by U.S. producers.

²Imports calculated from items shown under Tariff section.

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

⁴See Appendix B.

⁵See Appendix C for definitions.

⁶From waste biterms associated with solar salt.

⁷From the Dead Sea.

⁸From seawater.

⁹As constituted before Dec. 1991.

CADMIUM

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

Domestic Production and Uses: Three companies, in Illinois, Oklahoma, and Tennessee, recovered cadmium as a byproduct of smelting domestic and imported zinc concentrates. A fourth company, in Colorado, recovered cadmium from other sources, such as lead smelter baghouse dust. Based on the average New York dealer price, the output of primary metal in 1993 was valued at \$1.0 million. The estimated consumption pattern included batteries, 55%; coating and plating, 14%; pigments, 16%; plastics and synthetic products, 10%; and alloys and other, 5%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production, refinery	1,550	1,678	1,676	1,620	1,050
Imports for consumption, metal	2,787	1,741	2,039	1,958	1,410
Exports, all forms	369	385	158	178	16
Shipments from Government stockpile excesses	—	—	—	—	160
Consumption, apparent	4,096	3,107	3,105	3,515	3,110
Price, average, dollars per pound, in 1- to 5-short ton lots, New York dealer	6.28	3.38	2.01	0.92	0.45
Stocks, yearend, producer and distributor	726	653	1,105	990	480
Employment, smelter and refinery	190	190	190	195	190
Net import reliance ¹ as a percent of apparent consumption	48	62	48	49	66

Recycling: Cadmium recycling has been practical only for nickel-cadmium batteries, some alloys, and dust from electric arc furnaces operated by the steel industry. The exact amount recycled is not known. The U.S. steel industry generated more than 500,000 metric tons of electric furnace dust in 1992. Minnesota and New Jersey are in the process of setting up collection networks for recycling nickel-cadmium batteries.

Import Sources (1989-92): Metal: Canada, 34%; Mexico, 17%; Australia, 8%; France, 7%; and other, 34%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN² 1/1/94
	Cadmium sulfide	2830.30.0000	3.1% ad val.	25% ad val.
	Pigments and preparations based on cadmium compounds	3206.30.0000	3.1% ad val.	25% ad val.
	Unwrought cadmium; waste and scrap; powders	8107.10.0000	Free	33¢/kg.

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

Government Stockpile:

Stockpile Status—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Cadmium	2,722	27	2,722	149

Events, Trends, and Issues: Demand for rechargeable nickel-cadmium batteries continues to grow in the Western World. More than 60% of the cadmium consumed by Western countries now goes into batteries, making batteries the principal end use for the nonferrous metal. Japanese production of nickel-cadmium batteries increased 51% between 1988 and 1992. About 75% of the batteries being produced by Western manufacturers are for cordless electronic equipment. The remaining 25% are used for industrial purposes, such as emergency power supplies for hospital operating rooms. This ratio could change dramatically if demand for the electric vehicle (EV) accelerates. Nickel-cadmium batteries could conceivably capture 30% of the early EV battery market, but competition from nickel-metal hydride batteries may be intense because of environmental concerns about cadmium. Much of the present battery research is being driven by the impending 1998 deadline requiring 2% of new vehicles sold in California to be emission free. In 1991, U.S. automakers joined

CADMIUM

forces with the U.S. Department of Energy and the utility industry, represented by the Electric Power Research Institute, forming the U.S. Advanced Battery Consortium. The consortium already has awarded more than \$75 million in research contracts to battery developers.

A few States recently passed consumer protection legislation that limits the use of pigments containing cadmium, lead, or other heavy metals in a variety of goods. In February 1992, a major U.S. pigments producer halted domestic sales of cadmium pigments for paints, coatings, and plastics because of the shrinking market, more stringent environmental regulations, increased availability of alternative pigments, and potential liability for both the supplier and consumer. Demand for inorganic cadmium-base pigments reportedly is only one-eighth as large as it was in 1988. Further substitution, however, is expected to be slow because inorganic alternatives often lack the required brilliance or temperature stability. Some organic alternatives release carcinogens when the pigment is incinerated.

On December 14, 1992, a much stricter national standard for occupational exposure to airborne cadmium took effect. The new standard, issued by the Occupational Safety and Health Administration (OSHA), established a single permissible exposure limit (PEL) of 5 micrograms per cubic meter of air, averaged during an 8-hour work period. The standard applies to all cadmium compounds, including dust and fumes. In some industries, such as plastic manufacturing, workers are permitted to use respirators to meet the standard because exposure to cadmium is usually intermittent or brief. OSHA has determined that at least six industries may have difficulty meeting the new 5-microgram PEL, even if they adopt state-of-the-art engineering controls and improved work practices because of the inherent nature of the processes employed. The agency has established separate engineering control air limits (SECAL's) ranging from 15 to 50 micrograms for facilities built around those processes. The six industries are nickel-cadmium battery manufacturing, zinc-cadmium refining, pigments manufacturing, plastic stabilizers, lead smelting, and cadmium plating. The new unified standard was issued because of concerns that workers chronically exposed to cadmium under the old, more lenient, standards still faced significant risk of developing kidney dysfunction or lung cancer. Extensive corrections and amendments to the final rule were published in the Federal Register of April 23, 1993, pages 21778-21850.

The New York dealer price for cadmium metal was down substantially from 1992 levels because of the global recession, demand weaknesses in the defense and aerospace industries, new regulatory restrictions, and consumer concerns about recyclability and potential liability. At the beginning of 1992, the price ranged from \$1.90 to \$2.05 per pound and already was under extreme pressure. By January 1993, the monthly average had fallen to \$0.60. The price eventually bottomed out at \$0.38 in July and began showing signs of recovering in October.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves ³	Reserve base ³
	1992	1993 [*]		
United States	1,620	1,050	70,000	210,000
Australia	1,003	1,000	55,000	145,000
Belgium	1,520	1,500	—	—
Canada	1,529	1,500	80,000	170,000
Japan	2,950	2,600	10,000	15,000
Mexico	630	600	35,000	40,000
Other countries	9,498	9,200	285,000	390,000
World total	18,750	17,000	535,000	970,000

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 midcontinental United States and Carboniferous-age coals of other countries also contain large potential resources of cadmium. The amount of cadmium in undiscovered cadmium resources has been estimated between 5 million and 50 million tons.

Substitutes: Coatings of zinc or vapor-deposited aluminum substitute for some cadmium-plating applications. Tin may be used in place of cadmium pigments, but often at the risk of reduced performance.

^{*}Estimated.

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

²See Appendix B.

³See Appendix C for definitions.

CEMENT

(Data in thousand short tons, unless noted)¹

Domestic Production and Use: One State agency and 48 companies operated 119 plants in 38 States to produce 76.6 million tons of portland cement, 3.0 million tons of masonry cement, and minor quantities of other cement in 1993. The value of the production was about \$3.9 billion. At yearend, the capacity of 112 plants producing portland cement clinker, including 3 white cement facilities, reached a level of approximately 256,000 tons per day. Allowing for an average of about 53 days downtime for maintenance and rebricking kilns, the apparent annual clinker production capacity, excluding Puerto Rico, was 83.5 million tons. An additional eight plants operated grinding mills only for imported, purchased, or interplant transfers of clinker. Estimated finish grinding capacity, excluding Puerto Rico, was 100 million tons. The 5 largest companies composed 38% of the clinker production capacity, and the 10 largest accounted for 52.2%. Forty-nine percent of the portland cement production came from the following six States in declining order: Texas, California, Pennsylvania, Michigan, Missouri, and Alabama. Uses of cement by type of customer were 72% for ready-mix concrete; 13% for manufacturers of concrete products such as block, pipe, and prestressed precast concrete; 5% by building material dealers; 5% by highway contractors; and 5% by other contractors, Government agencies, and miscellaneous users.

Salient Statistics—United States: ²	1989	1990	1991	1992	1993*
Production, portland, masonry, and other	77,189	77,111	73,582	78,734	79,600
Shipments from mills, including masonry cement	86,238	86,200	74,477	80,000	83,000
Imports for consumption	15,741	13,273	8,701	6,797	8,000
Exports	512	554	698	823	710
Consumption, apparent ³	90,676	89,623	79,418	81,934	84,708
Price, average mill value, dollars per ton	49.20	49.65	49.75	48.83	49.00
Stocks, mill yearend	6,300	6,214	6,382	6,054	6,000
Employment, mine and mill*	18,600	18,100	18,000	18,100	18,000
Net import reliance ⁴ as a percent of apparent consumption	16	14	10	7	7

Recycling: None.

Import Sources (1989-92): Canada, 29%; Mexico, 19%; Japan, 12%; Spain, 9%; and other, 31%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁶
			1/1/94	1/1/94
	Cement clinker	2523.10.0000	Free	\$1.32/mt.
	White nonstaining portland cement	2523.21.0000	22¢/mt	\$1.76/mt.
	Other portland cement	2523.29.0000	Free	\$1.32/mt.
	Aluminous cement	2523.30.0000	Free	\$1.32/mt.
	Other hydraulic cement	2523.90.0000	Free	\$1.32/mt.

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

Government Stockpile: None.

Events, Trends, and Issues: U.S. demand for cement (excluding Puerto Rico) increased by 4% to 83.0 million tons. Over the year, however, decreases in cement shipments occurred due to poor weather conditions, including heavy snowfall in various parts of the country and flooding in the Midwest. Through the first half of the year, the West North Central region was showing an approximately 15% decrease. The Pacific, East North Central, and Middle Atlantic regions decreased cement shipments by 7.7%, 3.2%, and 1.5% respectively. Consumption in the Mountain, West South Central, East South Central, South Atlantic, and New England regions increased by 12.4%, 8.1%, 4.5%, 3.4%, and 2.1%, respectively.

CEMENT

The U.S. cement industry continued to try to improve its profitability by cutting costs, limiting capital expenditures, and attempting to institute price increases for cement. Cement prices had not increased since the 1980's, and indeed had dropped through 1992.

Imports of cement increased by approximately 18% over those of 1992. This was the first year for imports to increase since 1987. In 1987 cement imports had reached an all time high of 17.7 million and then decreased by an average of 25% every year after. Canada was the major supplier of imported cement, followed by Mexico, Spain, and Colombia. Together these countries provided 78% of cement imported for consumption in the United States. Exports decreased after more than 5 years of consecutive increases to approximately 710,000 tons, or about a 13% decrease from 1992. Canada continued to be the principal recipient of U.S. exports, receiving more than 75% of the total.

The Department of Commerce conducted administrative reviews of the antidumping orders on gray portland cement clinker from Mexico. Based on an analysis of the rates, the final results were amended on the antidumping orders. Resulting antidumping margins ranged from 42.74% to 53.26%.

Over two thirds of the companies in the cement industry utilized waste fuels in their plants, reflecting the continuing trend to utilize byproducts and wastes. However, the Environmental Protection Agency sought fines against 39 companies, including a few cement companies, for violations in burning hazardous waste. The cement companies were cited for failure to contain hazardous waste emissions. Utilization of wastes in the cement industry is expected to continue to play an important role in waste management, with no less attention given to clean air and water, and solid waste issues.

World Production and Capacity:

	Cement production		Yearend clinker capacity	
	1992	1993 ^e	1992	1993 ^e
United States (includes Puerto Rico)	80,050	81,000	82,000	83,000
Brazil	30,975	31,000	34,000	34,000
China	335,000	335,000	350,000	360,000
France	23,810	21,000	30,000	30,000
Germany	41,340	42,000	54,000	54,000
India	55,115	59,000	70,000	70,000
Italy	45,577	46,000	98,000	98,000
Japan	99,980	100,000	102,000	102,000
Korea, Republic of	47,000	50,000	49,000	56,000
Russia	140,000	143,000	155,000	155,000
Spain	29,000	30,000	30,000	30,000
Turkey	31,534	32,000	28,000	28,000
Other countries	424,042	426,000	450,000	470,000
World total (may be rounded)	1,383,423	1,396,000	1,532,000	1,570,000

World Resources: Although domestic resources of raw materials are adequate, they are sometimes remote from cement market areas. Countries deficient in one or more raw materials have experienced little difficulty importing their requirements.

Substitutes: Aluminum, steel, fiberglass, wood, stone, and clay products may be used in the building and construction markets.

*Estimated.

¹See Appendix A for conversion to metric units.

²Excludes Puerto Rico and the Virgin Islands.

³Adjusted to eliminate duplication of imports shipped by domestic cement manufacturers.

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

⁵See Appendix B.

CESIUM

(Data in kilograms of cesium content, unless noted)

Domestic Production and Use: Although cesium was not recovered from any domestically mined ores, 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 are not available for the domestic cesium industry. Collected data, such as production of metal and compounds and producer stocks, must be withheld to avoid disclosing company proprietary data. Other statistics such as consumption, imports, and exports are not available.

The cesium market is very small. As a result, there is no active trading in the metal and therefore no official market price. However, several companies publish prices for cesium and cesium compounds. These prices are relatively stable during time periods up to several years in length. The per-unit price for the metal or compound purchased from these companies varies inversely with the quantity of material purchased. For example, in 1993, one company offered 1-gram ampoules of 99.98%-grade cesium metal at \$38.50. The price for 100 grams of the same material from this company was \$505.00 or \$5.05 per gram. At another company, the price for 1 pound or more ranged from \$325.50 to \$426.00 per pound (\$0.72 to \$0.94 per gram) depending upon the metal's grade.

Recycling: None.

Import Sources (1989-92): The United States is 100% import reliant. Although there is no information on the countries shipping cesium-bearing material to the United States, it is believed that Canada is the major source of this raw material. Other possible sources of cesium-bearing material include Germany and the United Kingdom.

<u>Tariff: Item</u>	<u>Number</u>	<u>Most favored nation (MFN)</u>	<u>Non-MFN¹</u>
		<u>1/1/94</u>	<u>1/1/94</u>
Alkali metal, other	2805.19.0000	6.6% 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.

CESIUM

Events, Trends, and Issues: It was estimated that U.S. demand for cesium remained essentially unchanged from a year ago. 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. Cesium forms independent minerals in pegmatites and is commonly obtained as a coproduct in the processing of titanium, beryllium, and lithium minerals. Reserves and the reserve base are associated mainly with the cesium silicate mineral, pollucite, concentrates of which contain more than 20% cesium.

	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 are not known.

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. Certain other elements can be substituted in light-sensing equipment, and potassium may be used instead of cesium in magnetohydrodynamic power generation.

NA Not available.

¹See Appendix B.

²See Appendix C for definitions.

CHROMIUM

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

Domestic Production and Use: The United States consumed about 10% 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 chromite ore by end use was metallurgical and chemical industry, 93%, and refractory industry, 7%. Consumption of chromium ferroalloys and metal by end use was: stainless and heat-resisting steel, 80%; full-alloy steel, 7%; superalloys, 2%; and other end uses, 11%. The value of chromium materials consumption was about \$250 million. Secondary chromium is recovered from stainless steel scrap.

<u>Salient Statistics—United States:</u> ¹	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>
Production: Mine	—	—	—	—	—
Secondary	99	94	90	95	88
Imports for consumption	379	346	309	324	342
Exports	25	14	31	16	18
Government stockpile releases	—	—	—	13	75
Consumption: Reported (excludes secondary)	378	346	323	328	319
Apparent ² (includes secondary)	452	439	377	416	488
Price, chromite, yearend:					
Turkish, dollars per metric ton, Turkey	185	135	130	110	110
South African, dollars per metric ton, Republic of South Africa	65	55	50	60	60
Stocks, industry, yearend	139	125	118	118	117
Net import reliance ³ as a percent of apparent consumption	78	79	76	77	82

Recycling: In 1993, chromium contained in purchased stainless steel scrap accounted for 18% of demand.

Import Sources (1989-92): Chromium contained in chromite ore and chromium ferroalloys and metal: Republic of South Africa, 47%; Turkey, 14%; Zimbabwe, 10%; Yugoslavia,⁴ 8%; and other, 21%.

<u>Tariff:</u> ⁵	<u>Item</u>	<u>Number</u>	<u>Most favored nation (MFN)</u> <u>1/1/94</u>	<u>Non-MFN⁶</u> <u>1/1/94</u>
	Ore and concentrate	2610.00.0000	Free	Free.
	High-carbon ferrochromium	7202.41.0000	1.9% ad val.	7.5% ad val.

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

Government Stockpile: The stockpile conversion program by which stockpiled chromite ore is upgraded to ferrochromium was Presidentially mandated in 1982 and congressionally required (Public Law 99-591) until 1993 at a rate of no less than 48,534 tons of ferrochromium per year. The Defense Logistics Agency of the Department of Defense converted about 180,000 tons of chromite ore into high-carbon ferrochromium in 1993. Uncommitted inventory shown below includes both stockpile-grade and nonstockpile-grade material. Committed inventory is set aside for disposal.

Stockpile Status—9-30-93

<u>Material</u>	<u>Uncommitted inventory</u>	<u>Committed inventory</u>	<u>Authorized for disposal</u>	<u>Disposals Jan.-Sept. 93</u>	<u>Average chromium content</u>
Chromite ore:					
Metallurgical-grade	649	437	649	—	28.6%
Chemical-grade	220	—	189	—	28.6%
Refractory-grade	355	—	211	—	—
Chromium ferroalloys:					
High-carbon ferrochromium	694	40	467	56	71.4%
Low-carbon ferrochromium	284	2	—	—	71.4%
Ferrochromium-silicon	53	—	—	—	42.9%
Chromium metal	7	—	—	—	—

CHROMIUM

Events, Trends, and Issues: There is no chromite production 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 small. The two largest chromite ore producers, each accounting for about one-third of world production, are South Africa and Kazakhstan. Both are currently in the process of major political change. Kazakhstan has been the major supplier of chromite ore to the USSR,⁷ where demand has declined. Economic and political reorganization is taking place. This lull in demand may be followed by strong growth-driven demand resulting from the institution of reforms in those countries. In the 1989-90 time period, world demand for ferrochromium by the metallurgical industry exceeded supply, resulting in increased prices and production capacity expansion. Chromite ore prices subsequently increased slightly. The end of the cold war in 1991 resulted in reduced chromium demand in military-related applications in the United States and other Western countries and coincided with the onset of generally weak economic conditions. Excess ferrochromium and chromite ore production capacity resulting from expansion in the 1991-92 time period and current weak demand have suppressed prices.

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

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁸	Reserve base ⁸ (shipping grade) ⁹
	1992	1993 ^e		
United States	—	—	—	10,000
Albania	150	150	6,000	6,000
Brazil	340	320	8,000	16,000
Finland	480	450	29,000	29,000
India	1,000	900	59,000	77,000
Kazakhstan	3,600	3,500	130,000	130,000
Philippines	132	130	7,000	7,000
South Africa, Republic of	3,361	2,300	960,000	5,500,000
Turkey	850	850	8,000	20,000
Zimbabwe	560	550	140,000	930,000
Other countries	423	400	15,000	21,000
World total (may be rounded)	11,000	10,000	1,400,000	6,700,000

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 Kazakhstan. The largest U.S. chromium resource is in the Stillwater Complex in Montana.

Substitutes: There is no substitute for chromite ore in the production of ferrochromium, chromium chemicals, or chromite refractories. There is no substitute for chromium in stainless steel, the major end use of chromium, nor for chromium in superalloys, the major strategic end use of chromium. 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 result in savings of 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.

^eEstimated.

¹Data in thousand metric tons of contained chromium, unless noted otherwise.

²Calculated total demand for chromium.

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

⁴As constituted before Apr. 1992.

⁵In addition to the tariff items listed, certain imported chromium materials (see United States Code, chapter 26, sections 4661 and 4672) are subject to excise tax.

⁶See Appendix B.

⁷As constituted before Dec. 1991.

⁸See Appendix C for definitions.

⁹Shipping-grade chromite ore is deposit quantity and grade normalized to 45% Cr₂O₃.

CLAYS

(Data in thousand metric tons, unless noted)

Domestic Production and Use: In 1993, clays were produced in most States except Alaska, Delaware, Hawaii, Rhode Island, Vermont, and Wisconsin. The leading 85 firms supplied 41% of the output, and about 300 firms provided the remainder. Together, these firms operated about 1,100 mines. Estimated value of all marketable clay produced was about \$1.8 billion. Major domestic uses for specific clays were estimated as follows: kaolin—61% paper, 6% fiberglass, and 4% paint; ball clay—22% floor and wall tile, 15% dinnerware, and 15% sanitaryware; fire clay—71% grogs, calcines, and firebrick; bentonite—23% iron ore pelletizing, 22% drilling mud, and 17% foundry sand bond; fuller's earth—78% absorbent uses and 7% insecticide dispersant; and common clay—97% construction materials.

Salient Statistics—United States:¹

	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993^e</u>
Production, mine:					
Kaolin	8,974	9,762	9,575	8,064	9,642
Ball clay	903	788	784	854	918
Fire clay ²	826	625	474	1,055	1,167
Bentonite	3,112	3,474	3,432	3,354	3,474
Fuller's earth	1,882	2,307	2,740	2,413	2,455
Common clay	<u>26,557</u>	<u>25,948</u>	<u>27,233</u>	<u>24,972</u>	<u>26,527</u>
Total	42,000	43,000	44,237	40,712	44,183
Imports for consumption	28	30	35	41	46
Exports	3,755	4,123	3,997	4,158	4,045
Consumption, apparent	39,000	39,000	40,275	37,595	40,184
Price	Per ton, depending on the type and quality				
Stocks, yearend ³	NA	NA	NA	NA	NA
Employment: ⁴ Mine	2,000	2,000	2,000	2,000	2,000
Mill	9,200	9,100	9,000	9,000	9,000
Net import reliance ⁴ as a percent of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1989-92): Mexico, 40%; United Kingdom, 21%; Canada, 20%; and other, 19%.

CLAYS

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Most favored nation (MFN)</u> <u>1/1/94</u>	<u>Non-MFN⁵</u> <u>1/1/94</u>
	Kaolin and other kaolinitic clays, whether or not calcined ⁶	2507.00.0000	32.5¢	\$2.46.
	Bentonite ⁶	2508.10.0000	39.4¢	\$3.20.
	Fuller's and decolorizing earths ⁶	2508.20.0000	24.6¢	\$1.48.
	Fire clay ⁶	2508.30.0000	49.2¢	\$1.97.
	Common blue and other ball clays ⁶	2508.40.0010	46.7¢	\$1.97.
	Other clays ⁶	2508.40.0050	46.7¢	\$1.97.
	Chamotte or dinas earth ⁶	2508.70.0000	Free	Free.
	Activated clays and earths ⁷	3802.90.2000	2.5%	0.6¢ + 30%.
	Expanded clays and mixtures ⁷	6806.20.0000	4.9%	30%.

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.

Events, Trends, and Issues: The total tonnage and value of clays sold or used by domestic producers increased 7% and 20%, respectively, in 1993. There was an increase in sales and/or use for every clay type, with the largest increases being in common clay and kaolin. Imports for consumption increased 12% to 46,000 tons. China and Mexico were the major sources for imported clays. Exports decreased 3% to 4 million tons. Canada, Finland, Italy, Japan, and the Netherlands were major markets for exported clays. U.S. apparent consumption was estimated to be 40.2 million tons.

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

World Resources: Clays are divided for commercial purposes into kaolin, ball clay, fire clay, bentonite, fuller's earth, and common clay. 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.

*Estimated. E Net exporter. NA Not available.

¹Excludes Puerto Rico.

²Refractory uses only.

³Data on stocks are not available and are assumed to be zero for apparent consumption and net import reliance calculations.

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

⁵See Appendix B.

⁶Per metric ton.

⁷Ad valorem per kilogram.

COBALT

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

Domestic Production and Use: Domestic mine production ceased at the end of 1971, and the only U.S. cobalt refinery stopped processing imported nickel-cobalt matte in late 1985. Most secondary cobalt is derived from recycled superalloy or cemented carbide scrap and from 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 that produced powder from imported primary metal and one that produced powder from recycled materials. In addition to the powder producers, six processors 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 42% of U.S. demand; catalysts, approximately 15%; paint driers, about 11%; magnetic alloys, about 10%; cemented carbides, about 8%; and other uses, 14%. The total estimated value of cobalt consumed in 1993 was \$190 million.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Production: Mine	—	—	—	—	—
Secondary	1,184	1,225	1,578	1,613	1,600
Imports for consumption	6,157	6,421	6,924	5,757	5,700
Exports	889	1,340	1,536	1,424	900
Shipments from Government stockpile excesses	—	—	—	—	300
Consumption:					
Reported (includes secondary)	7,172	7,512	7,240	6,473	6,200
Apparent (includes secondary)	7,164	7,635	7,786	6,526	6,320
Price, average annual spot for cathodes, dollars per pound	7.64	10.09	16.92	22.93	13.80
Stocks, industry, yearend	4,550	3,220	2,400	1,820	2,200
Net import reliance ¹ as a percent of apparent consumption	83	84	80	75	75

Recycling: About 1,600 tons of cobalt was recycled from purchased scrap in 1993. This represented about 26% of estimated reported consumption for the year.

Import Sources (1989-92): Zambia, 26%; Zaire, 21%; Canada, 18%; Norway, 13%; and other, 22%.

Tariff:	Item	Number	Most favored nation (MFN)² 1/1/94	Non-MFN³ 1/1/94
Unwrought cobalt, alloys	8105.10.3000		5.5% 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		5.5% ad val.	45% ad val.
Chemical compounds:				
Cobalt oxides and hydroxides	2822.00.0000		2.6¢/kg	44¢/kg.
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 Defense Logistics Agency accepted bids at prices close to the market price of Russian cobalt ingot. Most of the bids were from chemical processors and trading firms.

Stockpile Status—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Cobalt	23,792	22	5,621	276

COBALT

Events, Trends, and Issues: U.S. demand for cobalt declined slightly in 1993. The 1993 producer price was \$18 per pound of cobalt. Free market prices gradually decreased from a high of \$16.50 per pound during the first quarter of 1993 to about \$12.40 per pound in October 1993. The fall in free market prices was attributed to weak demand, consumption from stocks, and imports of Russian cobalt into Western markets.

Zaire's cobalt production continued to decline as the result of a continuing political stalemate and the postponement of much-needed foreign investment. In 1992, Zambia replaced Zaire as the leading exporter of cobalt to the United States. In 1993, Zambia was expected to replace Zaire as the world's largest cobalt producer.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁴	Reserve base ⁴
	1992	1993 [*]		
United States	—	—	—	860,000
Albania	300	—	—	23,000
Australia	1,350	1,300	23,000	90,000
Canada	2,219	2,200	45,000	260,000
Cuba	1,500	1,500	1,040,000	1,800,000
Finland	—	—	23,000	34,000
New Caledonia ⁵	800	800	230,000	860,000
Philippines	—	—	—	400,000
Russia	1,700	1,700	140,000	230,000
Zaire	5,700	1,500	2,000,000	2,500,000
Zambia	7,000	7,000	360,000	540,000
Other countries	1,355	1,350	90,000	1,200,000
World total (may be rounded)	21,924	17,400	4,000,000	8,800,000

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 Zaire and Zambia. In addition, millions of tons of hypothetical and speculative cobalt resources exist in manganese nodules and crusts on the ocean floor.

Substitutes: Nickel may be substituted satisfactorily for cobalt in superalloys. In other applications, nickel substitution can result in a loss in performance. Various potential substitutes include nickel, platinum, barium or strontium ferrite, and iron in magnets; tungsten, molybdenum carbide, ceramics, and nickel in machinery; nickel and ceramics in jet engines; nickel in catalysts; and copper, chromium, and manganese in paints.

^{*}Estimated.

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

²No tariff for Canada.

³See Appendix B.

⁴See Appendix C for definitions.

⁵Overseas territory of France.

COLUMBIUM (NIOBIUM)

(Data in thousand kilograms of columbium content, unless noted)

Domestic Production and Use: There has been no significant columbium-mining industry since 1959, with the exception of small unreported quantities of columbium-bearing concentrates produced in 1989-92. 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 1993 was about \$50 million. Major end-use distribution of reported columbium consumption was as follows: high-strength low-alloy steels, 40%; carbon steels, 32%; superalloys, 13%; stainless and heat-resisting steels, 13%; and other, 2%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production, mine	(1)	(1)	(1)	(1)	—
Imports for consumption:					
Concentrates, tin slags, and other ²	NA	NA	NA	NA	NA
Ferrocolumbium ³	2,411	1,897	2,133	2,449	2,000
Exports, concentrate, metal, alloys, waste, and scrap ⁴	104	227	270	350	100
Consumption, reported:					
Raw material ⁵	NA	NA	NA	NA	NA
Ferrocolumbium ⁶	2,439	2,586	2,412	2,555	2,400
Consumption, apparent	3,403	3,357	3,311	3,500	3,400
Price: Columbium, dollars per pound ⁴	2.65	3.25	2.83	2.83	2.67
Pyrochlore, dollars per pound ⁶	2.75	2.75	2.75	2.75	2.75
Stocks, industry, processor and consumer, yearend	NA	NA	NA	NA	NA
Employment, processor ⁸	450	NA	NA	NA	NA
Net import reliance ⁹ as a percent of apparent consumption	100	100	100	100	100

Recycling: Insignificant.

Import Sources (1989-92): Brazil, 68%; Canada, 24%; Germany, 4%; and other, 4%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁷
			1/1/94	1/1/94
	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	5.5% ad val.	45% ad val.

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

Government Stockpile: The uncommitted inventories shown below include 344,000 kilograms in nonstockpile-grade concentrates, 151,000 kilograms in nonstockpile-grade ferrocolumbium, and 26,000 kilograms in concentrates and 41,000 kilograms in ferrocolumbium with status (inventory) not yet determined.

Stockpile Status—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Columbium:				
Carbide powder	10	—	—	—
Concentrates	889	—	—	—
Ferrocolumbium	422	—	—	—
Metal	7	—	—	—

COLUMBIUM (NIOBIUM)

Events, Trends, and Issues: Overall reported consumption of columbium for the first one-half of the year decreased from that of the previous year. Consumption of columbium by the steelmaking and superalloy sectors declined by about 5% and 8%, respectively. For the same period, overall columbium imports decreased from those of the previous year. The published price for columbite ore fell from a range of \$2.60 to \$3.05 per pound of contained columbium and tantalum pentoxides to \$2.40 to \$2.80 per pound in early May, where it remained through early October. The published price for steelmaking-grade ferrocolumbium remained at \$6.58 per pound of contained columbium, and the published price for high-purity ferrocolumbium and nickel columbium remained at \$18.50 and \$20.50 per pound of contained columbium, respectively. The published price for columbium oxide was \$8.17 per pound of oxide, and the published price for columbium metal remained at \$30 to \$50 per pound.

In August, the U.S. Trade Representative announced that the Generalized System of Preferences (GSP), which had expired on July 4, 1993, was extended until September 30, 1994. The GSP extension was part of the Budget Reconciliation Act signed by the President. The legislation extending the GSP is retroactive to July 4. Additionally, the legislation removes the statutory prohibition against providing GSP benefits to the countries which made up the former U.S.S.R.⁸ Under GSP, the United States grants duty-free access to goods from more than 140 developing countries and territories.

In Proclamation 6599 of September 30, 1993, the President designated Russia as a beneficiary developing country for purposes of the GSP. GSP status for Russia is part of the Administration's overall efforts to help that country pursue badly needed market reforms. Ukraine and Kyrgyzstan also were being considered for GSP status.

It is estimated that in 1994 domestic columbium mine production will be zero and U.S. apparent consumption will be about 3.5 million kilograms. The majority of total U.S. demand will continue to be mainly supplied by columbium imports in both ore and upgraded forms.

World Mine Production, Reserves, and Reserve Base:

	Mine production ^a		Reserves ^b	Reserve base ^c
	1992	1993		
United States	(¹)	—	—	Negligible
Brazil	11,735	11,700	3,311,000	3,629,000
Canada	2,300	2,300	136,000	408,000
Nigeria	17	20	64,000	91,000
Zaire	463	460	32,000	91,000
Other countries ¹⁰	131	120	6,000	9,000
World total (may be rounded)	14,646	14,600	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 million kilograms of columbium resources in identified deposits, most of which were considered uneconomic at 1993 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.

^aEstimated. NA Not available.

¹A small unreported quantity was produced.

²Metal, alloys, synthetic concentrates, and columbium oxide.

³Includes nickel columbium and a small quantity of other columbium materials.

⁴Average value, contained pentoxides for material having a Cb_2O_5 to Ta_2O_5 ratio of 10 to 1.

⁵Average value, contained pentoxide.

⁶Defined as imports - exports + adjustments for Government and industry stock changes.

⁷See Appendix B.

⁸As constituted before Dec. 1991.

⁹See Appendix C for definitions.

¹⁰Excludes any production from Bolivia, China, and countries in the former U.S.S.R.

COPPER

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

Domestic Production and Use: Domestic mine production in 1993 rose to a record high of almost 1.8 million tons valued at about \$4.1 billion. The principal mining States, in descending order, were Arizona, Utah, New Mexico, Montana, and Michigan; copper was also recovered at mines in seven other States. While copper was recovered as a principal or byproduct metal at about 50 mines, the top 15 mines accounted for more than 95% of production. Eight primary and 5 secondary smelters, 9 electrolytic and 6 fire refineries, and 15 electrowinning plants were operating at yearend. Refined copper and direct melt scrap were consumed at about 40 brass mills; 20 wire rod mills; and 750 foundries, chemical plants, and miscellaneous consumers. Copper and copper alloy products were consumed¹ in building construction, 42%; electrical and electronic products, 24%; industrial machinery and equipment, 13%; transportation equipment, 11%; and consumer and general products, 10%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production: Mine	1,498	1,588	1,631	1,765	1,770
Refinery: Primary ²	1,477	1,577	1,577	1,711	1,750
Secondary ³	480	441	418	433	450
Copper from all old scrap	548	537	518	554	565
Imports for consumption:					
Ores and concentrates	47	92	61	102	40
Refined	300	262	289	290	340
All imports	515	512	512	593	600
Exports: Ores and concentrates	267	258	253	266	200
Refined	130	211	263	177	210
All exports	725	780	802	679	630
Consumption: Refined, reported	2,203	2,150	2,048	2,178	2,350
Apparent, total ⁴	2,185	2,168	2,105	2,311	2,450
Price, average, cents per pound:					
Domestic producer, cathode	130.95	123.16	109.3	107.4	92.0
London Metal Exchange, high-grade	128.91	121.02	106.2	103.7	87.0
Stocks, yearend, refined ⁵	87	81	112	185	180
Employment, mine and mill, thousands	12.4	12.9	13.7	13.6	14
Net import reliance ⁶ as a percent of apparent consumption	7	3	E	2	6

Recycling: Old scrap, converted to refined metal and alloys, provided 565,000 tons of copper or 23% of apparent consumption. Purchased new scrap, derived from copper fabricating operations, yielded 750,000 tons of contained copper. Of the total copper recovered from scrap, copper smelters and refiners recovered 34%; ingot makers, 10%; brass mills, 47%; and miscellaneous manufacturers, foundries, and chemical plants, 9%. About 75% of the copper contained in new scrap was consumed at brass mills. Copper in all old and new, refined or remelted scrap composed 44% of U.S. copper supply.

Import Sources (1989-92): Canada, 49%; Chile, 18%; Mexico, 15%; and other, 18%. Refined copper composed 62% of imports of unalloyed unwrought copper.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁷
			1/1/94	1/1/94
	Unrefined copper; anodes	7402.00.0000	1% ad val. ⁸	6% ad val. ⁸
	Refined and alloys, unwrought	7403.00.0000	1% ad val.	6% ad val.
	Copper powder	7406.10.0000	5.4% ad val.	49% ad val.
	Copper wire (bare)	7408.11.6000	4% ad val.	28% ad val.

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

Government Stockpile: Included in the quantity of refined copper shown below were 6,124 tons of copper in brass and 548 tons of nonstockpile-grade material. In March through October, the Defense Logistics Agency held monthly sales, in 4-million-pound lots, of stockpiled copper. In November and December it offered the balance of copper metal in 2 lots of about 8 million pounds.

COPPER

Material	Stockpile Status—9-30-93		Authorized for disposal	Disposals Jan.-Sept. 93
	Uncommitted inventory	Committed inventory		
Refined copper	13.9	2.4	13.9	12.7

Events, Trends, and Issues: World copper production remained at about the same level as in 1992. A positive political climate and favorable geologic setting continued to stimulate increased production from new and expanded facilities in Chile. Political turmoil in Zaire further crippled production in that country. A small loss of U.S. mine production, which rose nominally during the year, resulted from heavy rains early in the year that diluted leach solutions at solvent extraction/electrowinning operations. Expansions were completed at two U.S. smelters. While world refined production and capacity increased slightly, world consumption of refined copper declined. Demand in Western Europe was particularly poor, falling almost 10%, owing to weakening economies. A weak Japanese demand was offset by growth in other Asian markets. Refined copper demand in the United States and Canada ran counter to the world trend. Domestic brass mills reportedly ran at capacity despite a slight increase in net imports of brass mill products. Domestic demand for refined copper rose in 1993 by about 8%. Consumption was expected to increase in 1994 to more than 2.4 million tons.

While domestic stocks of refined copper, which had risen sharply at yearend 1992, remained relatively stable throughout the year, a global surplus led to the near doubling of inventories in London Metal Exchange (LME) warehouses to more than 600,000 tons by October. At midyear, anomalous market conditions developed, with tightness reported in the spot copper market and backwardation of prices (forward prices sold at a discount to spot prices) on the LME. When the LME Board intervened to limit backwardation in September, the price of copper plummeted by almost 10 cents per pound to the lowest level in more than 6 years. The lower prices, which held through the remainder of the year, raised concerns about the viability of many copper operations.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ^a	Reserve base ^a
	1992	1993 ^a		
United States	1,765	1,770	45,000	90,000
Australia	326	300	7,000	21,000
Canada	764	750	11,000	23,000
Chile	1,910	2,020	88,000	140,000
China	375	380	3,000	8,000
Indonesia	280	270	11,000	17,000
Peru	368	370	7,000	25,000
Philippines	123	130	7,000	11,000
Poland	387	390	20,000	36,000
U.S.S.R. ¹⁰	12	800	37,000	54,000
Zaire	171	90	10,000	30,000
Zambia	440	420	12,000	34,000
Other countries	1,570	1,590	50,000	98,000
World total (may be rounded)	9,290	9,300	310,000	590,000

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 equipment, automobile radiators, and refrigerator 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.

^aEstimated. E Net exporter.

¹Some electrical components are included in each end use. Estimated after Copper Development Association, 1992.

²From domestic and imported materials.

³From new and old scrap at primary and secondary refineries.

⁴Defined as primary refined production + copper from old scrap + refined exports ± changes in refined stocks.

⁵Held by industry and by Commodity Exchange Inc.; excludes Government stocks.

⁶Defined as imports - exports + adjustments for Government and industry stock changes for refined copper.

⁷See Appendix B.

⁸Value of copper content.

⁹See Appendix C for definitions.

¹⁰As constituted before Dec. 1991.

DIAMOND (INDUSTRIAL)

(Data in million carats, unless noted)

Domestic Production and Use: Synthetic diamond production maintained its record-high level. Most industrial diamond produced domestically was synthetic grit and powder. The output was from three firms, two in New Jersey and one in Ohio. Six firms recovered and sold industrial diamond as the principal product. About 35 firms recovered industrial diamond in secondary operations. Major uses of all industrial diamond were machinery, 27%; mineral services, 18%; stone and ceramic products, 17%; abrasives, 16%; contract construction, 13%; transportation equipment, 6%; and other, 3%. The mineral services industry, primarily drilling, accounted for 59% of stone consumption.

Salient Statistics—United States:¹	1989	1990	1991	1992	1993^a
Bort, grit, and powder and dust, natural and synthetic:					
Production: Manufactured diamond	W	90.0	90.0	95.0	100.3
Secondary	3.0	5.9	3.5	3.4	15.8
Imports for consumption	61.6	85.4	70.0	97.3	15.0
Exports and reexports	78.2	71.0	78.8	83.6	96.1
In manufactured products ^a	.6	.6	.6	.6	.6
Sales from Government stockpile excesses	—	3.0	5.0	10.4	—
Consumption, apparent	75.8	112.7	89.1	121.9	134.4
Price, value of imports, dollars per carat	.72	.76	.83	.70	.57
Net import reliance ² as a percent of apparent consumption	E	13	E	19	14
Stones, natural:					
Production: Mine	—	—	—	—	—
Secondary	.6	.5	.3	.1	.1
Imports for consumption	8.8	11.0	7.6	9.8	5.5
Exports and reexports ³	2.8	1.7	2.9	5.6	3.7
Sales from Government stockpile excesses	—	—	—	—	1.3
Consumption, apparent	6.6	9.8	5.0	4.3	1.8
Price, value of imports, dollars per carat	6.94	6.57	6.68	4.56	6.35
Net import reliance ² as a percent of apparent consumption:	91	95	94	98	95

Recycling: About 15.9 million carats were salvaged in secondary production from salvage stone, sludge, and swarf.

Import Sources (1989-92): Bort, grit, and powder and dust, natural and synthetic: Ireland, 60%; Russia, 9%; Ukraine, 6%; Japan, 3%; and other, 22%. Stone, natural: Ireland, 28%; United Kingdom, 26%; Zaire, 23%; Republic of South Africa, 1%; and other, 22%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN^a
			1/1/94	1/1/94
Miners' diamond, carbonados	7102.21.1010		Free	Free.
Other	7102.21.1020		Free	Free.
Industrial diamond, natural advanced	7102.21.3000		4.9% 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.

DIAMOND (INDUSTRIAL)

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

Government Stockpile: Some excess crushing bort was sold at auction, and a small amount was disposed to support the other stockpile projects.

Material	Stockpile Status—9-30-93			
	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Crushing bort	4.0	—	3.9	—
Industrial stones	6.6	0.7	3.4	1.3

Events, Trends, and Issues: Industrial diamond industry experienced another robust year, and U.S. consumption is estimated to have increased significantly. Total U.S. sales, including exports, were up. It is estimated that the industrial diamond worldwide market performed similarly to the U.S. market. Companies in Ireland, the Republic of South Africa, Sweden, and the United States increased production capacity for synthetic industrial diamond during 1993.

World Mine Production, Reserves, and Reserve Base:⁵

	Mine production		Reserves ⁶	Reserve base ⁶
	1992	1993 ^e		
United States	—	—	—	Unknown
Australia	21.0	21.0	500	900
Botswana	5.0	5.0	125	200
Brazil	0.9	0.9	5	15
China	0.8	0.8	10	20
South Africa, Republic of	5.8	6.0	70	150
Russia	9.0	8.0	40	65
Zaire	12.0	12.0	150	350
Other countries	1.2	2.0	80	200
World total	55.7	55.7	980	1,900

World Resources: The potential to discover diamond resources in the United States, Canada, and Russia has improved. However, evaluation of deposits already discovered will take several more years. Technology has been developed to synthesize diamond for industrial use worldwide in the range of sizes of powder, dust, and grit; and firms in the U.S. and Japan manufacture synthetic stones. World resources of natural industrial diamond in the stone-size range are unknown.

Substitutes: Competitive materials are cubic boron nitride, fused aluminum oxide, and silicon carbide as manufactured abrasive materials and garnet, emery, and corundum as natural abrasive minerals. Synthesized polycrystalline diamond was competitive with natural stones in many applications. Research continued on additional uses of synthetic polycrystalline compacts and shapes as substitutes for stones and the uses of diamond films and diamond like carbon coatings.

*Estimated. E Net exporter. W Withheld to avoid disclosing company proprietary data.

¹Industry stocks and employment were unknown.

²Defined as imports - exports including reexports + adjustments for Government and industry stock changes.

³Includes diamonds in manufactured abrasive products.

⁴See Appendix B.

⁵Natural industrial diamond only.

⁶See Appendix C for definitions.

DIATOMITE

(Data in thousand metric tons, unless noted)

Domestic Production and Use: The estimated value of processed diatomite, f.o.b. plant, was \$115 million in 1993. Five companies with 11 processing facilities in 4 States produced diatomite. California and Nevada were the principal producing States. End uses of diatomite were filter aid, 72%; fillers, 14%; and other, 14%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production ¹	617	631	610	595	622
Imports for consumption	1	1	(²)	(²)	2
Exports	137	144	152	163	167
Consumption, apparent	481	488	458	432	457
Price, average value, dollars per ton, f.o.b. plant	222	219	229	201	185
Stocks, producer, yearend	36	36	36	36	36
Employment, mine and plant ^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 (1989-92): Mexico, 85%; Germany, 5%; Canada, 4%; and other, 6%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁴ 1/1/94
	Diatomite, crude or processed	2512.00.0000	Free	Free.

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

Government Stockpile: None.

DIATOMITE

Events, Trends, and Issues: The United States remained the largest producer and consumer of diatomite and exported processed diatomite to more than 50 countries primarily for filtration use.

All domestic mining is by open pit, and challenging land use problems exist. Control of dust in mining is adequate because of the high moisture content of the crude ore. Almost all processing is enclosed to permit effective control of silica dust.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁶	Reserve base ⁵
	1992	1993 ^a		
United States ¹	595	622	250,000	500,000
Brazil	13	13		2,000
Denmark ⁶	61	60		NA
France	250	250	Other	2,000
Germany	40	40	countries:	NA
Iceland	22	22	550,000	2,000
Italy	26	25		NA
Korea, Republic of	90	90		NA
Mexico	55	55		2,000
Romania	40	40		NA
Spain	110	110		NA
U.S.S.R. ⁷	190	180		NA
Other countries	89	90		NA
World total	1,581	1,597	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, although, in most instances, diatomite is a superior material. 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.

^aEstimated. E Net exporter. NA Not available.

¹Processed ore sold and used by producers.

²Less than ½ unit.

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

⁴See Appendix B.

⁵See Appendix C for definitions.

⁶Includes sales of molar production.

⁷As constituted before Dec. 1991.

FELDSPAR

(Data in thousand metric tons, unless noted)

Domestic Production and Use: U.S. feldspar production (including aplite) in 1993 had an estimated value of about \$30 million. The three largest producers accounted for about 75% of the output, with five other companies supplying the remainder. North Carolina provided 60% of the 1993 output, and five other States contributed smaller quantities.

Production of lithium ores and mica yielded moderate quantities of byproduct or coproduct feldspar and feldspar-silica mixtures in 1993, 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. The larger recipients of feldspar shipments were estimated to be California, Georgia, New Jersey, Ohio, Oklahoma, Pennsylvania, and Texas. Lesser feldspar shipments went to at least 24 other States and foreign destinations, including Canada and Mexico. In ceramics and glass, feldspar functions as a flux. Estimated 1993 end-use distribution of domestic feldspar was glass, 65%, and pottery and other, 35%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production, marketable	655	630	580	725	760
Imports for consumption	12	11	18	13	8
Exports	9	25	8	18	19
Consumption, apparent	658	616	590	720	749
Price, average value, marketable production, dollars per ton	42.75	43.49	44.83	39.31	39.08
Stocks, producer, yearend ¹	NA	NA	NA	NA	NA
Employment, mine and preparation plant	450	450	430	400	400
Net import reliance ² as a percent of apparent consumption	<1	E	2	E	E

Recycling: Insignificant.

Import Sources (1989-92): Mexico, 99%; and other, 1%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN³
			1/1/94	1/1/94
	Feldspar	2529.10.0000	Free	49¢/ton.

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

Government Stockpile: None.

FELDSPAR

Events, Trends, and Issues: An increase in feldspar (including aplite) consumption in 1993 reflected a slight rise in glass container shipments compared to those of the previous year. Glass bottles, feldspar's largest end use, continued to have substantial competition from other container materials.

An estimated 6% increase in new housing starts resulted in higher demand for pottery, including whiteware such as tile and plumbing fixtures, feldspar's second largest end use. According to a non-Government source, total plumbing shipments in 1992, the latest information available, consisted of approximately 38% plastic and fiberglass fixtures, 30% vitreous china fixtures, 23% metal fixtures, and 9% other nonmetal fixtures.

World Mine Production, Reserves, and Reserve Base:

	Mine production ^a		Reserves and reserve base ^d
	1992	1993	
United States	^b 725	760	Significant in the United States and assumed to be similar in other countries.
Brazil	115	120	
France	400	400	
Germany	385	390	
Italy	1,500	1,500	
Japan	63	65	
Korea, Republic of	250	250	
Mexico	155	160	
Norway	90	90	
Russia	105	100	
Spain	200	200	
Thailand	700	700	
Turkey	200	200	
Uzbekistan	100	100	
Venezuela	95	100	
Other countries	687	765	
World total	5,770	5,900	

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

^aEstimated. E Net exporter. NA Not available.

¹Change in stocks assumed to be zero for apparent consumption and net import reliance calculations.

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

³See Appendix B.

⁴See Appendix C for definitions.

⁵Reported figure.

FLUORSPAR

(Data in thousand metric tons, unless noted)

Domestic Production and Use: One company in southern Illinois shipped an estimated 50,000 tons of fluorspar in 1993. Zinc and lead concentrates were produced as coproducts of processing in Illinois.

An estimated 65% of the reported fluorspar consumption in the United States in 1993 went into the production of hydrofluoric acid (HF) in Louisiana, Texas, and Kentucky. HF is the primary ingredient from which virtually all organic and inorganic fluorine-bearing chemicals are produced, and is also a key ingredient in the processing of aluminum and uranium. An estimated 16% of the fluorspar was consumed as a flux in steelmaking and in iron and steel foundries. The remainder was consumed in aluminum fluoride manufacture, primary aluminum production, glass manufacture, enamels, welding-rod coatings, and other end uses or products.

To supplement domestic fluorine supplies, about 58,000 tons of fluorosilicic acid (equivalent to 102,100 tons of 92% fluorspar) was recovered from phosphoric acid plants processing phosphate rock. Fluorosilicic acid was used primarily to make aluminum fluoride for the aluminum industry and in water fluoridation, either directly or after processing into sodium silicofluoride.

Salient Statistics—United States:		1989	1990	1991	1992	1993*
Production:	Finished, all grades ^a	66	64	58	51	50
	Fluorspar equivalent from phosphate rock	91	82	106	106	102
Imports for consumption:						
	Acidspar	554	407	276	295	335
	Metspar	102	107	100	115	70
	Fluorspar equivalent from hydrofluoric acid plus cryolite	204	161	128	106	111
Exports, ² ceramic- and acid-grade		5	15	74	14	13
Consumption: Apparent ³		698	582	501	480	438
	Reported: Acidspar	W	W	W	W	W
	Metspar	W	W	W	W	W
	Total	642	565	484	485	440
Stocks, yearend, consumer		79	75	69	48	65
Employment, mine and mill ^e		200	180	180	180	180
Net import reliance ⁵ as a percent of apparent consumption		91	89	88	89	89

Recycling: Primary aluminum producers recycled fluorides from smelting operations. There was no recycling in other consuming industries.

Import Sources (1989-92): Mexico, 35%; China, 33%; Republic of South Africa, 22%; and other, 10%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁶ 1/1/94
	Acid grade (more than 97% CaF ₂)	2529.22.0000	\$2.10/lb	\$5.60/lb.
	Metallurgical grade (less than 97% CaF ₂)	2529.21.0000	13.5% ad val.	13.5% ad val.

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

Government Stockpile: Based on revised national security needs dictated by new post-cold war planning assumptions, the Department of Defense has been authorized to dispose of the entire fluorspar stockpile. The overall mechanism for this disposal would be the National Defense Authorization Act for Fiscal Year 1993, which authorized disposal of obsolete and excess materials contained in the National Defense Stockpile. The Defense Logistics Agency, Defense National Stockpile Center announced that it would receive and consider offers on a daily basis for the purchase of any and all metallurgical-grade fluorspar and nonstockpile-grade fluorspar at 11 different stockpile locations in Connecticut, Indiana, New Mexico, and Pennsylvania. A similar announcement was made for about 282,000 short wet tons (256,000 metric tons) of acid-grade fluorspar located at Wilmington, DE.

FLUORSPAR

Stockpile Status—9-30-93 (Thousand short dry tons)

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Acid grade	888	—	886	7
Metallurgical grade	389	3	389	16

Events, Trends, and Issues: The U.S. Environmental Protection Agency (EPA) published the Hydrogen Fluoride Study Report to Congress. The report was required by section 112(n)(6) of the Clean Air Act Amendments of 1990, which required EPA to identify potential hazards to public health and the environment considering a range of events, and to make recommendations for reducing hazards, if appropriate. The study determined that "owners/operators can achieve an adequate margin of protection both for their workers and the surrounding community by assiduously applying existing industry standards and practices, existing regulations, and future guidance and regulations applicable to various classes of hazardous substances in various settings." The conclusions of this study should allay the concerns of producers and consumers of hydrofluoric acid, who may have been required to spend large sums of money for new equipment and training. In particular, the petroleum refining industry estimated it could have cost \$4 billion to replace HF alkylation units with sulfuric acid units.

The largest HF producer in North America increased HF capacity at its Geismar, LA, plant. The plant's annual capacity was expanded from 104,000 tons to 120,000 tons. The capacity expansion was accomplished by implementing a series of process improvements instead of by installing additional furnace capacity.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁷ ^a	Reserve base ⁷ ^a
	1992	1993 ^a		
United States	51	50	W	10,000
China	1,600	1,600	27,000	46,000
France	160	120	10,000	14,000
Italy	80	50	6,000	7,000
Kenya	81	80	2,000	3,000
Mexico	364	370	19,000	23,000
Mongolia	277	160	20,000	30,000
South Africa, Republic of	258	260	30,000	36,000
Spain	90	85	6,000	8,000
U.S.S.R. ⁹	*300	300	62,000	94,000
United Kingdom	85	85	2,000	3,000
Other countries	500	500	¹⁰ 25,000	37,000
World total (may be rounded)	3,850	3,660	210,000	310,000

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

Substitutes: Olivine and/or dolomitic limestone were used as substitute fluxes for fluorspar. Gaseous hydrocarbons and carbon dioxide have been substituted for chlorofluorocarbons (CFC's) as aerosol propellants, hydrocarbons for CFC's in plastic foam production, and aqueous cleaning agents for CFC's in cleaning printed circuit boards.

*Estimated. W Withheld to avoid disclosing company proprietary data.

¹Shipments.

²Exports are all general imports reexported.

³Excludes fluorspar equivalent of fluorosilicic acid, hydrofluoric acid, and cryolite.

⁴Apparent consumption figures were revised by deleting "minus export" from the apparent consumption equation. All fluorspar exports are general imports that have been reexported. They do not show up in the imports for consumption, but when included in apparent consumption distort the resulting consumption figure.

⁵Defined, in this case, as shipments + imports + adjustments for Government and industry stock changes.

⁶See Appendix B.

⁷See Appendix C for definitions.

⁸Measured as 100% calcium fluoride.

⁹As constituted before Dec. 1991.

¹⁰Includes the United States.

GALLIUM

(Data in kilograms of gallium content, unless noted)

Domestic Production and Use: No domestic primary gallium recovery was reported in 1993. 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 \$3.8 million. Gallium arsenide (GaAs) components represented about 95% of domestic gallium consumption. About 54% of the gallium consumed was used in optoelectronic devices, which include light-emitting diodes, laser diodes, photodetectors, and solar cells. Integrated circuits represented 30% of gallium demand, and the remainder 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:	1989	1990	1991	1992	1993*
Production, primary ^a	—	—	—	—	—
Imports for consumption	15,284	9,894	11,271	8,479	13,000
Exports	NA	NA	NA	NA	NA
Consumption: Reported	9,667	9,860	11,241	10,563	11,000
Apparent	NA	NA	NA	NA	NA
Price, yearend, dollars per kilogram, 99.99999%-pure ¹	525	525	525	425	425
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, refinery ^a	20	20	20	20	20
Net import reliance ² 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-base devices were reprocessed:

Import Sources (1989-92): France, 47%; Germany, 33%; Switzerland, 6%; United Kingdom, 4%; and other, 10%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN³ 1/1/94
	Gallium metal	8112.91.1000	3.7% 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.

GALLIUM

Events, Trends, and Issues: Gallium demand in the United States remained about the same as that in 1992. The cutbacks in the U.S. defense industry funding have resulted in decreases in defense-related GaAs research. As a result, GaAs manufacturers were seeking commercial applications for some of the military microwave applications. Motion detectors for school buses that would sense motion to the front, side, and underneath the bus were one potential commercial application for defense-related GaAs devices. The motion detectors would use GaAs-base monolithic microwave/millimeter wave integrated circuits that were developed with Department of Defense funding. Another Federal program that funded materials research for defense purposes was expected to redefine its targets for dual-use purposes, meaning that the research would integrate potential military and civilian applications.

The U.S. gallium refiner began operating its 99.99999%-pure gallium refinery in 1992, but, because many companies had not switched to the higher purity material, the plant reportedly operated at about one-half of its rated capacity. Although the price of gallium was quoted at \$425 per kilogram for 99.99999%-pure material, early in 1993, imported material of this grade reportedly was selling at \$330 per kilogram, and 99.99%-pure gallium was selling at \$160 to \$185 per kilogram. As a result of these low prices, rumors persisted during the year that the French firm would abandon its gallium business, but the company refuted these rumors and stated that it would continue marketing gallium.

Japan's gallium consumption in 1993 was projected to decline significantly. Imports of both crude and refined gallium were expected to be about 12,000 kilograms, a 60% decrease from the 1992 level. Industry sources reported that domestic shipments were also declining, and the price of 99.9999%-pure gallium was estimated to be about \$470 per kilogram, a decrease of more than 50% in a 10-year period. The country's declining consumption was attributed to falling demand for compound semiconductor material and price competition among light-emitting diode manufacturers.

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 1993, world primary production was estimated to be about 28,000 kilograms, with Germany and Japan as the largest producers. Countries with smaller output were China, Hungary, Slovakia, and the former U.S.S.R. France was a significant producer of refined gallium, using as feed material crude gallium produced in Australia that had been stockpiled since 1990.

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 residues from zinc processing. 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), about 2 million kilograms of this metal are present in the bauxite deposits in Arkansas. U.S. bauxite resources, which are mainly subeconomic deposits, contain approximately 15 million kilograms of gallium. 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 light-emitting diodes. Indium phosphide components can be substituted for GaAs-base 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-base integrated circuits are used in place of silicon in many defense-related applications, and there are no effective substitutes for GaAs in these applications.

*Estimated. NA Not available.

¹Nominal.

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

³See Appendix B.

GARNET, INDUSTRIAL¹

(Data in metric tons of garnet, unless noted)

Domestic Production and Use: Garnet was produced in 1993 by four firms, three in New York and one in Idaho. Output of refined material was valued at \$14.8 million. The end uses for garnet were abrasive in petroleum industry, 41%; filtration media, 20%; transport manufacturing, 19%; finishing wood furniture, 10%; electronic components, 7%; and ceramics and glass, 3%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production (crude)	42,605	47,009	50,860	54,139	46,100
Sold by producers (refined)	41,320	45,935	48,048	46,098	52,400
Imports for consumption	5,000	5,000	5,000	6,000	12,200
Exports	9,716	10,000	10,000	8,876	12,100
Consumption, apparent	36,604	44,164	44,040	45,697	52,100
Price, range of value, dollars per ton	60-2,000	60-2,000	60-2,000	100-2,000	100-2,000
Stocks, producer	5,443	2,214	11,113	8,638	9,400
Employment, mine and mill*	150	150	150	150	150
Net import reliance ² as a percent of apparent consumption	E	E	E	E	E

Recycling: One cost advantage of using garnet as a blasting medium is that it can be both recycled and reclaimed. It is common for garnet to be recycled three to five times in most contained or semicontained operations. There is a garnet reclamation plant near Harvey, LA.

Import Sources (1989-92): Australia, 57%, India, 30%, and China, 13%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN³ 1/1/94
Emery, natural corundum, natural garnet, and other natural abrasive, crude		2513.21.0000	Free	Free.
Emery, natural corundum, natural garnet, and other natural abrasive, other than crude		2513.29.0000	0.7¢/kg	2.2¢/kg.
Natural abrasives on woven textile		6805.10.0000	2.5% ad val.	20% ad val.
Natural abrasives on paper or paperboard		6805.20.0000	2.5% ad val.	20% ad val.
Natural abrasives sheets, strips, disks, belts, sleeves, or similar form		6805.30.0000	2.5% ad val.	20% ad val.

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

Government Stockpile: None.

GARNET, INDUSTRIAL

Events, Trends, and Issues: Imports from Australia continued to be used in the U.S. filtration and blasting media markets, but did not appear to affect domestic production negatively. The market appears to be large enough to absorb additional imports without harming U.S. producers. The garnet reclaim plant in Harvey, LA, was used intermittently and as a distribution warehouse. Currently, evaluation and feasibility studies are underway on major garnet deposits in Arizona, California, and Montana.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁴	Reserve base ⁴
	1992	1993 [*]		
United States	54,139	46,099	5,000,000	25,000,000
Australia	23,000	30,000	1,000,000	7,000,000
China	10,000	18,000	Moderate to Large	Moderate to Large
India	10,000	10,000	500,000	20,000,000
Other countries	2,000	2,000	6,520,000	20,000,000
World total ⁴	106,139	106,099	Moderate	Large

World Resources: Garnets occur worldwide in a variety of rocks, particularly gneisses and schists. They also occur as contact-metamorphic deposits in crystalline limestones, pegmatites, and serpentinites, and in high-temperature intrusive contacts and vein deposits. Alluvial garnet is also a coproduct with many heavy-mineral sand and gravel deposits in the world. Large domestic resources of garnet are concentrated in coarsely crystalline gneiss near North Creek, NY. One of the world's largest known garnet deposits, located in Ranglely County, ME, is not currently being mined. The medium-grained ore from this deposit has an unusually high garnet concentration of 50% to 60%. Significant resources of garnet occur also in Idaho, Montana, New Hampshire, North Carolina and Oregon. World resources of garnet are large.

Substitutes: Garnet is competitive in abrasive applications with natural and manufactured abrasives such as diamond, cubic boron nitride, fused aluminum oxide, silicon carbide, and quartz sand; in filtration media with ilmenite, magnetite, and plastics; and in nonskid surfaces with emery.

^{*}Estimated. E Net exporter.

¹Excludes gem and synthetic garnet.

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

³See Appendix B.

⁴See Appendix C for definitions.

GEMSTONES¹

(Data in million dollars, unless noted)

Domestic Production and Use: Output of natural gemstones was primarily from Tennessee, Arkansas, Arizona, and Indiana. Output of synthetic gemstones was primarily from 14 firms, 4 in Arizona, 3 in California, and 1 each in Massachusetts, Michigan, New Jersey, New Mexico, North Carolina, Ohio, and Washington. It was estimated that visitors found 135 carats of diamonds in the Crater of Diamonds State Park in Arkansas. There was considerable production of freshwater pearls in Tennessee; turquoise in Arizona and Nevada; beryl in Maine; tourmaline, beryl, kunzite, and garnet in California; and sapphire in Montana. Major uses were jewelry, carvings, and gem and mineral collections.

Salient Statistics—United States:

	1989	1990	1991	1992	1993 [*]
Production: Natural ²	42.9	52.9	84.4	66.2	52.1
Synthetic	18.8	20.5	17.9	18.9	19.5
Imports for consumption	5,115	4,609	4,635	4,839	5,184
Exports, including reexports	1,473	1,613	1,712	1,450	1,612
Consumption, apparent	3,704	3,069	3,025	3,475	3,644
Price	Variable, depending on size, type, and quality				
Stocks, yearend ³	NA	NA	NA	NA	NA
Employment, mine ⁴	800	800	800	800	1,000
Net import reliance ⁵ as a percent of apparent consumption	98	98	97	98	98

Recycling: Insignificant.

Import Sources (1989-92 by value): Israel, 25%; Belgium, 22%; India, 16%; United Kingdom, 5%; and other, 32%. Diamond imports were about 85% of the total value of gem imports.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN ⁶ 1/1/94
	Diamonds, unworked or sawn	7102.31.0000	Free	Free.
	Diamond, less than ½ carat	7102.39.0010	Free	10% ad val.
	Diamond, cut, more than ½ carat	7102.39.0050	Free	10% ad val.
	Precious stones, unworked	7103.10.0000	Free	Free.
	Precious stones, simply sawn	7103.10.4000	21% 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	2.1% ad val.	10% ad val.
	Other precious stones, other	7103.99.5000	21% ad val.	50% ad val.
	Imitation precious stones	7018.10.2000	2.8% ad val.	20% ad val.
	Synthetic cut, but not set	7104.90.1000	3.1% ad val.	10% ad val.
	Pearls, natural	7101.10.0000	Free	10% ad val.
	Pearls, cultured	7101.21.0000	2.1% ad val.	10% ad val.
	Pearls, imitation not strung	7018.10.1000	8% ad val.	60% ad val.

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

Government Stockpile: None.

GEMSTONES

Events, Trends, and Issues: Except for a few gem diamonds found each year in Arkansas, U.S. diamond production is insignificant. Domestic commercial gemstone production includes agates, beryls, freshwater pearls, garnets, jade, jasper, mother-of-pearl, opals, peridot, quartz, sapphire, tourmalines, and turquoise. Significant steps are being made in the marketing of lines of jewelry made with U.S. gemstones.

Exploration for diamonds continues in Alaska, Colorado, Michigan, Minnesota, Wisconsin, and Wyoming. The first phase of the diamond exploration project at the Crater of Diamonds State Park in Arkansas was completed. Significant diamond exploration efforts by multiple companies continued in the Northwest Territories of Canada and in several areas in Australia. In February, the Central Selling Organization, which markets about 80% of the world's diamonds, reduced the cut diamond purchases from producers to 15% from 25% and raised rough prices by 1.5%.

World Mine Production,⁷ Reserves, and Reserve Base:

	Mine production		Reserves and reserve base ⁸
	1992	1993 ⁶	
United States	—	—	World reserves and reserve base of gem diamond are substantial. No reserves or reserve base data are available for other gemstones.
Angola	935	800	
Australia	21,000	21,000	
Botswana	10,000	10,000	
Brazil	600	600	
Central African Republic	296	300	
China	200	200	
Ghana	175	200	
Guinea	90	90	
Guyana	8	8	
India	3	3	
Indonesia	6	6	
Namibia	1,500	1,500	
Russia	9,000	8,000	
Sierra Leone	165	150	
South Africa, Republic of	4,400	5,000	
Tanzania	70	70	
Venezuela	108	200	
Zaire	3,000	3,000	
Other countries	507	600	
World total (rounded)	52,000	51,700	

World Resources: The world gem diamond reserves are estimated to be about 300 million carats, including near-gem materials. Most of the reserves are in southern Africa, Russia, and Western Australia. Estimation of a reserve base is now very volatile because of the changing economic evaluation of near-gem materials and new discoveries in Australia, Canada, and Russia.

Substitutes: Plastics, glass, metals, wood, paper, 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 are materials of similar appearance, but with different chemical and physical properties, that are substituted for natural gemstones.

*Estimated. NA Not available.

¹Excludes industrial diamond and garnet. See Diamond (Industrial) and Garnet (Industrial).

²Natural includes production of freshwater pearls, natural and cultured.

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

⁴Estimate includes operators of fee site deposits.

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

⁶See Appendix B.

⁷Data in thousands of carats of gem diamond.

⁸See Appendix C for definitions.

GERMANIUM

(Data in kilograms of germanium content, unless noted)

Domestic Production and Use: The value of domestic refinery production of germanium, based on the 1993 producer price, was about \$10.6 million. Industry generated scrap, imported concentrates, and some processed residues from certain domestic ores were the feed materials for refined germanium production in 1993. The domestic industry consisted of three germanium refineries, one each in New York, Oklahoma, and Pennsylvania, and a mining operation located in Tennessee. The company in Tennessee exported germanium-bearing residues generated from the production of zinc metal. The major end uses for germanium were infrared optics, 25%; fiber-optic systems, 35%; detectors, 10%; semiconductors (including transistors, diodes, and rectifiers), 10%; and other applications (catalysts, phosphors, metallurgy, and chemotherapy), 20%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production, refinery*	20,000	18,000	15,000	13,000	10,000
Total imports ¹	40,000	50,000	27,000	13,000	22,000
Exports	NA	NA	NA	NA	NA
Consumption*	36,000	34,000	33,000	29,000	25,000
Price, producer, yearend, dollars per kilogram:					
Zone refined, first reduction quality	1,060	1,060	1,060	1,060	1,060
Dioxide	660	660	660	660	660
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant* ²	120	110	100	100	100
Net import reliance ³ as a percent of apparent consumption	NA	NA	NA	NA	NA

Recycling: More than 50% 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 (1989-92): Belgium, 24%; France, 24%; United Kingdom, 13%; Germany, 10%; and other, 29%.

Tariff: Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁴ 1/1/94
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	3.7% ad val.	25% ad val.
Other	8112.30.9000	5.5% ad val.	45% ad val.

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

Government Stockpile:

Stockpile Status—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Germanium	68,207	—	7	706

GERMANIUM

Events, Trends, and Issues: Free market prices, published by Metal Bulletin (London), remained in a low range of \$340 to \$350 per kilogram throughout the first 9 months of 1993. Global oversupply of germanium materials together with low market demand are likely to continue in the near future.

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

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves ⁵	Reserve base ⁶
	1992	1993 ⁴		
United States	13,000	10,000	450,000	500,000
Other countries ⁶	52,000	40,000	NA	NA
World total	65,000	50,000	NA	NA

World Resources: The available resources of germanium are associated with some zinc and lead-zinc-copper sulfide ores. Potential worldwide germanium resources would increase to some several billion kilograms if germanium were to be recovered from ash and flue dusts resulting from burning certain coals for power generation.

Substitutes: Less expensive silicon substitutes for germanium in certain electronic applications. Certain bimetallic compounds of tellurium, selenium, indium, and gallium 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 substitutes for germanium metal, but at the expense of performance.

*Estimated. NA Not available.

¹Does not include imports of germanium dioxide and other germanium compounds for which data are not available.

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

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

⁴See Appendix B.

⁵See Appendix C for definitions.

⁶Excludes Zaire.

GOLD

(Data in metric tons¹ of gold content, unless noted)

Domestic Production and Use: Gold was produced by about 200 lode mines, nearly all in Western States, a dozen or more large placer mines, nearly all in Alaska, and numerous small placer mines, mostly in Alaska and Western States. A small amount of domestic gold was recovered as a byproduct of processing base metals, chiefly copper. Twenty-five mines yielded 75% of the gold produced. The value of 1993 mine production was more than \$3.7 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 useful products. Nearly all jewelry manufacturing was centered in the New York, NY, and Providence, RI, areas. Estimated uses in 1993 were as follows: jewelry and arts, 70%; industrial (mainly electronic), 23%; and dental, 7%.

Salient Statistics—United States:		1989	1990	1991	1992	1993^e
Production:	Mine	266	295	296	329	330
	Refinery: Primary	184	225	225	284	260
	Secondary (incl. toll)	158	144	153	163	130
Imports ^{2 3}		153	98	179	174	NA
Exports ^{2 3}		211	296	284	369	NA
Consumption, reported		115	118	114	110	100
Demand, apparent ^{2 4}		341	244	307	280	NA
Stocks, yearend, Treasury ⁵		8,147	8,146	8,146	8,145	8,146
Price, dollars per ounce		382.58	384.93	363.29	344.97	355.00
Employment, mine and mill ^e		15,100	16,100	15,100	14,700	14,500
Net import reliance ⁶ as a percent of apparent consumption		E	E	E	E	NA

Recycling: Conversion of old scrap to refined gold provided about 70 metric tons of metal to the market, a quantity equivalent to about 70% of domestic gold consumption. The balance of secondary production was from prompt industrial scrap, partly toll refined.

Import Sources (1989-92):³ Canada, 53%; Switzerland, 11%; Bolivia, 7%; and other, 29%.

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

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

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

Events, Trends, and Issues: Domestic gold mines continued to produce at record levels, thereby maintaining the United States position as the world's second largest gold-producing nation, after the Republic of South Africa. Domestic production continued to be dominated by Nevada and California, where combined output accounted for more than 70% of the U.S. total. The trend in gold exploration activity, which apparently peaked about 1988, continued to decline in 1993 as North American exploration companies sought both unexplored territory and improved business and regulatory climates elsewhere. The principal focus of recent exploration has been on several Latin American nations where favorable geology, combined with recently liberalized mining regulations, hold the promise for greater long-term success and reduced risk to limited investment capital.

The Engelhard Industries/London daily price of gold during the first 10 months of the year fell within a range of about \$327 per troy ounce, set in March, to more than \$406, reached in early August. The August peak was the highest price seen since January 16, 1991, the opening day of the Persian Gulf War, when it was \$403 per ounce. Despite reports of generally low currency inflation, which is bearish for gold, factors reportedly contributing to the temporary run-up included reports of increased demand, especially in the Far East, and reportedly heavy speculative buying by commodity funds plus turmoil in European currency markets at the end of July. Prices during September through mid-October ranged from about \$345 to nearly \$380 per ounce.

GOLD

Environmental pollution abatement continued to be of concern to domestic gold producers, especially in Alaska, where there are many small placer mines. Provisions for reclamation of mined land is an integral part of an increasing number of gold mine plans.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁷	Reserve base ⁷
	1992	1993 ^e		
United States	329	330	4,800	5,000
Australia	240	240	2,500	2,700
Brazil	76	70	800	1,200
Canada	158	150	1,500	3,300
China ^a	140	160	NA	NA
Russia	146	140	3,100	3,400
South Africa, Republic of	614	630	18,000	29,000
Uzbekistan	80	80	2,300	2,500
Other countries	465	490	9,000	10,000
World total (may be rounded)	2,248	2,290	^b 42,000	^b 57,000

Of an estimated 114,000 tons of gold mined from historical times through 1993, about 15% is believed to have been lost, used in dissipative industrial uses, or otherwise unrecoverable or unaccounted for. Of the remaining 97,000 tons, an estimated 35,000 tons are official stocks held by central banks, and about 62,000 tons are privately held as coin, bullion, and jewelry.

World Resources: Total world resources of gold are estimated at 75,000 metric tons, of which 15% to 20% are byproduct resources. The Republic of South Africa has about one-half of 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.

^aEstimated. NA Not available. E Net exporter.

¹Metric ton (1,000 kg) = 32,150.7 troy ounces.

²Excludes gold contained in fabricated items and official monetary gold. Also excludes estimates of net imports of gold coin (in metric tons): 13.2 (1989), 8.5 (1990), 3.5 (1991), NA (1992), NA (1993).

³Excludes net bullion flow (in metric tons) to the market from foreign stocks at the New York Federal Reserve Bank: 132.2 (1989), 51.5 (1990), 61.6 (1991), 136.4 (1992), and 520.0 (estimated, 1993).

⁴Defined as refinery production from primary materials + refinery production from old scrap + net bullion flow to market from foreign stocks at the New York Federal Reserve Bank + net imports of bullion. Assumed to include some gold held for investment purposes.

⁵Includes gold in Exchange Stabilization Fund. Stocks were valued at the official price of \$42.22 per troy ounce.

⁶Defined as imports - exports + adjustments for Government and industry stock changes.

⁷See Appendix C. Definitions of reserves in some countries may not be comparable with guides presented in the appendix. Changes in the world reserves and reserve base numbers from numbers published earlier reflect adjustments for depletion and new gold discoveries.

⁸Excludes China and some other countries for which data were not available.

GRAPHITE (NATURAL)

(Data in thousand metric tons, unless noted)

Domestic Production and Use: Natural graphite was not produced domestically in 1993. Natural graphite was consumed by several hundred manufacturing firms, primarily in the Northeastern and Great Lakes regions. The main uses of natural graphite were estimated to be in refractories, 31%; brake linings, 18%; packings, 9%; lubricants, 7%; pencils, 7%; dressings and molds in foundry operations, 7%; and other, 21%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production, mine	W	—	—	—	—
Imports for consumption	62	50	34	50	52
Exports	11	12	19	20	18
Consumption, apparent	51	39	14	30	34
Price, imports (average dollars per ton at foreign ports):					
Flake	913	935	970	687	767
Lump and chip (Sri Lankan)	1,027	1,216	1,442	1,073	791
Amorphous (Mexican)	114	116	119	125	160
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine, mill, and processing plant	W	—	—	—	—
Net import reliance ¹ as a percent of apparent consumption	W	100	100	100	100

Recycling: None; however, the U.S. Bureau of Mines process to recover flake graphite from kish, a steelmaking waste, has advanced to the pilot-plant stage.

Import Sources (1989-92): Mexico, 30%; China, 25%; Canada 19%; Madagascar, 9%; Brazil, 5%; and other, 12%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN² 1/1/94
	Crystalline flake (not including flake dust)	2504.10.1000	0.7¢/kg	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—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Sri Lanka, amorphous lump	5	—	—	—
Madagascar, crystalline flake	15	(³)	15	—
Other than Sri Lanka and Madagascar crystalline	3	—	3	—

GRAPHITE (NATURAL)

Events, Trends, and Issues: Graphite was in surplus but had a somewhat improved supply-demand balance during 1993. 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. Imports of all kinds of graphite were up 4% from those of 1992. Exports were down 10%.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁴	Reserve base ⁴
	1992	1993 ⁵		
United States	—	—	—	1,000
Brazil	30	30	500	1,000
Canada	17	20	1,500	2,700
China	115	115	5,500	307,500
India	70	70	735	735
Korea, Republic of	77	80	3,150	20,000
Madagascar	14	15	980	980
Mexico	32	30	3,100	3,100
Other countries	212	220	5,535	42,985
World total ⁶	567	580	*21,000	*380,000

Resources: Domestic resources are relatively small, although the rest of the world's inferred reserve base exceeds 800 million tons of recoverable graphite. Deposits in Alabama, Alaska, New York, Pennsylvania, and Texas were not economically viable.

Substitutes: Substitute materials are more costly and/or do not perform as well as natural graphite for most applications. 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.

*Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹Defined 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.

²See Appendix B.

³Less than ½ unit.

⁴See Appendix C for definitions.

⁵Excluding U.S. production.

GYPSUM

(Data in thousand short tons, unless noted)¹

Domestic Production and Use: In 1993, output of crude gypsum was 17.0 million tons valued at \$105 million, 4% more than in 1992. Leading States were Oklahoma, Iowa, Texas, Michigan, Nevada, California, and Indiana, which together accounted for 76% of total output. Thirty-one companies mined crude gypsum at 58 mines in 19 States, and 13 companies calcined gypsum at 70 plants in 28 States. Of the total supply of crude gypsum (25.0 million tons, including 730,000 tons of byproduct gypsum), 19.8 million tons was calcined for gypsum products, and 5.8 million tons was used mainly as cement retarder or as agricultural land plaster. Calcined gypsum was sold as prefabricated product or as industrial or building plaster. Sales of gypsum for use in cement were 3.3 million tons and for agriculture and other uses, 2.5 million tons.

Available capacity of operating gypsumboard plants in the United States at yearend 1993 was 24.2 billion square feet per year. Sales of gypsumboard products were 19.7 billion square feet, which represented a capacity utilization of 81%.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Production: Crude	17,624	16,406	15,456	16,269	17,000
Byproduct	725	735	681	695	730
Calcined	17,893	17,553	15,358	16,610	16,900
Prefabricated products (million square feet)	21,899	20,000	17,565	19,208	19,700
Imports, crude, including anhydrite	9,304	8,726	7,633	7,915	7,600
Exports, crude, not ground or calcined	108	129	74	108	50
Consumption, crude, apparent ²	27,643	26,766	23,247	24,605	25,000
Price: Average crude, f.o.b. mine, dollars per ton	7.29	6.07	6.09	6.18	6.20
Average calcined, f.o.b. plant, dollars per ton	15.96	15.87	15.67	15.04	15.10
Stocks, producer, crude, yearend	3,008	1,980	2,429	2,594	2,874
Employment, mine and calcining plant	6,800	6,800	6,800	6,700	6,700
Net import reliance ³ as a percent of apparent consumption	35	36	31	31	29

Recycling: A relatively small amount of byproduct gypsum generated in flue gas desulfurization, phosphate rock acidulation, and other chemical processes is used for agricultural and wallboard purposes.

Import Sources (1989-92): Canada, 70%; Mexico, 23%; Spain, 6%; and other, 1%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁴
			1/1/94	1/1/94
Gypsum; anhydrite	2520.10.0000		Free	Free.

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

Government Stockpile: None.

GYPSUM

Events, Trends, and Issues: Sales of gypsum products increased for the second consecutive year, but the continued sluggishness in construction kept demand below the record highs of 1989. Severe price competition and low profit margins continued to plague the industry.

In 1993, the gypsum wallboard industry shipped 19.7 billion square feet, a 3% increase from the shipments of 1992. Imports of wallboard, principally from Canada, were 270 million square feet, about double the amount in 1992. Wallboard exports to 42 different countries were 93 million square feet, 41% less than the 158 million square feet exported in 1992. Stronger domestic demand caused more imports of board and fewer exports.

As long as the cost of land for solid waste disposal continues to be economical and solid waste pollution remains noncritical, only a small amount of the potentially useful byproduct gypsum scrubbed from powerplant stack gases and produced by chemical plants will be used. Several plants mix small amounts of byproduct gypsum into their wallboard products.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁵	Reserve base ⁵
	1992	1993 ^a		
United States	16,269	17,000	800,000	Large
Australia	2,205	2,300		
Canada	7,776	8,000	500,000	Large
China	12,100	12,000		
Egypt	1,300	1,300		
France	6,300	6,300		
India	1,710	1,700		
Iran	8,800	8,800		
Italy	1,325	1,400		
Japan	6,000	6,000		
Mexico	6,100	6,200		
Poland	770	800		
Spain	5,500	5,500		
Thailand	7,700	7,700		
United Kingdom	3,300	3,400		
Other countries	20,641	19,600		
World total	107,796	108,000	2,600,000	Large

Reserves and reserve base are large in major producing countries, but data are not available.

World Resources: Domestic resources are adequate, but are unevenly distributed. There are no gypsum deposits on the eastern seaboard of the United States, and large imports from Canada augment the domestic supply of crude ore in these industrial areas. Large deposits occur in the Great Lakes region, midcontinent region, California, and other States. 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 now substitutes for crude gypsum in special agricultural applications, and it is beginning to be utilized in place of crude gypsum for cement set-retarding and manufacturing wallboard.

^aEstimated.

¹See Appendix A for conversion to metric units.

²Defined as crude + byproduct + net import reliance.

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

⁴See Appendix B.

⁵See Appendix C for definitions.

HAFNIUM¹

(Data in metric tons of hafnium content, unless noted)

Domestic Production and Use: Two companies, one in Oregon and the other in Utah, produced hafnium in 1993 as a byproduct of extracting zirconium metal from zircon sand. Both metals are present in the ore and typically in a Zr to Hf ratio of 50:1. For all uses except nuclear applications, the near-identical metals can remain unseparated. However, because of extremely opposite absorption characteristics for thermal neutrons in nuclear reactor cores, the zirconium-cladded fuel rods must be hafnium free. Otherwise, the strong-absorbing hafnium would decrease the relative transparency of the zirconium cladding, and the reactor's efficiency. It is for this reason that one of hafnium's primary uses is in reactor control rods, to regulate the fission process via neutron absorption. However, the other market for hafnium, as an addition in superalloys, accounts for more of hafnium's consumption. Together, refractories and cutting tool coatings, in the respective forms of oxide and nitride, are also a sizable area of consumption.

<u>Salient Statistics—United States:</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>
Imports for consumption:					
Unwrought hafnium, waste and scrap, kilograms	5,702	9,140	2,570	2,330	2,500
Wrought hafnium, kilograms	NA	NA	NA	NA	NA
Price, sponge, dollars per kilogram, domestic ²	165-300	165-210	165-210	165-210	165-210
Net import reliance ³	NA	NA	NA	NA	NA

Recycling: Insignificant.

Import Sources (1989-92): Unwrought hafnium, waste and scrap: France, 86%; and Germany, 14%.

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Most favored nation (MFN)</u> <u>1/1/94</u>	<u>Non-MFN⁴</u> <u>1/1/94</u>
	Unwrought hafnium, waste and scrap	8112.91.2000	Free	25.0% ad val.

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

Government Stockpile: The U.S. Department of Energy maintains a consistent supply of hafnium at approximately 35 metric tons. The stockpile, which consists of oxide and various forms of metal, is maintained primarily for nuclear-powered navy vessels.

HAFNIUM

Events, Trends and Issues: Availability of hafnium continued to exceed demand, and 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 main uses. These are, in decreasing size, superalloy additions, nuclear reactor control rods, and refractories/abrasives.

World Mine Production, Reserves, and Reserve Base: World primary hafnium production statistics are not available. Hafnium occurs with zirconium in the minerals zircon and baddeleyite.

	Reserves ⁵ (thousand metric tons, HfO ₂ content)	Reserve base ⁵
United States	60	66
Australia	420	464
Brazil	18	20
India	26	29
South Africa, Republic of	<u>250</u>	<u>275</u>
World total (rounded)	780	850

World Resources: Resources of hafnium in the United States are estimated to be about 130,000 tons, available in the 13-million-ton domestic resources of zircon. World resources of hafnium are associated with those of zircon and baddeleyite and exceed 1 million tons.

Substitutes: Silver-cadmium-indium control rods are used in place of hafnium at numerous nuclear power plants. Zirconium can be used interchangeably with hafnium in certain superalloys; in others, only hafnium produces the desired or required grain boundary refinement.

*Estimated. NA Not available.

¹See also Zirconium.

²Price range from American Metal Market.

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

⁴See Appendix B.

⁵See Appendix C for definitions.

HELIUM

(Data in million cubic meters of contained helium gas)¹

Domestic Production and Use: During 1993, the estimated value of Grade-A (99.995% or better) helium extracted at the U.S. Bureau of Mines Exell Helium Plant was \$16 million; the estimated value of Grade-A helium extracted by private industry was \$169 million. The total sales value for domestic consumption and exports was \$185 million. Eleven private industry plants and one Bureau facility extracted helium from natural gas: five of the privately owned plants were in Kansas, four in Texas, one each in Colorado and Wyoming. The Grade-A helium produced was consumed principally in Western and Gulf Coast States. The estimated 1993 domestic consumption of 64.4 million cubic meters (2.32 billion cubic feet) was used primarily for cryogenic applications, 31%; for welding cover gas, 20%; for pressurizing and purging, 15%; for lifting gas, 8%; for controlled atmospheres, 6%; and other, 20%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Helium extracted from natural gas ²	66.3	64.6	86.4	92.0	96.7
Withdrawn from storage ³	13.6	20.2	1.7	2.4	(3.6)
Grade-A helium sales	79.9	84.8	88.1	94.4	93.1
Imports for consumption	—	—	—	—	—
Exports ⁴	22.1	24.7	27.1	30.7	28.7
Consumption, apparent ³	57.8	60.1	61.0	63.7	64.4
Employment, plant ⁵	570	590	600	600	615
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. Bureau facilities in 1993. The Bureau's price for bulk liquid helium was \$2.380 per cubic meter measured as gas (\$66 per thousand cubic feet) until October 1, 1993, when the price was raised to \$2.524 per cubic meter (\$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 (1989-92): None.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁶
			1/1/94	1/1/94
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 U.S. Bureau of Mines stockpile is a separate operation run pursuant to Public Law 86-777. During 1993, the Bureau accepted 28.6 million cubic meters (1,031 million cubic feet) of private helium for storage and redelivered 17.0 million cubic meters (613 million cubic feet) for a net increase in privately owned storage of 11.6 million cubic meters (418 million cubic feet). On September 30, 1993, 949 million cubic meters (34.2 billion cubic feet) of helium was in storage, of which 63 million cubic meters (2.3 billion cubic feet) was owned by private firms.

Events, Trends, and Issues: Helium reserves for most countries were changed to reflect better and/or new information on reserves. Private industry continues building a helium purification plant near Moab, Utah. New crude helium plants near Satanta, Kansas; Dumas, Texas; and Masterson, Texas; began production in 1993.

It is estimated that in 1994 domestic production of helium will be 100.0 million cubic meters (3.6 billion cubic feet), and that U.S. apparent consumption will be 65.0 million cubic meters (2.3 billion cubic feet).

HELIUM

World Production, Reserves, and Reserve Base:

	Production		Reserves ⁷	Reserve base ^{7,8}
	1992	1993 ⁹		
United States	94.4	100.0	8,182	12,759
Algeria	NA	NA	NA	2,108
Canada	NA	NA	NA	2,080
China	NA	NA	NA	1,054
Netherlands	NA	NA	NA	721
Poland	1.4	1.4	NA	832
U.S.S.R. ⁹	4.2	4.2	NA	9,153
Other countries	NA	NA	NA	2,080
World total (rounded)	100.0	105.6	NA	30,787

World Resources: The identified helium resources of the United States were estimated to be 12.8 billion cubic meters (460 billion cubic feet) as of January 1, 1993. This includes 0.9 billion cubic meters (34 billion cubic feet) of helium stored in the Cliffside Field, 6.7 billion cubic meters (242 billion cubic feet) of helium in helium-rich natural gas (0.30% helium or more), and 5.1 billion cubic meters (184 billion cubic feet) in helium-lean natural gas (less than 0.30% helium). It is postulated that, by the end of the century, most of the helium-rich natural gasfields currently supplying helium will be exhausted except for the Hugoton and Riley Ridge Fields. These currently depleting gasfields contain an estimated 4.2 billion cubic meters (150 billion cubic feet) of helium. The remaining 2.6 billion cubic meters (92 billion cubic feet) of helium-rich gas resources is nondepleting. Riley Ridge contains 3.4 billion cubic meters (121 billion cubic feet) of helium of which 2.0 billion cubic meters (72 billion cubic feet) is now 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 helium-lean resources. The identified helium-lean resources of 5.1 billion cubic meters (184 billion cubic feet) include 1.2 billion cubic meters (43 billion cubic feet) of measured and 3.9 billion cubic meters (141 billion cubic feet) of indicated helium resources.

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 U.S.S.R., 9.2; Algeria, 2.1; Canada, 2.1; China, 1.1; Poland, 0.8; and the Netherlands, 0.7. An international consortium is currently building a plant in Algeria that will recover about 8.3 million cubic meters of helium per year. As of January 1, 1993, the U.S. Bureau of Mines had analyzed 19,500 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.

*Estimated. E Net exporter. NA Not available.

¹Measured 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.

²Helium content of both Grade-A and crude helium (consisting of approximately 70% helium and 30% nitrogen).

³Extracted from natural gas in prior years (injected in parentheses).

⁴Grade-A helium.

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

⁶See Appendix B.

⁷See Appendix C for definitions.

⁸All domestic measured and indicated helium resources in the United States.

⁹As constituted before Dec. 1991.

ILMENITE¹(Data in thousand metric tons of contained TiO₂, unless noted)

Domestic Production and Use: Two firms produced ilmenite concentrate from three heavy-mineral sands operations in Florida, and one firm produced ilmenite in California as a byproduct of sand and gravel production. Based on average prices, the value of reported U.S. ilmenite and titanium slag consumption in 1993 was about \$185 million. Major coproducts of ilmenite from sand deposits are zircon and rutile. Ilmenite and titanium slag were consumed by five companies. Five titanium pigment producers used 99% of the ilmenite and titanium slag consumed. The rest was used in welding-rod coatings and for manufacturing alloys, carbide, and chemicals.

Salient Statistics—United States:

	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>
Production	W	W	W	W	W
Imports for consumption ²	543	505	462	615	571
Exports ³	8	8	12	16	11
Consumption: ² Reported	755	760	751	882	910
Apparent	W	W	W	W	W
Price, dollars per metric ton:					
Ilmenite:					
Bulk, 54% TiO ₂ , f.o.b. Australian ports	70	73	72	65	64
Slag: ⁴					
80% TiO ₂ , f.o.b. Sorel, Quebec	270	280	293	276	274
85% TiO ₂ , f.o.b. Richards Bay, Republic of South Africa	288	298	293	322	322
Stocks, mine, distributor and consumer, yearend ²	216	265	218	254	220
Employment, mine and mill ³	396	405	395	400	381
Net import reliance ⁴ as a percent of apparent consumption	W	W	W	W	W

Recycling: None.**Import Sources (1989-92):** Republic of South Africa, 53%; Australia, 29%; Canada, 13%; and other, 5%.

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Most favored nation (MFN)</u> <u>1/1/94</u>	<u>Non-MFN⁵</u> <u>1/1/94</u>
	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.

ILMENITE

Events, Trends, and Issues: In 1993, U.S. mine production of ilmenite was about the same as that of 1992. Total imports of ilmenite plus slag decreased by about 7%. Imports increased from India, Norway, and Sierra Leone, while imports from Australia, Canada, and South Africa decreased.

In the United States, the major domestic producer of ilmenite began operating a new mining site in Florida. Several companies considered developing deposits in Minnesota, North Carolina, and Virginia.

Environmental problems related to ilmenite include (1) land use conflicts where heavy-mineral sands deposits exist principally along the Atlantic coast and (2) the potential for water pollution from pigment-producing processes. Solutions to the latter problem include the development of economic, environmentally acceptable processes for making synthetic rutile or titanium tetrachloride from lower grade ilmenites and the development of methods to recover and recycle spent sulfuric acid as well as to neutralize and control the effluents produced. The two U.S. producers using the sulfate process treated their spent acid effluent with calcium carbonate and lime, producing a gypsum byproduct.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁶	Reserve base ⁶
	1992	1993 [*]		
United States	W	W	7,800	33,300
Australia	850	850	24,000	66,000
Brazil	39	40	1,600	1,600
Canada (slag production)	602	600	27,000	73,000
China	75	75	30,000	41,000
Egypt	—	—	—	1,400
Finland	—	—	1,400	1,400
India	162	160	31,000	31,000
Italy	—	—	—	9,000
Madagascar	—	—	—	15,000
Malaysia	186	190	—	1,000
Norway (both ilmenite and slag)	323	300	32,000	90,000
South Africa, Republic of (slag)	751	800	36,000	45,000
Sri Lanka	32	35	3,600	3,800
U.S.S.R. ⁷	175	150	5,900	13,000
Other countries	38	50	3,300	3,300
World total (rounded)	⁸ 3,200	⁸ 3,300	200,000	430,000

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, the Republic of South Africa, the former U.S.S.R., and the United States.

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

*Estimated. W Withheld to avoid disclosing company proprietary data.

¹See also Rutile and Titanium and Titanium Dioxide.

²Includes titanium slag from Canada, Norway, and the Republic of South Africa and leucogene from Australia.

³Includes operating employees shown under Rutile, subject to the same footnoted comments.

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

⁵See Appendix B.

⁶See Appendix C for definitions.

⁷As constituted before Dec. 1991.

⁸Excludes U.S. production.

INDIUM

(Data in metric tons, unless noted)

Domestic Production and Use: Domestic indium production was derived from the upgrading of imported indium. Two companies, one each in New York and Rhode Island, were the major producers of indium metal and indium products in 1993. Several firms produced high-purity indium shapes, alloys, and compounds. Estimated uses in 1993 were coatings, 45%; solders and alloys, 35%; electrical components and semiconductors, 15%; and research and other, 5%. The estimated value of primary metal consumed in 1993, based on the average price, was \$6.3 million.

<u>Salient Statistics—United States:</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>
Production, refinery	NA	NA	NA	NA	NA
Imports for consumption	26.8	30.2	36.3	54.4	75.0
Exports	NA	NA	NA	NA	NA
Consumption*	28.0	30.0	30.0	30.0	35.0
Price, average annual, dollars per kilogram (99.97% indium)	275.00	230.00	218.00	200.00	180.00
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment	NA	NA	NA	NA	NA
Net import reliance ¹ as a percent of apparent consumption	NA	NA	NA	NA	NA

Recycling: Insignificant.

Import Sources (1989-92): Canada, 38%; France, 18%; Belgium, 13%; United Kingdom, 12%; and other, 19%.

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Most favored nation (MFN) 1/1/94</u>	<u>Non-MFN² 1/1/94</u>
Unwrought, waste and scrap		8112.91.3000	Free	25% ad. val.

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

Government Stockpile:

Stockpile Status—9-30-93

<u>Material</u>	<u>Uncommitted inventory</u>	<u>Committed inventory</u>	<u>Authorized for disposal</u>	<u>Disposals Jan.-Sept. 93</u>
Indium	0.8	—	—	—

Events, Trends, and Issues: Domestic production consisted of the upgrading of standard grade indium into high-purity (99.999% and above) metal. U.S. demand was met through imports, which reached a record high in 1993. Canada was the largest source, owing to the joint venture agreement between the major U.S. indium refiner and a Canadian base metals producer. The companies announced their refinery production capacity will be increased 30 tons per year, although actual production will be adjusted to market conditions.

The largest use for indium was in thin-film coatings, which were used in applications such as liquid crystal displays, infrared reflecting window coatings, defrosters for windows on commercial refrigeration units and aircraft windshields, and in electroluminescent lamps. Other significant uses were for low-melting point solders and alloys, and semiconductor applications.

INDIUM

Indium use as a substitute for mercury in alkaline batteries grew in 1993. Indium and other base metal alloys are used to inhibit the formation of hydrogen gas in the battery canister. Domestic battery manufacturers expect to eliminate mercury from alkaline batteries by early 1994.

The Defense Logistics Agency received its first shipment of indium for the National Defense Stockpile in 1993, although the metal was purchased in 1992. The goal for indium has been revised from 41,990 kilograms to 7,740 kilograms. No indium was purchased in 1993.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production ^e		Reserves ³	Reserve base ³
	1992	1993		
United States	NA	NA	300	600
Belgium	15	15	(⁴)	(⁴)
Canada	40	45	700	2,000
China	10	10	400	1,000
France	30	30	(⁴)	(⁴)
Italy	10	15	(⁴)	(⁴)
Japan	30	25	100	150
Peru	2	2	100	150
Russia	1	1	200	300
Other countries	2	2	800	1,500
World total	^b 140	^b 145	2,600	5,700

World Resources: Indium occurs predominantly in solid solution in sphalerite, an ore of zinc. Significant quantities of indium also are contained in ores of copper, lead, and tin, but many deposits are either subeconomic or information does not exist to formulate reliable estimates. Indium is recovered almost exclusively as a byproduct of zinc. Estimates of the average indium content of the Earth's crust are approximately 0.05 to 0.2 parts per million. The average indium content of zinc deposits ranges from less than 1 to 100 parts per million. The highest known concentrations of indium occur in vein, replacement, and contact metasomatic sulfide deposits, usually associated with tin-bearing minerals. However, these types of deposits are often difficult to process economically.

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

*Estimated. NA Not available.

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

²See Appendix B.

³Estimates, based on the indium content of zinc ores. See Appendix C for definitions.

⁴Reserves for European countries are included in "Other."

⁵Excludes U.S. production.

IODINE

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

Domestic Production and Use: Iodine produced in 1993 from companies operating in Oklahoma accounted for 100% of the elemental iodine value estimated at \$20 million. The large 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 closed its operation north of Woodward because of the low price of iodine. A third company expanded production at Vici, OK, and exported iodine to Germany. Of the 32 consumers that participate in the annual survey, 29 plants reported consumption of iodine in 1992. Major consumers were located in the East. Prices of crude iodine published in October 1993 ranged between \$9 and \$9.50 per kilogram. Imports of iodine through August averaged \$8 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 as animal feed supplements, catalysts, inks and colorants, pharmaceuticals, photographic equipment, sanitary and industrial disinfectants, stabilizers, and other uses.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production	1,508	1,973	1,999	1,995	1,900
Imports for consumption, crude content	3,300	3,200	3,600	3,700	3,700
Exports	NA	2,100	1,300	1,800	1,700
Shipments from Government stockpile excesses	200	252	36	115	—
Consumption:					
Apparent	3,000	3,300	4,100	4,000	3,900
Reported	2,900	3,100	3,200	3,400	NA
Price, average c.i.f. value, dollars per kilogram, crude	19.50	13.78	10.16	9.03	8.17
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, processing plant	30	50	50	50	35
Net import reliance ¹ as a percent of apparent consumption	84	56	52	50	51

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

Import Sources (1989-92): Japan, 68%; Chile, 31%; and other, 1%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN² 1/1/94
	Iodine, crude	2801.20.0000	Free	Free.
	Iodide, calcium and cuprous	2827.60.1000	Free	25% ad val.
	Iodide, potassium	2827.60.2000	2.8% ad val.	7.5% ad val.

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

Government Stockpile:

Stockpile Status—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Stockpile-grade iodine	2,632	507	2,623	—

IODINE

Events, Trends, and Issues: Japan continued to be the largest producer of iodine in the world; Chile was the second largest producer. Several international companies continued joint ventures in Chile to produce iodine from ore and tailings.

Fluoriodocarbons were investigated as halon replacements. Much research is needed before approval is acquired.

A large company in Chile offered shares to finance capital investment in iodine and nitrate projects.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ³	Reserve base ³
	1992	1993 ^e		
United States	1,995	1,900	550,000	550,000
Chile	5,600	6,300	900,000	1,200,000
China	500	500	400,000	400,000
Indonesia	35	35	100,000	100,000
Japan	7,500	7,300	4,000,000	7,000,000
U.S.S.R. ⁴	1,500	1,500	400,000	—
World total (rounded)	15,400	15,400	6,400,000	9,700,000

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.

^eEstimated. NA Not available.

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

²See Appendix B.

³See Appendix C for definitions.

⁴As constituted before Dec. 1991.

IRON ORE¹(Data in million metric tons of usable ore,² unless noted)

Domestic Production and Use: Value of usable ore shipped from mines in Minnesota, Michigan, and six other States in 1993 was estimated at \$1.7 billion. Iron ore was produced by 19 companies operating 20 mines, 16 concentration plants, and 10 pelletizing plants. The mines included 19 open pits and 1 underground operation. Virtually all ore was concentrated before shipment. Nine mines operated by six companies accounted for the vast majority of the output.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production, usable	59.0	56.4	56.8	55.6	55.2
Shipments	58.3	57.0	56.7	55.6	53.8
Imports for consumption	19.6	18.1	13.3	12.5	11.6
Exports	5.4	3.2	4.0	5.1	4.2
Consumption: Reported (ore and total agglomerate) ³	80.4	76.9	66.4	75.1	76.5
Apparent	75.0	71.4	63.7	65.8	63.4
Price (Oct.), Lake Superior pellets, cents per ton of Fe ⁴	58.0-74.0	58.0-74.0	72.5-74.0	72.5-74.0	72.5-74.0
Stocks, mine, dock, and consuming plant, yearend, excluding byproduct ore	21.7	21.6	24.0	21.3	20.5
Employment, mine, concentrating and pelletizing plant, quarterly average	7,700	7,600	7,800	8,000	7,800
Net import reliance ⁵ as a percent of apparent consumption (iron in ore)	22	21	11	12	12

Recycling: Insignificant.

Import Sources (1989-92): Canada, 52%; Brazil, 24%; Venezuela, 19%; Mauritania, 4%; and other, 1%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁶
			1/1/94	1/1/94
	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: 12.0% (Domestic), 11.2% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: Domestic production of iron ore remained at about the same level as that of 1992, despite a labor action that idled four plants through August and much of September. Although crude steel production rose slightly, nearly two-thirds of the increase was accounted for by higher electric arc furnace production. Minimills continued to capture market share from the integrated producers.

Two iron ore producers in Minnesota were involved in obtaining permits to build direct reduced iron plants that would use the FASTMET process. A domestic steelmaker, in conjunction with other companies, proposed a project to construct a COREX plant. The proposed plant was selected by the U.S. Department of Energy for possible future funding.

An increasing number of North American steelworks were using fluxed pellets. This more easily reducible type of pellet, which was developed in the late 1960's, is created by adding limestone and/or dolomite to the iron ore concentrate during the balling stage. Fluxed pellets accounted for 43% of total U.S. production in 1992, and that percentage was expected to increase in 1993. Environmental concerns continued to include reclamation of process water and solid waste, reduction of dust and noise, and control of groundshock from blasting. Technological research focused on improving the quality of fluxed pellets, direct ironmaking, scaling up of the iron carbide process, substitution of organic binders for bentonite, and reduction of fuel costs.

IRON ORE

Cold-bond pelletization was being explored as a replacement for sintering of waste oxides from ironmaking and steelmaking. A revolutionary direct-steelmaking pilot plant completed its second year of operation. The long-range project is being funded by the American Iron and Steel Institute and the U.S. Department of Energy.

World Mine Production, Reserves, and Reserve Base:⁷

	Mine production		Crude ore		Iron content	
	1992	1993 ^a	Reserves	Reserve base	Reserves	Reserve base
United States	55.6	55.2	16,100	25,000	3,800	6,000
Australia	117.2	120.0	16,000	28,000	10,200	18,000
Brazil	146.0	148.0	11,100	17,000	6,500	10,000
Canada	34.1	35.0	11,900	26,000	4,600	10,000
China ^a	194.0	200.0	9,000	9,000	3,500	3,500
France	5.7	5.0	2,200	2,200	900	900
India	54.0	55.0	5,400	12,000	3,300	6,300
Liberia	1.7	2.0	900	1,600	500	800
Mauritania	10.3	10.3	400	700	200	300
South Africa, Republic of	28.2	29.0	4,000	9,300	2,500	5,900
Sweden	19.3	20.0	3,000	4,600	1,600	2,400
U.S.S.R. ^a	200.0	200.0	63,700	78,000	23,500	29,000
Other countries	63.7	59.7	7,400	16,000	2,300	6,300
World total (may be rounded)	929.8	940.0	150,000	230,000	65,000	100,000

World Resources: World resources are estimated to exceed 800 billion metric tons of crude ore containing more than 230 billion tons of iron. U.S. resources are estimated to be about 110 billion metric 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.

^aEstimated.

¹See also Iron and Steel Scrap.

²Agglomerates, concentrates, direct-shipping ore, and byproduct ore for consumption.

³Includes weight of lime, flue dust, and other additives used in producing sinter for blast furnaces. Consumption data are not entirely comparable to those of 1987 and earlier years owing to changes in data collection.

⁴Delivered rail of vessel at lower lake ports.

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

⁶See Appendix B.

⁷See Appendix C for definitions.

⁸As constituted before Dec. 1991.

IRON AND STEEL¹

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

Domestic Production and Use: The iron and steel industry and ferrous foundries produced goods valued at about \$55 billion. The steel industry consisted of 81 companies that produced raw steel at 118 locations, with combined raw steel production capability of 101 million tons. Indiana accounted for about 23% of total raw steel production, followed by Ohio, 17%, and Pennsylvania, 9%. Pig iron was produced by 15 companies operating integrated steel mills, with approximately 58 blast furnaces, of which 41 or 42 were in continuous operation. Integrated companies accounted for about 67% 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, 26%; transportation (predominantly for automotive production), 16%; construction, 15%; cans and containers, 5%; and other, 38%. Ferrous foundries, numbering about 1,000, were importers of pig iron into the United States, mainly from Brazil.

Salient Statistics—United States:¹	1989	1990	1991	1992	1993[*]
Pig iron production ²	50.7	49.7	44.1	47.4	48.0
Steel production:	88.9	89.7	79.7	84.3	87.0
Basic oxygen furnaces, percent	59.6	59.1	60.0	62.0	62.0
Electric arc furnaces, percent	35.9	37.3	38.4	38.0	38.0
Open hearth furnaces, percent	4.5	3.5	1.6	—	—
Continuously cast steel, percent	64.8	67.4	75.8	79.3	85.0
Shipments:					
Steel mill products	76.3	77.1	71.5	74.6	78.0
Steel castings	1.1	1.1	0.9	0.9	0.9
Iron castings	8.4	7.8	6.9	7.3	7.5
Imports of steel mill products	15.7	15.6	14.3	15.5	14.5
Exports of steel mill products	4.2	3.9	5.8	3.9	3.5
Apparent steel consumption ³	87.5	89.0	80.8	86.2	88.7
Producer price index for steel mill products (1982 = 100) ⁴	114.5	112.1	109.5	106.4	108.0
Steel mill product stocks at service centers, yearend ⁵	6.2	6.0	5.4	5.3	5.6
Total employment, average ⁶					
Blast furnaces and steel mills	210,000	209,000	199,000	187,000	175,000
Iron and steel foundries	137,000	132,000	126,000	120,000	120,000
Net import reliance ⁷ as a percent of apparent consumption	13	13	12	13	12

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

Import Sources (1989-92): European Community (EC), 30%; Canada, 19%; Japan, 18%; Brazil, 9%; Republic of Korea, 8%; and other, 16%.

Tariff:⁸	Item	Number	Most favored nation (MFN)⁹	Canada	Non-MFN¹⁰
			1/1/94	1/1/94	1/1/94
Pig iron		7201.10.0000	Free	Free	\$1.11/t.
Carbon steel:					
Semifinished		7207.12.0050	4.2%	1.6%	20%.
Structural shapes		7216.33.0090	0.9%	0.3%	2%.
Bars, hot-rolled		7213.20.0000	1.9%	0.7%	5.5%.
Line pipe		7305.11.1060	1.9%	0.7%	5.5%.
Tinplate		7210.12.0000	3.5%	1.4%	6%.
Sheets, hot-rolled		7208.24.5030	4.9%	1.9%	20%.
Hot-rolled, pickled		7208.24.1000	5.1%	2%	0.4¢/kg + 20%.
Cold-rolled		7209.22.0000	5.1%	2%	0.4¢/kg + 20%.
Galvanized		7210.49.0090	6.5%	2.6%	21.5%.
Stainless steel:					
Semifinished		7218.90.0015	5.2%	2%	29%.
Bars, cold-finished		7222.20.0075	10.6%	4.2%	29%.
Pipe and tube		7304.41.0045	11.6%	11.3%	36%.
Cold-rolled sheets		7219.33.0030	10.1%	4%	29%.

IRON AND STEEL

Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: Steel production and shipments in the United States increased during 1993, but profitability remained an elusive goal for the major steel companies. Persistently low prices continued during the first half of 1993, but, during the second half, prices were somewhat higher, reducing the losses. Overall, results were mixed, with some companies recording small profits and others continuing in the red.

On March 31, 1992, Voluntary Restraint Agreements restricting the level of steel imports to the United States expired, following which a number of domestic steel companies filed antidumping and countervailing duty cases charging injury to the U.S. steel industry as a result of unfairly priced or subsidized steel imports. Late in 1992, preliminary findings by the U.S. International Trade Commission (ITC) supported the charges of injury, and provisional duties were imposed on the steel products under investigation. On July 27, 1993, however, the ITC issued its final decision, largely supporting the charges of injury in cases related to corrosion-resistant (galvanized) products and hot-rolled plate. The ITC found no injury in the cases related to hot-rolled sheet, the largest import market, and no injury in most of the cases related to cold-rolled sheet, the second most important import market. The provisional duties were removed from the products for which no injury was found. To some extent, the provisional duties were a deterrent to imports during the first half of 1993.

World Production:

	Pig iron		Raw steel	
	1992	1993 ^a	1992	1993 ^a
United States	47.4	48.0	84.3	87.0
Brazil	23.2	23.0	24.0	25.0
China	73.0	82.0	80.0	90.0
European Community (EC)	79.1	76.0	132.3	130.0
Japan	73.1	75.0	98.1	103.0
Korea, Republic of	19.3	22.0	28.1	33.0
Russia	44.0	40.0	67.0	60.0
Ukraine	35.3	30.0	42.0	36.0
Other countries	103.2	100.0	165.5	164.0
World total	497.6	496.0	721.3	728.0

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.

^aEstimated.

¹Production and shipments data source is the American Iron and Steel Institute (AISI); see also Iron Ore and Iron and Steel Scrap.

²More than 95% of iron made is transported molten to steelmaking furnaces located at the same site.

³Defined as steel shipments + imports - exports + adjustments for industry stock changes.

⁴Bureau of Labor Statistics.

⁵Steel Service Center Institute.

⁶Bureau of Labor Statistics. Blast furnaces and steel mills: SIC 3312; Iron and steel foundries: SIC 322.

⁷Defined as imports - exports + adjustments for Government and industry stock changes.

⁸All tariff percentages are ad valorem.

⁹No tariff for Israel and certain Caribbean and Andean nations.

¹⁰See Appendix B.

¹¹No tariff for use in civil aircraft.

IRON AND STEEL SCRAP¹

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

Domestic Production and Use: Total value of 1993 domestic purchases (receipts of ferrous scrap by all domestic consumers from brokers, dealers, and other outside sources) and exports was estimated at \$6.5 billion, up 29% compared with \$5.0 billion in 1992. The steel industry accounted for about three-fourths of the domestic scrap consumption, 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:	1989	1990	1991	1992	1993*
Production: Home scrap	23.0	25.3	21.7	22.0	23.0
Purchased scrap ²	51.9	54.7	48.7	49.6	52.4
Imports for consumption ³	1.1	1.5	1.2	1.4	1.6
Exports ³	11.3	11.7	9.5	9.4	10.6
Consumption: Reported	65.5	70.5	62.9	65.3	68.0
Apparent	64.6	69.5	62.4	64.0	66.7
Price, average, dollars per metric ton ⁴ delivered: No. 1 Heavy Melting composite price, Iron Age Average:					
Pittsburgh, Philadelphia, Chicago	105.96	105.68	91.74	83.88	106.09
Stocks, consumer, yearend	4.2	4.4	4.1	3.7	3.4
Employment, dealers, brokers, processors	109,700	109,300	108,800	107,300	106,200
Net import reliance ⁵ as a percent of apparent consumption	E	E	E	E	E

Recycling: All iron and steel scrap is recycled material, consisting of about 35% home scrap, 25% prompt industrial scrap, and 40% old (obsolete) scrap.

Import Sources (1989-92): Canada, 80%; Venezuela, 6%; Japan, 6%; Mexico, 5%; and other 3%.

Tariff:	Item	Number	Most favored nation (MFN) <u>1/1/94</u>	Non-MFN⁶ <u>1/1/94</u>
Iron and steel waste and scrap:				
	No. 1 bundles	7204.41.0020	Free	74¢/mt.
	No. 1 Heavy Melting	7204.49.0020	Free	74¢/mt.
	No. 2 Heavy Melting	7204.49.0040	Free	74¢/mt.
	Shredded	7204.49.0070	Free	74¢/mt.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: Through August 1993, raw steel production was 58.0 million tons, 87.2% of productive capability, compared with 56.0 million tons, or 81.8% of productive capability, in the first 8 months of 1992. Total net shipments of steel mill products through August 1993 were 53.3 million tons compared with 50.0 million tons for the first 8 months of 1992. Total annual raw steel production for 1993 was estimated to have increased approximately 3% more than that of 1992 to about 87.0 million tons.

The domestic ferrous castings industry shipped an estimated 7.5 million tons of all types of iron castings in 1993, 3% more than the 7.3 million tons shipped in the same time period in 1992, while the estimated 950,000 tons of steel castings shipments, including investment castings, was 2% more than the 930,000 tons shipped in 1992.

Composite prices quoted by Iron Age on a gross-ton-delivered basis, converted to metric tons, for No. 1 Heavy Melting steel scrap to domestic purchasers in the first 9 months of 1993, ranged from a low of \$95.80 in January to a high of \$111.22 in July and averaged \$103.91. In the first 9 months of 1992, No. 1 scrap averaged \$83.91, ranging from a low of \$82.35 in June to a high of \$85.95 in April. The average price paid

IRON AND STEEL SCRAP

by consumers for nickel-bearing stainless steel scrap through September was 17% lower in 1993 than in 1992. For example, in the Pittsburgh, PA, area, the average price through September paid by consumers was \$640.75 per ton in 1993 compared with \$770.69 in 1992.

Exports of all grades of ferrous scrap in the first 8 months of 1993 totaled 6.62 million tons valued at \$860 million (\$129.98 per ton) compared with 5.87 million tons valued at \$703 million (\$119.71 per ton) in the first 8 months of 1992.

In May, the Steel Can Recycling Institute, Pittsburgh, PA, changed its name to the Steel Recycling Institute and expanded its mission to promote and sustain all steel recycling, including cars, appliances, and construction materials, as well as steel cans. The American Iron and Steel Institute, Washington, DC, was awarded a Silver Anvil by the Public Relations Society of America for its development of the Steel Recycling Partnership Program.

An oil company in Los Angeles, CA, announced that it needed 500 cars registered in California and manufactured between 1971 and 1979 and would pay \$700 apiece for them. The buyback project was designed to gather "real world" data on the emissions of the vehicles to determine whether this program would be cost-effective in reducing air pollution. The oil company was successful 3 years ago in getting 8,000 pre-1971 cars ("clunkers") off the road and recycling them. Development of all-recyclable autos in the United States is expected to be enhanced when a new vehicle recycling development center is inaugurated in Highland Park, MI.

A scrap-based minimill facility in Lemont, IL, converted a chapter 7 involuntary liquidation petition into a chapter 11 protection-from-creditors case in June. The company shut down its operations in November and considered selling the plant.

It is estimated that in 1994 domestic net receipts (all receipts minus shipments) of scrap plus exports will total 55 million tons and that apparent U.S. consumption will be 68 million tons.

There were at least four accidental smeltings/meltings of radioactive scrap in the United States in 1993. This continued to be an international problem as well as a domestic one. In January, the Institute of Scrap Recycling Industries Inc., Washington, DC, published "Radioactivity In The Scrap Recycling Process—Recommended Practice and Procedure." A paper entitled "Radioactivity in Metal Scrap—An International Problem" from the U.S. Nuclear Regulatory Commission, Washington, DC, was presented in November at the Second Regional Congress on Radiological and Nuclear Safety in Zacatecas, Mexico.

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

World Resources: Not applicable.

Substitutes: Approximately 1.2 million tons of direct-reduced iron, a potential substitute for iron and steel scrap, was used in the United States in 1993.

^aEstimated. E Net exporter.

¹See also Iron Ore and Iron and Steel.

²Receipts - shipments by consumers + exports - imports.

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

⁴Metric ton = 2,204.623 pounds, avoirdupois.

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

⁶See Appendix B.

IRON AND STEEL SLAG

(Data in thousand metric tons, unless otherwise noted)

Domestic Production and Use: In 1993, an estimated 22 million tons of iron and steel slags (byproducts of iron and steelmaking), valued at \$136 million, were sold or used. About 65% of this amount was iron slag with an f.o.b. value of \$111 million, and the balance was steel slag with an f.o.b. value of \$25 million. Iron-blast-furnace slags were processed at 30 facilities in 12 States; these slags consisted of air-cooled, expanded, and granulated types. Steel slags from open-hearth, basic oxygen, and electric arc furnaces were processed at 70 facilities in 25 States. About 80% of the Nation's iron and steel slags were produced in Illinois, Indiana, Kansas, Michigan, and Ohio. Iron and steel slags were used mainly as construction materials. Iron slag was typically used as road base, 50%; asphaltic concrete aggregate and other concrete products, 30%; fill, 10%; and other, 10%. Of all iron and steel slag products shipped, 83% traveled by truck, with an average marketing range of 30 miles; 4% traveled by waterway, with an average marketing range of 250 miles; and 3% traveled by rail, with an average marketing range of 175 miles. The remaining 10% was used in the plant at which it was processed.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Production, marketable	20,743	21,908	20,252	20,961	21,000
Imports for consumption	100	227	150	100	105
Exports	7	5	5	4	4
Consumption, reported	20,743	21,908	20,252	20,961	21,000
Price average value, dollars per ton, f.o.b. plant	5.77	5.78	6.60	5.80	6.20
Stocks, yearend	NA	NA	NA	NA	NA
Employment ^a	3,000	3,000	3,000	3,000	3,000
Net import reliance ¹ as a percent of reported consumption	.4	1	.7	.5	.5

Recycling: Prior to processing, some steel slag is recycled to blast furnaces, directly or as agglomerates, as a source of iron and flux materials. The exact amount recycled is not known; however, it may be as high as 80% of the steel slag generated each year. Ferrous scrap, recovered from slag during processing, is also recycled to blast and steel furnaces.

Import Sources (1989-92): Canada, 90%; Japan, 8%; and other, 2%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN² 1/1/94
	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	29.5¢/ton	73.8¢/ton.

Depletion Allowance: Not applicable.

Government Stockpile: None.

IRON AND STEEL SLAG

Events, Trends, and Issues: The amount of iron slag produced continued to decline slightly because of blast furnace closings. Early indications were that slag, sold or used, had increased by 5% to 10% depending upon the area of the country.

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

World Resources: Not applicable.

Substitutes: Crushed stone and sand and gravel are the predominant aggregate substitutes in construction materials.

*Estimated. NA Not available.

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

²See Appendix B.

KYANITE AND RELATED MINERALS

(Data in thousand metric tons, unless noted)

Domestic Production and Use: One firm in Virginia, with integrated mining and processing operations, produced all of the kyanite in the United States from hard-rock open pit mines. Synthetic mullite was produced by three companies in Georgia, Kentucky, and New York. 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.

<u>Salient Statistics—United States:</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>
Production: Mine	W	W	W	W	W
Synthetic mullite	W	W	W	W	W
Imports for consumption (andalusite)	10	18	5	6	14
Exports*	41	35	33	35	35
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption, apparent	W	W	W	W	W
Stocks, producer	NA	NA	NA	NA	NA
Employment, kyanite mine and plant*	150	150	150	150	150
Net import reliance ¹ as a percent of apparent consumption	E	E	E	E	E

Price: U.S. kyanite, 59%-62% Al_2O_3 , 35-325 Tyler mesh, raw/calcined 18-ton lots, f.o.b. plant, \$135 to \$160 per ton. Andalusite, Transvaal, Republic of South Africa, 60% Al_2O_3 , c.i.f. main European port, \$205 to \$220 per ton. Synthetic mullite, \$165 to \$1,650 per ton, depending on type and grade.

Recycling: Insignificant.

Import Sources (1989-92): Republic of South Africa, 100%.

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Most favored nation (MFN)</u> <u>1/1/94</u>	<u>Non-MFN²</u> <u>1/1/94</u>
	Kyanite, sillimanite, andalusite, and dumortierite	2508.50.0000	Free	Free.
	Mullite	2508.60.0000	4.9% ad val.	30% ad val.

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

Government Stockpile:

Stockpile Status—9-30-93

<u>Material</u>	<u>Uncommitted</u> <u>inventory</u>	<u>Committed</u> <u>inventory</u>	<u>Authorized</u> <u>for disposal</u>	<u>Disposals</u> <u>Jan.-Sept. 93</u>
Kyanite, lump	1.1	—	1.1	—

KYANITE AND RELATED MINERALS

Events, Trends, and Issues: U.S. output of kyanite was similar to that of 1992. Although U.S. iron and steelmaking was showing an increase in 1993 compared to that of previous year, fewer refractories were being required in the steelmaking process. Refractories have been the major end use for kyanite and related materials, with iron and steel being the largest user of refractories. U.S. kyanite has been active in international markets. Besides refractories, the mineral has been finding a range of applications in other products such as welding rods, catalysts, kiln furniture, whiteware, electrical insulators, etc.

World Mine Production, Reserves, and Reserve Base:

	Mine production ^a		Reserves and reserve base ³
	1992	1993	
United States	W	W	Large in the United States and the Republic of South Africa; assumed to be large in other countries.
France	50	50	
India	45	45	
South Africa, Republic of	⁴ 231	230	
Other countries	<u>14</u>	<u>15</u>	
World total ⁵	340	340	

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 at present, but some may be eventually. The characteristics of kyanite resources in the rest of the world are believed 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.

^aEstimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.

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

²See Appendix B.

³See Appendix C for definitions.

⁴Reported figure.

⁵Excludes the United States and countries for which information is not available.

LEAD

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

Domestic Production and Use: The value of recoverable mined lead in 1993, based on the average U.S. producer price, was \$275 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, a smelter in Montana, and a refinery in Nebraska. About 82% of secondary production came from 29 plants with annual capacities of 6,000 tons or more. Lead was consumed at about 200 manufacturing plants. Transportation was the major end use, with about 70% consumed in batteries, fuel tanks, solder, seals, and bearings. Electrical, electronic, and communications uses (including batteries), ammunition, TV glass, construction (including radiation shielding), and protective coatings accounted for more than 25% of consumption. The balance was used in ballast and weights, ceramics and crystal glass, tubes and containers, type metal, foil, wire, kame, and specialized chemicals.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production: Mine, lead in concentrates	420	497	477	408	390
Primary refinery:					
From domestic ore	379	386	324	284	270
From imported materials ¹	17	18	22	21	20
Secondary refinery, old scrap	842	874	830	861	880
Imports for consumption, lead in concentrates	5	11	12	5	10
Exports, lead in concentrates	57	57	88	72	80
Imports for consumption, metal, wrought and unwrought	122	97	122	198	150
Exports, metal, wrought and unwrought	34	64	102	70	50
Consumption: Reported	1,278	1,275	1,246	1,237	1,230
Apparent	1,333	1,297	1,227	1,277	1,280
Price, average, cents per pound: U.S.	39.4	46.0	33.5	35.1	32.0
London	30.6	37.1	25.3	24.5	18.0
Stocks, metal, producers, consumers, yearend	98	112	81	103	100
Employment: Mine and mill (peak)	1,800	2,100	2,300	1,700	1,500
Primary smelter, refineries	800	800	700	600	600
Secondary smelters, refineries	1,700	1,800	1,700	1,700	1,800
Net import reliance ² as a percent of apparent consumption	8	3	6	10	11

Recycling: Recovery of lead from scrap batteries was approximately 780,000 tons (784,000 tons in 1992).

Import Sources (1989-92): Lead in concentrates: Peru, 33%; Mexico, 30%; Canada, 29%; Australia, 4%; and other, 4%. Metal, wrought and unwrought: Canada, 69%; Mexico, 23%; Peru, 3%; Australia, 1%; and other, 4%. Total lead content: Canada, 68%; Mexico, 24%; Peru, 4%; Australia, 2%; and other, 2%.

Tariff:	Item	Number	Most favored nation(MFN) 1/1/94	Non-MFN³ 1/1/94
	Unwrought lead (except bullion)	7801.00.0000	3.0% ad val. ⁴	10.0% ad val.

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

Government Stockpile:

	Stockpile Status—9-30-93			
Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Lead	525	12	525	20

LEAD

Events, Trends, and Issues: The year was one of considerable decline in prices. Prices decreased rather steadily throughout the year, world lead stocks remained relatively high, and production was halted or reduced at several domestic mines and smelters. Production was unexpectedly stopped or reduced at several mines and smelters by union strikes or by the massive flooding that occurred on major rivers through much of the Midwest during the summer.

Lead-acid batteries continued to be the overwhelmingly dominant use of lead, accounting for about 80% of lead consumption. Lead-acid batteries also continued to be the Nation's most recycled commodity, with a recycling rate well over 90%. Fifteen firms operated 20 battery-breaking plants and 22 smelter-refineries. Two such plants in Ohio and Tennessee remained at least temporarily shut down, and some others curtailed operations. A new \$38-million lead-acid recycling center in Boss, MO, completed its first full year of operation and produced at full capacity.

One bill, essentially a revamping of an earlier bill introduced in 1992, was introduced in the House of Representatives. Entitled "The Lead-based Paint Hazard Abatement Trust Fund Act of 1993." The bill was intended to tax all (both primary and secondary) lead production to pay for a \$1 billion trust fund for a lead abatement project; a parallel bill was introduced in the Senate.

Government stockpile disposals of lead took place for the first time since 1975. Public Law 102-484, passed October 23, 1992, authorized these new lead (and other material) disposals. Sales commenced in March, were held once a month, and were conducted by an open bid procedure. Several types of lead, mostly in ingot form, were made available, including corroding grade, chemical grade, common desilverized grade, and common grade. Government stockpile lead was stored at 19 depots around the country, with Hammond, IN, being the leading repository, followed by Mechanicsburg, PA, and Somerville, NJ.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁵	Reserve base ⁵
	1992	1993 ^a		
United States	400	400	10,000	22,000
Australia	600	600	10,000	35,000
Canada	300	300	6,000	13,000
China	400	400	7,000	11,000
Mexico	200	200	1,000	2,000
Morocco	100	100	500	1,000
Peru	200	200	2,000	3,000
South Africa, Republic of	100	100	2,000	3,000
Sweden	100	100	500	1,000
Other countries	800	800	24,000	36,000
World total (may be rounded)	3,200	3,200	63,000	130,000

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 the Republic of South Africa. Identified subeconomic lead resources of the world are about 1.4 billion tons.

Substitutes: Substitution of plastics has reduced the use of lead in building construction, electrical cable covering, and 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.

^aEstimated.

¹Included in imports for calculating net import reliance (see footnote 2).

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

³See Appendix B.

⁴Total rate not to be less than 2.3424¢ per kilogram lead content.

⁵See Appendix C for definitions.

LIME^{1,2}(Data in thousand short tons, unless noted)³

Domestic Production and Use: In 1993, lime producers at 113 plants in 33 States sold or used 18.3 million tons of lime valued at about \$971 million, an increase of about 400 thousand tons and \$22 million from 1992. Most of this increase was accounted for by commercial producers serving the construction markets. Quicklime sales increased, and hydrate sales decreased. Ten companies, operating 28 plants, accounted for 59% of the output. Principal producing States, in decreasing order, were Ohio, Alabama, Pennsylvania, Kentucky, Texas, Missouri, and Illinois. These seven States produced 11.0 million tons or 60% of the total output. The leading individual uses for lime were in steelmaking, flue gas desulfurization, paper and pulp manufacturing, water purification, and soil stabilization.

Salient Statistics—United States:

	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993⁴</u>
Production ⁴	17,152	17,452	17,270	17,857	18,300
Imports for consumption	218	173	174	213	197
Exports	32	54	52	65	66
Consumption, apparent ⁵	17,337	17,571	17,392	18,005	18,431
Price, dollars per ton at plant, average	49.68	51.66	51.56	53.18	53.21
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and plant	5,400	5,500	5,500	5,500	5,500
Net import reliance ⁶ as a percent of apparent consumption	1	1	<1	<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 (1989-92): Canada, 85%; and Mexico, 15%.

<u>Tariff:</u>	<u>Item.</u>	<u>Number</u>	<u>Most favored nation (MFN)</u> <u>1/1/94</u>	<u>Non-MFN⁷</u> <u>1/1/94</u>
	Quicklime	2522.10.0000	Free	0.2¢/kg. ⁸
	Slaked lime	2522.20.0000	Free	0.3¢/kg. ⁸
	Hydraulic lime	2522.30.0000	Free	0.2¢/kg. ⁸

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

Government Stockpile: None.

LIME

Events, Trends, and Issues: In 1993, lime production increased slightly despite some regional shipping problems caused by the summer floods. The floods delayed barge shipments up and down the Mississippi River and its tributaries. Rail shipments were also delayed because of the closure of numerous rail bridges over the flooded rivers. While some shipments were shifted to truck transport, the normal barge and rail volumes were too large for this to be a total solution. The slight increase in commercial sales was almost entirely the result of continued improvements in the construction markets.

A new lime plant started production near Frannie, WY, in January 1993. The plant contained a 400-ton-per-day Kennedy Van Saun preheater rotary kiln and will primarily supply environmental markets in the upper Great Plains region.

The lime industry was relieved when the Administration's tax on energy (the so-called Btu tax) was dropped from Federal budget legislation in favor of a gasoline tax. Energy composes 32% to 36% of total costs in lime production, and the tax would have possibly increased industry costs by as much as 5%. Passing such an increase along to customers would have been difficult because of the lime industry's competitive nature.

World Lime Production and Limestone Reserves and Reserve Base:

	Production		Reserves and reserve base ⁹
	1992	1993 ⁸	
United States	17,857	18,300	Adequate for all countries listed.
Belgium	1,211	1,200	
Brazil	6,100	6,100	
Canada	3,178	3,200	
China	21,000	22,000	
France	3,300	3,300	
Germany	8,500	8,500	
Italy ¹⁰	3,970	3,900	
Japan (quicklime only)	9,400	8,800	
Mexico	7,170	7,200	
Poland	3,300	3,300	
Romania	2,800	2,800	
South Africa, Republic of (sales)	1,900	1,860	
U.S.S.R. ¹¹	25,400	25,000	
United Kingdom	2,800	2,800	
Other countries	23,000	22,300	
World total (may be rounded)	141,000	141,000	

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.

*Estimated. NA Not available.

¹Data are for quicklime, hydrated lime, and refractory dead-burned dolomite.

²Excludes Puerto Rico, unless noted.

³See Appendix A for conversion to metric units.

⁴Sold or used by producers.

⁵Stocks data are not available; stock changes are assumed to be zero for apparent consumption and net import reliance calculations.

⁶Defined as imports - exports + adjustments for Government and industry stock changes.

⁷See Appendix B.

⁸Rates include weight of the container.

⁹See Appendix C for definitions.

¹⁰Includes hydraulic lime.

¹¹As constituted before Dec. 1991.

LITHIUM

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

Domestic Production and Use: The United States was the largest producer and consumer of lithium minerals and compounds worldwide. The value of domestic lithium production was estimated to be about \$100 million in 1993. Two companies produced lithium compounds for domestic consumption as well as for export to other countries.

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 synthetic rubber production.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production	W	W	W	W	W
Imports for consumption	630	790	590	770	750
Exports	3,000	2,600	2,400	2,100	1,800
Consumption: Apparent	W	W	W	W	W
Estimated ¹	2,700	2,700	2,600	2,300	2,500
Price, yearend, dollars per kilogram:					
Lithium carbonate	3.81	4.03	4.21	4.32	4.42
Lithium hydroxide, monohydrate	4.83	5.11	5.37	5.53	5.75
Stocks, producer, yearend	W	W	W	W	W
Employment, mine and mill*	230	230	230	230	230
Net import reliance ² as a percent of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1989-92): Chile, 99%; and other, 1%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN³ 1/1/94
Other alkali metals		2805.19.0000	6.6% 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.

Events, Trends, and Issues: The U.S. Department of Energy (DOE) offered for sale 13.6 million kilograms of its 36 million kilogram stock of lithium hydroxide monohydrate. Bids on four lots were received from three bidders, and two lots totaling about 9,000 kilograms were awarded. The successful bids averaged \$1.43 per kilogram, with the sale totaling \$13,000. DOE intends to offer lithium hydroxide monohydrate until the entire stock has been disposed. Part of the material has been depleted of the lithium 6 isotope and may be contaminated with mercury. The DOE lithium hydroxide stocks were excess from a weapons program that used lithium to make tritium, a compound necessary for nuclear fusion reactions.

Interest continued in the development of lithium batteries. A U.S. company began marketing a AA lithium battery, the first time this size of lithium battery directly competed with the more common alkaline battery. Specialty-sized lithium batteries have been on the market for several years. Lithium batteries may prove to provide the best combination of properties desirable for powering the electric vehicles being developed by major automakers.

LITHIUM

One U.S. lithium company had been negotiating with several governments in South America concerning the development of a brine operation. The company abandoned talks in Bolivia and Chile, but was continuing its investigations in Argentina. A Chilean nitrate and iodine producer acquired the rights to produce potash from the Salar de Atacama in Chile. Lithium will be a byproduct of the potash production, and lithium carbonate production could begin by the end of the century.

Another U.S. mining company became 100% owner of the company that produces lithium ore concentrates in Canada. The mine in Manitoba produces ceramic- and glass-grade spodumene concentrates, most of which are exported to the United States. The U.S. firm bought the mine primarily to acquire tantalum reserves, although the tantalum operation has been inactive since 1984.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁴	Reserve base ⁴
	1992	1993 ⁵		
United States	W	W	344,000	408,000
Argentina ⁶	2	2	NA	NA
Australia ⁶	1,300	1,500	372,000	435,000
Bolivia	—	—	—	5,440,000
Brazil	32	32	907	NA
Canada	590	500	181,000	363,000
Chile	1,600	1,800	1,270,000	1,360,000
China ⁶	310	310	NA	NA
Namibia ⁶	24	25	NA	NA
Portugal	200	200	NA	NA
Russia	900	900	NA	NA
Zaire	—	—	—	318,000
Zimbabwe	200	250	23,000	27,000
World total (may be rounded)	⁶ 5,200	⁶ 5,500	⁷ 2,200,000	⁸ 8,400,000

World Resources: The identified lithium resources total 760,000 tons in the United States and 11.9 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.

⁵Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹Based primarily on monitoring at the concentrate stage and assuming a 15% lithium loss during conversion of concentrate into chemicals.

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

³See Appendix B.

⁴See Appendix C for definitions.

⁵These estimates denote only an approximate order of magnitude; no basis for more exact estimates is available. Output by China has never been reported.

⁶Excludes U.S. production.

⁷Excludes Argentina, China, Namibia, Portugal, and the former U.S.S.R.

⁸Excludes Argentina, Brazil, China, Namibia, Portugal, and the former U.S.S.R.

MAGNESIUM COMPOUNDS¹

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

Domestic Production and Use: Seawater and natural brines accounted for more than 65% of U.S. magnesium compounds production. Magnesium oxide and other compounds were recovered from seawater by five 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 68% of the magnesium compounds consumed in the United States was used for refractories. The remainder was consumed in agricultural, chemical, construction, and industrial applications.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production	513	499	442	427	420
Imports for consumption	171	147	156	179	200
Exports	26	59	57	49	50
Consumption, apparent	658	587	541	557	570
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, plant*	750	700	650	650	650
Net import reliance ² as a percent of apparent consumption	22	15	18	23	26

Recycling: None.

Import Sources (1989-92): China, 40%; Canada, 21%; Greece, 13%; Mexico, 9%; and other, 17%.

Tariff:³ Item	Number	Most favored nation (MFN)	Canada	Non-MFN⁴
		1/1/94	1/1/94	1/1/94
Crude magnesite	2519.10.0000	Free	Free	\$10.33/ton.
Dead-burned and fused magnesia	2519.90.1000	0.4¢/kg.	Free	1.7¢/kg.
Caustic-calcined magnesia	2519.90.2000	\$2.07/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.

MAGNESIUM COMPOUNDS

Events, Trends, and Issues: Because of the anticipated growth in the market for water treatment chemicals, a Michigan brine producer increased its magnesium hydroxide production capacity to 125,000 tons per year, which represented an increase of about 30,000 tons per year.

In Greece, two mining operations that closed in 1992 were undergoing privatization. One began producing refractory magnesia bricks from stockpiled material, although no mining was taking place. The other company that had closed because of depletion of ore reserves discovered new magnesite deposits on the island of Euboea. The firm expects that the discovery will aid in its efforts to find a buyer. As a part of Turkey's ongoing program to privatize state-run industries, the country's largest magnesite producer also was undergoing privatization.

A new magnesite mine opened in Iran early in the year, with reserves estimated at 2 million tons. The material was processed at an existing plant to produce dead-burned magnesia for use in the country's iron and steel and cement industries. In Jordan, a potash manufacturer was constructing a 1,200-ton-per-year pilot plant for magnesia production, to be completed in January 1994. Depending on the pilot-plant results, the company may build a 100,000-ton-per-year plant.

World Mine Production, Reserves, and Reserve Base:

	Magnesite production		Magnesite reserves and reserve base ⁵	
	1992	1993 ⁶	Reserves	Reserve base
United States	W	W	10,000	15,000
Australia	236	250	NA	NA
Austria	274	250	15,000	20,000
Brazil	72	70	45,000	65,000
China [*]	749	750	745,000	1,045,000
Czechoslovakia ⁶	101	100	20,000	30,000
Greece	72	100	30,000	30,000
India	159	150	30,000	45,000
Korea, North [*]	461	460	445,000	745,000
Russia [*]	317	300	650,000	725,000
Serbia and Montenegro	56	30	5,000	10,000
Spain	144	140	10,000	30,000
Turkey	461	450	65,000	160,000
Other countries	105	100	420,000	475,000
World total (may be rounded)	⁷ 3,200	⁷ 3,150	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 may be recovered.

World Resources: Resources from which magnesium compounds may 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.

^{*}Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹See also Magnesium Metal.

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

³Tariffs are based on gross weight.

⁴See Appendix B.

⁵See Appendix C for definitions.

⁶As constituted before Jan. 1993.

⁷Excludes the United States.

MAGNESIUM METAL¹

(Data in thousand metric tons, unless noted)

Domestic Production and Use: Three companies in Texas, Utah, and Washington produced primary magnesium in 1993 valued at approximately \$405 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 44% 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 20% of U.S. consumption of primary metal; desulfurization of iron and steel, 15%; reducing agent in nonferrous metals production, 9%; cathodic protection, 5%; and other uses, 7%.

Salient Statistics—United States:		1989	1990	1991	1992	1993*
Production:	Primary	152	139	131	137	145
	Secondary	51	55	51	57	57
Imports for consumption		12	27	32	12	28
Exports		57	52	55	52	42
Consumption:	Reported, primary	105	96	92	94	95
	Apparent	133	145	134	142	153
Price, yearend, dollars per pound		1.63	1.43-1.63	1.43	1.46-1.53	1.46
Stocks, producer and consumer, yearend		26	26	27	13	22
Employment*		1,800	1,750	1,650	1,450	1,400
Net import reliance ² as a percent of apparent consumption		E	E	E	E	E

Recycling: In 1993, about 31,000 tons of the secondary production was recovered from old scrap.

Import Sources (1989-92): Canada, 70%; Norway, 13%; Mexico, 6%; Russia, 3%; and other, 8%.

Tariff: Item	Number	Most favored nation (MFN)	Canada	Non-MFN³
		1/1/94	1/1/94	1/1/94
Unwrought metal	8104.11.0000	8.0% ad val.	3.2% ad val.	100% ad val.
Unwrought alloys	8104.19.0000	6.5% ad val.	2.6% ad val.	60.5% ad val.
Wrought metal	8104.90.0000	14.8¢/kg on Mg content + 3.5% ad val.	5.9¢/kg on Mg content + 1.4% ad val.	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.

MAGNESIUM METAL

Events, Trends, and Issues: After being granted most-favored-nation status in 1992, Russia became the largest U.S. import source of primary magnesium in 1993. Through August, almost 70% of the primary magnesium imported into the United States came from Russia. Press reports indicated that much of the imported magnesium was oxidized and consequently was destined for the iron and steel desulfurization market. In October, Russia was approved for Generalized System of Preferences (GSP) trade status, which means that primary magnesium will be duty free into the United States instead of being subject to a rate of 8.0%.

The largest U.S. magnesium producer announced in October that it would shut down about 30% of its production capacity in response to the oversupply of magnesium. This oversupply was caused principally by large quantities of exports from former Soviet countries, particularly Russia, that had to be absorbed in both the U.S. and European markets. This announcement was coupled with the Washington magnesium producer's decision to close two furnaces for about 3 months to perform retrofitting. Closure of this capacity was expected to bring supply situation into balance with demand.

In a final determination, the Department of Commerce found that the amended contract between the largest Canadian magnesium producer and the power company did not confer a subsidy, so the countervailing duties on pure and alloy magnesium dropped by 14%. After this reduction, total countervailing and antidumping duties on pure magnesium were 38.94% ad valorem, and these duties were 7.61% ad valorem on alloy magnesium. The Canadian producer petitioned the United States-Canada Binational Secretariat for a review of the duties, and in October, the panel affirmed most of Commerce's determinations; however, once the panel's decision was final, antidumping duties that Commerce had recalculated in May for primary magnesium became effective. After the reduction of the antidumping duty from 31.33% to 21% ad valorem, total duties on primary magnesium were 28.65% ad valorem.

Estimated transaction prices for primary magnesium trended downward through most of the year. After starting the year at \$1.18 to \$1.20 per pound, the free market price for magnesium dropped to \$0.90 to \$0.93 per pound by mid-September, before starting to increase slightly.

World Primary Production, Reserves, and Reserve Base:

	Primary production	
	1992	1993*
United States	137	145
Brazil	7	8
Canada	26	28
China*	7	7
France	12	10
Italy	3	3
Japan	8	8
Kazakhstan*	20	20
Norway	30	25
Russia*	40	35
Serbia and Montenegro	4	4
Ukraine*	10	10
World total	304	303

Reserves and reserve base⁴

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.

*Estimated. E Net exporter.

¹See also Magnesium Compounds.

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

³See Appendix B.

⁴See Appendix C for definitions.

MANGANESE

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

Domestic Production and Use: Manganese ore containing 35% or more manganese was not produced domestically in 1993. Manganese ore was consumed mainly by about 20 firms with plants principally in the Eastern and Midwestern United States. The largest portion of ore consumption was related to steel production, directly through making pig iron and indirectly through upgrading ore to ferroalloys and metal. Most of the remaining ore was used 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 17%, 11%, and 10%, 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 \$350 million.

Salient Statistics—United States:¹

	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>
Production, mine ²	—	—	—	—	—
Imports for consumption:					
Manganese ore	579	307	234	247	185
Ferromanganese	432	380	320	304	360
Silicomanganese ³	232	224	258	257	260
Exports:					
Manganese ore	52	70	66	13	14
Ferromanganese	8	7	15	13	20
Shipments from Government stockpile excesses: ⁴					
Manganese ore	71	132	173	425	360
Ferromanganese	(50)	(51)	(67)	(128)	(80)
Consumption, reported: ⁵					
Manganese ore	559	497	472	438	450
Ferromanganese	399	413	346	339	350
Consumption, apparent, manganese ⁶	723	630	600	596	650
Price, average value, 46%-48% Mn metallurgical ore, dollars per mtu cont. Mn, c.i.f. U.S. ports	2.76	3.78	3.72	3.25	2.55
Stocks, producer and consumer, yearend:					
Manganese ore	470	379	275	276	260
Ferromanganese	68	56	50	28	30
Net import reliance ⁷ as a percent of apparent consumption	100	100	100	100	100

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

Import Sources (1989-92): Manganese ore: Gabon, 43%; Brazil, 23%; Australia, 20%; and other, 14%. Ferromanganese: Republic of South Africa, 32%; France, 28%; Mexico, 10%; Brazil, 7%; and other, 23%. Manganese contained in all manganese imports: Republic of South Africa, 25%; France, 14%; Brazil, 12%; Australia, 12%; and other, 37%.

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Most favored nation (MFN)</u> <u>1/1/94</u>	<u>Non-MFN⁸</u> <u>1/1/94</u>
	Ore and concentrate	2602.00.0040/60	Free	2.2¢/kg of contained Mn.
	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: Inventories and disposals as tabulated may include nonstockpile-grade material. The nonstockpile-grade materials included in the uncommitted inventories are 16,400 tons of natural battery ore, 80 tons of chemical ore, and 410,000 tons of metallurgical ore. Inventories of natural battery ore, metallurgical ore, and silicomanganese were reduced significantly by ore upgrading and disposal activities administered by the Defense Logistics Agency, U.S. Department of Defense.

MANGANESE

Material	Stockpile Status—9-30-93			
	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Battery: Natural ore	139	18	139	9
Synthetic dioxide	3	—	3	—
Chemical ore	154	2	154	3
Metallurgical ore	1,422	221	1,422	44
Ferromanganese:				
High-carbon	988	1	818	35
Medium-carbon	23	3	—	—
Silicomanganese	0.2	—	—	12
Electrolytic metal	13	—	—	—

Events, Trends, and Issues: Manganese ore and ferroalloy producers continued to operate in an environment where supply capability exceeded demand by as much as 30% worldwide. The price of metallurgical ore declined for the third successive year to fall by about one-fifth. Nevertheless, mines were under development or came on-stream in Brazil, Burkina Faso, and the Philippines; China's ore output continued to increase. In Western Europe, two of the three operations regularly producing ferromanganese using blast furnaces were closed. U.S. capacity for electrolytic manganese dioxide was expanded appreciably to meet growing demand from the battery 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 is not a hazard generally.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ^a	Reserve base ^a
	1992	1993 ^b		
United States	—	—	—	—
Australia	*1,200	1,400	26,000	72,000
Brazil	*1,800	1,600	21,000	58,000
China	*3,500	4,700	14,000	29,000
Gabon	1,556	1,600	52,000	160,000
India	*1,400	1,400	17,000	25,000
Mexico	407	400	4,000	9,000
South Africa, Republic of	2,464	2,400	370,000	4,000,000
U.S.S.R. ¹⁰	*117,000	116,200	300,000	450,000
Other countries	*600	700	Small	Small
World total (rounded)	*19,900	20,400	800,000	4,800,000

World Resources: Land-based resources are large but irregularly distributed. The Republic of South Africa and the former U.S.S.R. account for more than 80% of the world's identified resources; the Republic of South Africa accounts for more than 80% of the total exclusive of China and the former U.S.S.R.

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

*Estimated.

¹Manganese content typically ranges from 35% to 54% for manganese ore and from 74% to 95% for ferromanganese.

²Excludes insignificant quantities of low-grade mangiferous ore.

³More nearly represents amount consumed than does reported consumption; internal evaluation indicates that reported consumption of silicomanganese is considerably understated.

⁴Net quantity including effect of stockpile upgrading program. Data in parentheses denote increases in inventory.

⁵Total manganese consumption cannot be approximated from consumption of manganese ore and ferromanganese because of the use of ore in making manganese ferroalloys and metal.

⁶Thousand metric tons, manganese content. Based on estimates of average content for all significant components except imports, for which content is reported.

⁷Defined as imports - exports + adjustments for Government and industry stock changes.

⁸See Appendix B.

⁹Thousand metric tons, manganese content. See Appendix C for definitions.

¹⁰As constituted before Dec. 1991.

¹¹Equals sum of the tonnages estimated for Ukraine and Georgia, 5.8 and 5.2 million for Ukraine and 1.2 and 1.0 million for Georgia in 1992 and 1993, respectively. Small tonnages estimated for Kazakhstan are included in "Other countries."

MERCURY

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

Domestic Production and Use: Mercury was produced as a byproduct at nine gold mining operations in Nevada, California, and Utah. Other gold mines in these States were believed to have recovered mercury, but data were not available to make estimates. Several companies in the Eastern and Central United States recovered mercury from worn out or obsolete items such as batteries, electrical apparatus, fluorescent lamps, instruments, and dental amalgams. Mercury also was recovered at chlorine and caustic soda plants and from U.S. Department of Energy stocks. The value of mercury used in the United States was estimated at \$3 million. It was estimated that 30% of domestic consumption was used in the production of chlorine and caustic soda, 25% in electronic and electrical applications, and the remainder for all other uses.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Production: Mine ²	414	562	58	64	70
Secondary, industrial	137	108	165	176	200
Imports for consumption	131	15	56	92	60
Exports	221	311	786	977	90
Shipments from Government stocks: ³					
National Defense Stockpile	170	52	103	267	500
U.S. Department of Energy	180	193	215	103	100
Consumption: Reported	1,212	720	554	621	550
Apparent	NA	NA	NA	NA	NA
Price, average value, dollars					
per flask, New York, dealer	287.72	249.22	122.42	201.39	190.00
Stocks, industry, yearend ⁴	217	197	313	436	400
Employment, mine and mill, average	25	21	3	NA	NA
Net import reliance ⁵ as a percent					
of apparent consumption	NA	NA	NA	NA	NA

Recycling: From 1989 to 1992, annual secondary production averaged nearly 146 metric tons, equivalent to 19% of the average reported consumption for that period.

Import Sources (1989-92): Spain, 44%; Canada, 42%; Germany, 12; and other, 2%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁸
			1/1/94	1/1/94
Mercury		2805.40.0000	16.5¢/kg	55.1¢/kg.

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

Government Stockpile: In addition to the quantities shown below, 146 metric tons of secondary mercury was held by the U.S. Department of Energy at Oak Ridge, TN, as of September 30, 1993.

Stockpile Status—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Mercury	4,752	276	4,752	284

Events, Trends, and Issues: In May 1993, the U.S. Environmental Protection Agency (EPA) ban on the land disposal of high-mercury-content waste water and sludges went into effect for all chlor-alkali producers. The regulation initially was effective in May 1992, but several chlor-alkali manufacturers received a 1-year exemption from the rule because of the lack of treatment capacity for this type of waste material. The companies have since either installed on-site mercury recovery facilities or arranged to have the waste material shipped elsewhere for reclamation and disposal.

MERCURY

Several States have enacted laws to prevent the disposal of batteries that contain mercury. The main source of mercury from batteries has been the alkaline cell, the most popular type of consumer battery. However, the manufacturers have greatly reduced the mercury content of such batteries, and it is expected that, by the end of 1993, all alkaline batteries manufactured in the United States will contain no added mercury. Manufacturers also have been reducing the mercury content of other types of batteries such as carbon-zinc, zinc-air, and mercury-zinc.

The disposal of fluorescent light tubes also has been restricted in many areas of the country. This has led to the creation of several regional companies that primarily recovery mercury from fluorescent light tubes. All the components of the lamps, the glass, mercury, metal, and phosphors, are recycled. Some of these companies have branched out to process other types of mercury-bearing waste materials.

Domestic consumption of mercury has dropped more than 60% since 1988 owing to the potential environmental problems associated with its use and disposal. Many uses for mercury have been eliminated, while others now use less mercury. This will likely be the trend in the United States, Canada, Western Europe, and Japan as greater emphasis is placed on controlling the anthropogenic release of mercury to the environment.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁷	Reserve base ⁷
	1992	1993 ^a		
United States	64	70	3,000	4,000
Algeria	425	400	2,000	3,000
China	950	900	(^b)	(^b)
Mexico	700	700	5,000	9,000
Italy	—	—	—	69,000
Russia	400	400	7,500	13,000
Spain	—	—	76,000	90,000
Ukraine	200	200	2,500	4,000
Other countries	275	255	30,000	48,000
World total (may be rounded)	3,000	2,900	130,000	240,000

World Resources: World mercury resources are estimated at nearly 600,000 metric tons, principally in Italy, Kyrgyzstan, Russia, Slovenia, Spain, and Ukraine. There are sufficient resources for much more than 100 years, 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.

^aEstimated. NA Not available.

¹1 metric ton (1,000 kilograms) = 29,0082 flasks.

²For 1989, mercury mine production only. For 1990, includes mercury recovered both as a principal product and as a byproduct of gold mining. Mercury was recovered only as a byproduct of gold mining in later years.

³Metal sold from the National Defense Stockpile as excess to goal and surplus secondary mercury released from U.S. Department of Energy stocks.

⁴Consumer and dealer stocks only.

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

⁶See Appendix B.

⁷See Appendix C for definitions.

⁸Included in "Other countries."

MICA (NATURAL), SCRAP AND FLAKE¹

(Data in thousand metric tons, unless noted)

Domestic Production and Use: Scrap and flake mica production, excluding low-quality sericite, increased about 5% in 1993. North Carolina accounted for about 60% 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 bulk of domestic production was processed into small particle-size mica by wet and dry grinding. Primary uses were joint cement, paint, roofing, oil well drilling, and rubber products. The value of 1993 scrap mica production was \$4.7 million. Ground mica sales were valued at \$22 million. There were nine domestic producers of scrap and flake mica.

Salient Statistics—United States:

	1989	1990	1991	1992	1993 ^a
Production: ^{2 3} Mine	119	109	103	85	89
Ground	101	97	75	84	87
Imports for consumption ^a	13	13	13	15	16
Exports ^a	5	5	4	4	5
Consumption, apparent ⁴	109	105	84	95	98
Price, average, dollars per ton, reported:					
Scrap and flake	53	54	54	54	54
Ground:					
Wet	680	663	640	745	750
Dry	153	151	150	168	170
Stocks, producer, yearend ^a	7	7	7	7	7
Employment, mine ^a	80	80	80	80	80
Net import reliance ⁵ as a percent of apparent consumption	7	8	11	12	11

Recycling: None.

Import Sources (1989-92): Canada, 69%; India, 27%; and other, 4%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN ⁶ 1/1/94
	Mica powder	2525.20.0000	2.4% ad val.	20% ad val.
	Mica waste	2525.30.0000	Free	8.8¢/ kg.

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

Government Stockpile: None.

MICA (NATURAL), SCRAP AND FLAKE

Events, Trends, and Issues: Production of ground mica in the United States increased for the second consecutive year after 4 years of decline. The increase is a reflection of a continued improvement in construction activity. The United States remained the major producer of scrap and flake mica in 1993. Imported mica is used primarily for making mica paper and as a filler and reinforcer in plastics.

The principal environmental impact of mica mining was the land disturbance commonly associated with surface mining.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁷	Reserve base ⁷
	1992	1993 ^e		
United States ²	85	89	Large	Large
Canada	18	18	Large	Large
India	2	2	Large	Large
Korea, Republic of	5	5	Large	Large
Russia	33	33	Large	Large
Other countries	37	38	Large	Large
World total	180	185	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.

*Estimated.

¹See also Mica (Natural), Sheet.

²Sold or used by producing companies.

³Excludes low-quality sericite used primarily for brick manufacturing.

⁴Based on ground mica.

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

⁶See Appendix B.

⁷See Appendix C for definitions.

MICA (NATURAL), SHEET¹

(Data in metric tons, unless noted)

Domestic Production and Use: A minor amount of sheet mica, estimated at less than 500 kilograms, was produced in 1993. The domestic consuming industry was dependent on imports and shipments of Government stockpile excesses to meet demand. During 1993, an estimated 1,000 metric tons of sheet mica valued at \$1.6 million was consumed by 13 companies in 7 States, mainly in the East and Midwest. Most was fabricated into parts for electronic and electrical equipment. An additional 1,450 tons of imported worked mica was also consumed.

Salient Statistics—United States:

	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>
Production, mine ^o	(²)	(²)	(²)	(²)	(²)
Imports for consumption	2,745	2,700	2,340	3,461	4,800
Exports ^o	475	760	616	606	900
Shipments from Government stockpile excesses	8	32	2	264	150
Consumption, apparent	2,244	1,933	1,778	2,249	2,450
Price, average value, dollars per kilogram, muscovite mica, reported:					
Block	80	92	85	80	80
Splittings	1.36	1.55	1.54	1.53	1.55
Stocks, fabricator and trader, yearend ^e	2,267	2,306	2,254	3,124	4,724
Employment, mine	—	—	—	—	—
Net import reliance ³ as a percent of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1989-92): India, 63%; Belgium, 21%; Brazil, 3%; China, 3%; and other, 10%.

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Most favored nation (MFN)</u> <u>1/1/94</u>	<u>Non-MFN⁴</u> <u>1/1/94</u>
	Crude mica and mica rifted into sheets or splittings	2525.10.0000	Free	Free.

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

MICA (NATURAL), SHEET

Government Stockpile:

Stockpile Status—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Block:				
Muscovite	2,258	9	1,278	23
Phlogopite	59	—	—	—
Film, muscovite	516	3	431	11
Splittings:				
Muscovite	6,386	13	699	44
Phlogopite	598	1	598	51

Events, Trends, and Issues: Demand for sheet mica remained at about the same level as that of the previous year. Imports remained the primary source of sheet mica, and shipments from Government stockpile excesses remained a minor source of supply. There were no environmental problems associated with the manufacture of mica products.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ^b	Reserve base ^b
	1992	1993 ^a		
United States	(²)	(²)	Very small	Small
India	3,500	3,500	Very large	Very large
Russia	1,750	1,750	Moderate	Large
Other countries	950	950	Moderate	Large
World total	6,200	6,200	Large	Large

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

Substitutes: Plastics, fiberglass, and ceramics can be substituted for mica in many electrical and electronic uses. Mica paper made from scrap mica can be substituted for sheet mica in electrical uses.

^aEstimated.

¹See also Mica (Natural), Scrap and Flake.

²Less than ½ unit.

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

⁴See Appendix B.

⁵See Appendix C for definitions.

MOLYBDENUM

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

Domestic Production and Use: In 1993, molybdenum, valued at about \$225 million (based on average oxide price), was produced by 10 mines. A mine in Colorado mined molybdenum ore, whereas nine mines in Arizona, California, Montana, New Mexico, and Utah recovered molybdenum as a byproduct. Two 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 other, 15%.

Salient Statistics—United States:

	1989	1990	1991	1992	1993*
Production, mine	63,105	61,611	53,361	49,725	45,400
Imports for consumption	2,823	2,823	2,603	3,167	3,000
Exports, all primary forms	53,793	43,409	36,380	36,110	34,000
Consumption: Reported	17,204	18,060	16,931	17,068	15,900
Apparent	10,362	20,742	18,514	21,361	16,300
Price, average value, dollars per kilogram ¹	8.05	7.39	5.27	4.85	4.95
Stocks, mine and plant concentrates, product producers and end-use consumers	16,229	16,179	17,302	21,881	20,000
Employment, mine and plant, molybdenum production	1,300	1,400	1,000	750	550
Net import reliance ² as a percent of apparent consumption	E	E	E	E	E

Recycling: Secondary molybdenum in the form of metal or superalloys was recovered, but the amount was small. About 1,000 metric 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 (1989-92): Canada, 37%; China, 18%; Mexico 14%; Chile, 12%; and other, 19%.

Tariff	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN ³ 1/1/94
	Molybdenum ore and concentrates, roasted	2613.10.0000	13.2¢/kg + 1.9% ad val.	\$1.10/kg + 15% ad val.
	Molybdenum ore and concentrates, other	2613.90.0000	19.8¢/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	3823.90.3400	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	13.9¢/kg + 1.9% 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	6.6% ad val.	60% ad val.
	Other	8102.99.0000	5.5% ad val.	45% ad val.

MOLYBDENUM

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

Government Stockpile: None.

Events, Trends, and Issues: U.S. mine output of molybdenum in 1993 decreased 9% compared with that of 1992. Reported consumption of molybdenum decreased about 7%; exports, by about 7%; and U.S. producer inventories, by 9% compared with those of 1992.

It is estimated that in 1994 domestic mine production of molybdenum will be 42,500 metric tons and that U.S. reported consumption will be 15,000 metric tons.

The domestic price for technical-grade molybdic oxide averaged \$4.95 per kilogram of contained molybdenum during 1993. Mine capacity utilization was 40%.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁴	Reserve base ⁴
	1992	1993	(thousand metric tons)	
United States	49,725	45,400	2,720	5,350
Bulgaria	160	200	(⁵)	10
Canada	9,540	10,000	450	910
Chile	14,500	14,500	1,130	2,450
China	16,000	16,000	500	1,220
Iran	600	600	50	140
Mexico	1,582	1,600	90	230
Peru	3,000	3,000	140	230
U.S.S.R. ⁶	15,000	15,000	450	680
Other countries	1,560	1,600	—	590
World total (may be rounded)	111,667	108,000	5,500	12,000

World Resources: Identified resources amount to about 5.5 million metric tons of molybdenum in the United States and about 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, cast irons, and nonferrous metals. 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.

⁰Estimated. E Net exporter.

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

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

³See Appendix B.

⁴See Appendix C for definitions.

⁵Less than ½ unit.

⁶As constituted before Dec. 1991.

NICKEL

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

Domestic Production and Use: Ferronickel was produced by a smelter near Riddle, OR. On a monthly or annual basis, 200 facilities reported nickel consumption. The principal consuming State was Pennsylvania, followed by New Jersey and West Virginia. Approximately 42% of the primary nickel consumed went into stainless and alloy steel production, 36% into nonferrous alloys and superalloys, 18% into electroplating, and 4% into other uses. Ultimate end uses were as follows: transportation, 30%; chemical industry, 15%; electrical equipment, 10%; construction, 9%; fabricated metal products, 8%; household appliances, 7%; machinery, 7%; petroleum, 7%; and other, 7%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production: Mine	—	330	5,523	6,671	2,464
Plant	347	3,701	7,065	8,962	4,878
Imports: ¹ Ore	—	—	371	3,584	2,966
Primary	127,880	133,545	132,446	118,760	123,000
Secondary	9,137	11,634	6,212	9,506	6,870
Exports: ² Primary	4,242	8,873	9,104	8,560	7,510
Secondary	27,218	28,184	27,798	25,307	25,700
Consumption: Reported, primary	99,835	112,876	102,636	95,557	95,600
Reported, secondary	42,565	46,079	40,304	51,139	49,100
Apparent, primary	125,503	127,358	125,195	119,257	122,000
Apparent, secondary	23,285	31,632	18,486	35,274	30,000
Price, average annual, London Metal Exchange					
Cash, dollars per metric ton	13,308	8,864	8,156	7,001	5,130
Cash, dollars per pound	6.036	4.021	3.699	3.176	2.330
Stocks: Government, yearend	33,760	33,760	33,760	33,760	32,500
Consumer, yearend	15,403	12,576	14,291	15,913	16,800
Producer, yearend ³	6,326	8,065	11,794	10,140	9,430
Employment, yearend: Mine	—	12	8	10	2
Smelter	245	300	277	250	33
Port facility ⁴	—	—	—	23	5
Net import reliance ⁵ as a percent of apparent consumption	71	69	67	61	64

Recycling: About 49,000 tons of nickel was recovered from purchased scrap in 1993. This represented about 32% of apparent consumption for the year.

Import Sources (1989-92): Canada, 54%; Norway, 16%; Australia, 8%; Dominican Republic, 6%; and other, 16%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁶
			1/1/94	1/1/94
	Nickel ore and concentrates	2604.00.0000	Free	Free.
	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	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—9-30-93**

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Nickel	32,543	57	32,543	1,229

Events, Trends, and Issues: Domestic consumption of primary nickel continued to be weak because of the prolonged recession, but was running slightly ahead of the year-to-date total for 1992. Superalloy producers were especially hard hit by cutbacks in aircraft manufacturing, reduced defense spending, and the financial

NICKEL

difficulties of the airlines. Declining nickel prices and rising power costs in the Pacific Northwest forced the Nation's sole ferronickel producer to suspend operations indefinitely in July.

The global economic slowdown and a leveling off of demand for austenitic stainless steel caused nickel prices to decline. The situation was made worse by large exports of cathode and powder from Russia to the West and record-high stocks in the London Metal Exchange (LME) warehouse at Rotterdam. On September 16, 1993, the LME cash price fell below \$4,410 per metric ton (\$2.00 per pound) for the first time in 6 years. The price drop was a disaster for some marginal nickel producers whose break-even point had been about \$6,610 (\$3.00 per pound). Even the lowest-cost producers were being squeezed to some degree by declining prices for their products and rising operational costs. One new mine opened on the southern edge of the Yilgarn Craton in Western Australia and several others were being developed elsewhere in the craton. Smelter capacity was being expanded in Australia, Finland, and Indonesia. In Canada, a \$600-million upgrading program to reduce sulfur dioxide emissions from smelters in the Sudbury Basin was nearing completion.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁷	Reserve base ⁷
	1992	1993 ^a		
United States	6,671	2,464	23,000	2,500,000
Albania	150	—	—	2,300,000
Australia	64,000	60,000	2,200,000	6,800,000
Botswana	23,500	22,000	475,000	900,000
Brazil	21,000	24,000	666,000	4,300,000
Canada	192,086	172,000	6,200,000	14,000,000
China	37,000	37,000	725,000	900,000
Colombia	23,063	23,700	558,000	740,000
Cuba	32,190	29,000	18,000,000	23,000,000
Dominican Republic	25,000	24,000	450,000	680,000
Finland	9,171	7,500	80,000	100,000
Greece	15,400	7,600	450,000	900,000
Indonesia	78,100	69,000	3,200,000	13,000,000
New Caledonia	113,100	105,000	4,500,000	15,000,000
Philippines	15,400	12,000	410,000	11,000,000
Russia	215,000	185,000	6,600,000	7,300,000
South Africa, Rep. of	28,400	27,000	2,500,000	2,600,000
Ukraine	5,000	3,000	90,000	90,000
Yugoslavia ^a	2,000	1,300	158,000	200,000
Zimbabwe	12,200	11,000	77,000	100,000
Other countries	3,498	3,100	—	7,900,000
World total (rounded)	922,000	826,000	47,000,000	110,000,000

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. World resources of lower grade nickel deposits are very large. In addition, there are extensive deep-sea resources of nickel in manganese crusts and nodules covering large areas of ocean floor, particularly in the Pacific Ocean.

Substitutes: With few exceptions, substitutes for nickel would result in increased cost or some trade off 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.

^aEstimated.

¹Imports for consumption.

²In 1990, the export total was expanded to include shipments of nickel waste and scrap. The new total also includes shipments of catalysts as well as the traditional salts. All of the data for 1989-93 have been adjusted accordingly.

³Stocks of producers, agents, and dealers held only in the United States.

⁴Employment at port facility in Coos Bay, OR, used exclusively for drying and transshipping imported nickel ore.

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

⁶See Appendix B.

⁷See Appendix C for definitions.

^aAs constituted before Apr. 1992.

NITROGEN (FIXED)—AMMONIA

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

Domestic Production and Use: U.S. ammonia production during January-June 1993, was 6.2 million tons nitrogen (N), about 11% below the heavy volume of 7.0 million tons established during the same period in 1992. Domestic ammonia trends to date indicated an annual industry output of about 15.6 million tons of ammonia product (82.2% N) valued at about \$2 billion, f.o.b. U.S. gulf coast.

Ammonia was produced by 32 firms in 23 States. Geographically, Louisiana, Oklahoma, and Texas accounted for about 60% of U.S. ammonia production; the Southeast and Midwest, 15% each; and the Western States, 10%. The domestic ammonia industry operated at 98% of design capacity between January and June and was projected to average about 100% for the year. Domestic ammonia production capability in 1993 declined by 590,000 annual tons (4%) because of damage to a urea reactor at a major plant in Louisiana in mid-1992 and the closure of a plant at Helena, AR.

Domestic and export shipments of U.S. diammonium phosphate, which reached new record highs in 1992, were off substantially through August 1993.

Approximately 80% of U.S. apparent domestic ammonia consumption was for fertilizer use, including anhydrous ammonia for direct application, urea, ammonium nitrate, ammonium phosphates, and other nitrogen compounds. Ammonia was also used to produce plastics, synthetic fibers, and resins, 10%; explosives, 4%; and numerous other chemicals, 6%.

Salient Statistics—United States:¹

	1989	1990	1991	1992	1993*
Production ²	12,280	12,680	12,801	13,643	12,700
Imports for consumption	2,861	2,673	2,742	2,690	2,650
Exports	346	482	580	354	400
Consumption, apparent	14,871	14,923	14,825	15,858	15,010
Stocks, producer, yearend	849	797	936	1,057	1,000
Price, dollars per short ton, average annual, f.o.b. gulf coast ³	104	106	117	106	110
Employment, plant	2,500	2,500	2,500	2,500	2,500
Net import reliance ⁴ as a percent of apparent consumption	17	15	14	14	15

Recycling: None.

Import Sources (1989-92): Canada, 33%; the former U.S.S.R., 23%; Trinidad and Tobago, 27%; Mexico, 14%; and other, 3%.

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Most favored nation (MFN)</u>	<u>Non-MFN⁵</u>
			<u>1/1/94</u>	<u>1/1/94</u>
	Ammonia, anhydrous	2814.10.0000	Free	Free.
	Ammonia, aqueous	2814.20.0000	Free	Free.

Depletion Allowance: Not applicable.

Government Stockpile: None.

Events, Trends, and Issues: The year was highlighted by heavy midsummer flooding along the upper Mississippi River and a loss of about 5 million acres of coarse feedgrains and soybeans and an additional 3 million acres that could not be planted. Fertilizer consumption in 1993 is projected to decline moderately owing principally to flooding and an increase in setaside corn acreage mandated by the Secretary of Agriculture. Fertilizer application was essentially completed before midsummer flooding. U.S. nitrogen fertilizer consumption was projected to increase 2% to 3% in the fertilizer year ending June 30, 1994, owing to an increase of 8 million planted acres.

NITROGEN (FIXED)—AMMONIA

The United States continued to import significant quantities of ammonia and urea to satisfy domestic demand for nitrogen fertilizer and industrial products. About 2.2 million tons of ammonia valued at more than \$0.2 billion was imported through August. Shipments from the former U.S.S.R. declined significantly in the third quarter following last year's trend and should total 0.6 million tons by yearend, the same as last year. Ammonia imports from the Mideast and Algeria began to be landed in July; Mexican tonnage was down significantly. Urea imports through August were proceeding at an annual rate of 2.8 million tons or about 75% more than that of 1992. The International Trade Commission ruled that antidumping orders on solid urea from the former U.S.S.R. and Romania would be maintained.

One of the leading U.S. nitrogen producers added significant capacity through the purchase of plants at Lima, OH, and in Trinidad and Tobago. Two major producers of nitrogen and phosphate fertilizers formed a joint venture that further consolidated the industry. Consolidation was further effected through the purchase of ammonium phosphate facilities at Bartow, FL, by a major U.S. company heavily involved in fertilizer production and grain trade. December 1993 ammonia futures contracts settled at \$123 per metric ton f.o.b. Louisiana in late September or roughly 11% above December 1992 futures prices.

Recent ammonia supply-demand projections by the Food and Agriculture Organization of the United Nations (FAO) indicate a relatively balanced situation through fertilizer year 1997 in North America, where only one major new plant was under construction and came on-stream in Saskatchewan in late 1992. An oversupply situation could develop at the global level, however, owing to political and economic reforms in Europe and the former U.S.S.R. and a substantial addition to global ammonia capacity.

World Ammonia Production, Reserves, and Reserve Base:

	Plant production		Reserves and reserve base ⁶
	1992	1993	
United States	13,643	12,700	Available atmospheric nitrogen and sources of natural gas for production of ammonia are considered adequate for all countries listed.
Canada	3,104	3,400	
France	1,407	1,300	
Germany	2,160	2,160	
India	7,000	7,000	
Italy	1,098	1,000	
Japan	1,602	1,600	
Mexico	2,222	2,200	
Netherlands	2,667	2,800	
United Kingdom	869	800	
Other countries	56,760	57,500	
World total	92,530	92,460	

World Resources: The availability of nitrogen from the atmosphere for fixed nitrogen production is unlimited. Hydrogen required for ammonia production is obtained most commonly from natural gas and from other solid and liquid fossil fuels. Natural gas is typically used to manufacture ammonia because of its favorable price structure. Mineralized occurrences of nitrogen are found in the Atacama Desert of Chile, where an estimated 2.5 billion tons of ore is above a cutoff of 7% sodium nitrate.

Substitutes: Nitrogen is an essential fertilizer element that has no substitute. There are no viable substitutes for industrial-grade fixed nitrogen explosives and blasting agents. Natural sources are available for the production of some nitrogen compounds and polymers.

*Estimated.

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

²Annual and preliminary data as reported in Bulletins MA28B and MQ28B (DOC).

³Source: Green Markets Fertilizer Intelligence Weekly, a Pike & Fischer publication.

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

⁵See Appendix B.

⁶See Appendix C for definitions.

NONRENEWABLE ORGANICS

(Data in million metric tons, unless noted)

Domestic Production and Use: U.S. domestic demand for nonfuel organic feedstock materials, including natural gas liquids, dry natural gas, and coal, totaled 122.35 million tons in 1993 compared with 121.15 million tons in 1992. In 1993, organic materials use was valued at \$13.1 billion.¹

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Petrochemical industries:					
Production, total feedstocks: ²	55.66	57.75	67.79	65.91	65.99
Production, resins ³	31.61	33.04	33.22	35.12	36.17
Production, others ⁴	24.05	24.70	34.57	30.79	29.82
Imports for consumption ⁵	9.18	10.11	9.79	8.68	10.49
Exports ⁵	2.19	2.17	1.48	1.49	.99
Consumption, apparent	63.17	64.94	74.90	73.78	75.46
Price, dollars per metric ton	113.75	134.36	116.38	113.29	109.34
Stocks, yearend ⁶	3.99	4.74	5.94	5.26	5.29
Net import reliance ⁶ as a percent of apparent consumption	12	11	9	11	11
Other organics:⁷					
Production	49.77	50.58	50.88	50.13	51.35
Imports for consumption	2.61	2.69	2.29	2.41	2.95
Exports	5.55	5.94	5.91	5.86	6.61
Consumption, apparent	46.84	47.88	46.55	47.37	46.89
Price, dollars per metric ton	107.27	134.46	112.57	106.88	103.10
Stocks, yearend	6.23	5.68	6.39	5.70	6.50
Net import reliance ⁶ as a percent of apparent consumption	NA	NA	NA	NA	NA
Total nonrenewable organics:					
Production	105.43	108.33	118.67	116.04	117.34
Imports for consumption	11.79	12.80	12.08	11.09	13.44
Exports	7.74	8.11	7.39	7.35	7.60
Consumption, apparent	110.01	112.80	121.45	121.15	122.35
Price, dollars per metric ton	110.99	134.43	114.92	110.78	106.95
Stocks, yearend	10.22	10.42	12.33	10.96	11.79
Net import reliance ⁶ as a percent of apparent consumption	4	4	2	4	4

Recycling: Post-consumer plastics packaging was recycled at a rate of 7%, up 2 percentage points from 1992. Plastic bottles and rigid containers were recycled at a rate of 15% compared with 11% during the prior year. Polyethylene, polypropylene, and polyethylene terephthalate were the major materials recycled. Asphalt and lubricating oils also were recycled. Recycled materials are not included in the above statistics.

Import Sources (1989-92): Crude oil: Arab Organization of Petroleum Exporting Countries (OPEC), 25%; other OPEC, 31%; Mexico, 13%; Canada, 13%; and other, 18%. Liquefied petroleum gases: Canada, 61%; Mexico, 7%; Arab OPEC, 30%; Venezuela, 1%; and other, 1%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN^a 1/1/94
Plastics:				
	Polyethylene	3901.10:0000	12.5% ad val.	43% ad val.
	Polyvinyl chloride	3904.10.0000	10.1% ad val.	43.5% ad val.
	Synthetic fibers	5503.10.0000	4.9% ad val.	25% ad val.
	Synthetic rubber	4002.20.0000	Free	20% ad val.
	Lubricating oils	2710.00.3000	\$0.84/bbl	\$1.68/bbl.
	Asphalt	2714.10.0000	Free	Free.

NONRENEWABLE ORGANICS

Depletion Allowance: For oil and gas wells, 15% on a maximum of 1,000 barrels per day (Domestic).

Government Stockpile: Strategic Petroleum Reserves are maintained by the Federal Government for use during periods of major supply interruption. Petroleum consumed for nonfuel organic materials purposes is small relative to that for fuel purposes. There are no centralized stocks of natural gas or coal.

Material	Stockpile Status—9-30-93			
	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Strategic Petroleum Reserve ⁹	585.7	—	—	—

Events, Trends, and Issues: Demand for most commodity resins is expected to increase moderately over 1992 levels. The large-volume high-density polyethylene market continued to be adversely affected by oversupply and a downturn in demand, however, and domestic demand for synthetic rubber did not change significantly through June. Environmental concerns about chlorinated hydrocarbons and restricted consumer spending slowed demand for polyvinyl chloride plastics and resins. Plastics industry representatives worked to develop an international resin-identification system to aid recycling of plastics parts from durable goods.

World Production:

	Plastics ¹⁰		Synthetic fibers ¹⁰	
	1991	1992	1991	1992
United States	27,651	29,683	3,973	4,109
Belarus	717	629	443	385
Canada	2,223	2,281	NA	NA
China	2,640	3,142	1,909	2,083
France	3,586	3,853	118	122
Germany	3,070	3,183	980	982
Italy	1,878	1,821	708	725
Japan	9,504	9,360	NA	NA
Korea, Republic of	3,315	4,467	780	778
Russia	2,963	NA	529	472
Taiwan	2,260	2,494	1,457	1,598
Ukraine	746	555	136	NA
United Kingdom	1,013	934	332	318
Other countries	4,630	2,700	1,630	1,530
World total (rounded)	66,200	65,100	13,000	13,100

World Resources: Ample supplies of petrochemical feedstocks were available to meet anticipated demand during the 1990's. Persistent oversupply for selected commodity resins in mature market economies has led to industry consolidation and capacity rationalization. However, production capacity continued to expand in the developing regions—Pacific Rim, Latin America, and Middle East. Global oversupply is anticipated during the next few years.

Substitutes: Plastics continue to find new uses in the packaging, construction, electronics, and transportation industries. Materials derived from minerals and renewable agricultural and forestry products compete with nonrenewable organics in selected areas.

*Estimated. NA Not available.

¹Quantities valued at fossil fuel prices given in the Annual Energy Review 1992, June 1993, p. 71.

²Total feedstocks are liquefied petroleum gases, petrochemical feedstocks, special naphthas, and dry natural gas.

³Resins are feedstocks for the production of plastics, synthetic fibers, and synthetic rubber.

⁴Others are feedstocks for the production of solvents and other petrochemicals.

⁵Excludes dry natural gas.

⁶Defined as imports - exports + adjustments for Government and industry stock changes.

⁷Lubricants, petroleum coke and coal, and asphalt and road oil.

⁸See Appendix B.

⁹Million barrels. In Oct. 1992, legislation was passed to expand the Strategic Petroleum Reserve from 750 million barrels to 1 billion barrels.

¹⁰Data in thousand metric tons.

PEAT

(Data in thousand short tons, unless noted)¹

Domestic Production and Use: The estimated f.o.b. plant value of marketable peat production in the United States was about \$17 million in 1993. Alaskan peat output was valued at \$400,000 by the Department of Natural Resources, Division of Geological and Geophysical Surveys, in Fairbanks.

Peat was harvested and processed by about 70 producers in 20 contiguous States and Alaska. Reed-sedge peat accounted for about 60% of total U.S. peat production, followed by humus, 25%; sphagnum moss, 10%; and hypnum moss, 5%. Fuel-grade peat was produced in minor quantities.

The States of Florida and Michigan produced about 60% of the Nation's peat. Geographically, about 40% of U.S. peat output was from four southeastern States; 35% from the Great Lakes region; the Midwest and Northeast, 10% each; and 5% from the Western States.

About 85% of domestic peat was used as an organic source for general soil improvement, in potting soils, and by the nursery business. The remainder was consumed in myriad downstream specialty applications, including golf course management, landscaping, mushroom and turf cultivation, earthworm culture, seed inoculants, and mixed fertilizers. Peat was also used as an oil absorbent, in hygienic products, and as a fuel source.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Production	761	763	697	660	600
Commercial sales	775	795	775	719	700
Imports for consumption	530	599	632	704	720
Exports	33	13	14	24	10
Consumption, apparent ²	1,303	1,358	1,379	1,329	1,370
Price, average value, f.o.b. mine, dollars per ton	22.84	24.16	23.01	23.00	24.00
Stocks, producer, yearend	402	393	329	340	280
Employment, mine and plant	670	650	650	650	650
Net import reliance ³ as a percent of apparent consumption	42	44	49	50	56

Recycling: None.

Import Sources (1989-92): Canada, 99.9%; and others, less than ½ %.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁴
			1/1/94	1/1/94
Peat	2703.00.0000		Free	Free.

Depletion Allowance: 5% (Domestic).

Government Stockpile: None.

PEAT

Events, Trends, and Issues: The performance of the domestic peat industry did not appear to change significantly in 1993, according to a preliminary survey of producers conducted by the U.S. Bureau of Mines. Apparent domestic consumption was up about 3%, however, as the Canadian peat industry continued to capitalize on its aggressive U.S. marketing strategy, and U.S. producers relied more heavily on stock liquidation owing to inclement weather across much of the country.

Canadian sphagnum shipments to the United States were projected to reach an unprecedented record-high 720,000 tons in 1993, slightly above the previous record established in 1992. The value of Canadian imports was expected to approximate about \$115 million or \$160 per ton at U.S. Customs, about 3% above the all-time record set in 1992.

In addition to the pressure of Canadian competition, the U.S. peat industry was also adversely impacted by slow growth in the domestic economy, restricted harvesting across the Midwest and Great Lakes States owing to wet weather and flooding, recent trends in the commercial availability of large-volume yard waste compost substitutes, and the growing pressures of environmental regulation.

A new generation of industrial peat bioremediation products has been successfully test marketed that demonstrate significant growth opportunities for the U.S. peat industry. One such product, a unique oil absorbent based on Minnesota sphagnum peat, was recently selected by a major transportation firm as an economic and environmentally friendly substitute for traditional clay products.

World Production, Reserves, and Reserve Base:

	Production		Reserves ⁵	Reserve base ⁵
	1992	1993 ⁶		
United States	660	600	16,000	7,000,000
Canada	945	900	24,000	336,000,000
Finland	6,016	6,000	70,000	7,000,000
Germany	3,430	3,400	46,000	500,000
Ireland	7,160	6,000	171,000	900,000
U.S.S.R. ⁶	142,000	142,000	143,000	160,000,000
Other countries	2,877	3,000	3,000	1,600,000
World total (may be rounded)	163,088	162,900	5,700,000	510,000,000

World Resources: World resources of peat were estimated to be 2.1 trillion tons, of which the former U.S.S.R. has about 850 billion tons and Canada about 560 billion tons. Domestic deposits of peat occur in all 50 States, with estimated resources of about 340 billion tons or about 16% of the world total.

Substitutes: Straw, tree bark, and other fibrous plant materials can be used as a mulch. In some instances, composted materials may be substituted for peat as a soil amendment. The superior water-holding capacity and physicochemical properties of peat limit substitution alternatives.

⁰Estimated.

¹See Appendix A for conversion to metric units.

²Defined as production + imports - exports + adjustments for industry stocks.

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

⁴See Appendix B.

⁵See Appendix C for definitions.

⁶As constituted before Dec. 1991.

PERLITE

(Data in thousand metric tons, unless noted)

Domestic Production and Use: The estimated value (f.o.b. mine) of processed perlite produced in 1993 was \$16.7 million. Crude ore production came from nine mines operated by seven companies in five Western States. New Mexico continued to be the major producing State. Processed ore was expanded at 68 plants in 34 States. The principal end uses were building construction products, 65%; filter aid, 14%; horticultural aggregate, 9%; and other, 12%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production ¹	545	576	514	541	548
Imports for consumption*	59	59	54	65	45
Exports*	45	32	29	29	30
Consumption, apparent	559	603	540	577	563
Price, average value, dollars per ton, f.o.b. mine	29.90	31.43	29.33	30.32	30.49
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill	125	125	120	115	110
Net import reliance ² as a percent of apparent consumption	2	5	5	6	3

Recycling: Not available.

Import Sources (1989-92): Greece, 100%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN³ 1/1/94
Mineral substances, not specifically provided		2530.10.0000	Free	Free.

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

Government Stockpile: None.

PERLITE

Events, Trends, and Issues: Imports of perlite from Greece in 1993 decreased to 45,000 tons. It is estimated that in 1994 domestic production of processed perlite will total 575,000 tons and apparent consumption, 600,000 tons.

Perlite mining had the normal problems of disposal of overburden and the final condition of the abandoned pit sites, but overall mining perlite disturbed a relatively small area of surface. Mining generally occurred in remote areas, and environmental problems were not severe.

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. Foreign interests were actively investigating the possibility of exporting their perlite into the 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
	1992	1993 ^a		
United States	541	548	50,000	200,000
Greece	250	250	50,000	300,000
Other countries	606	650	600,000	1,500,000
World total (may be rounded)	1,400	1,450	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.

^aEstimated. NA Not available.

¹Processed perlite sold and used by producers.

²Defined 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.

³See Appendix B.

⁴See Appendix C for definitions.

PHOSPHATE ROCK

(Data in thousand metric tons, unless noted)

Domestic Production and Use: Marketable phosphate rock was produced by 14 companies. Its estimated value was \$750 million. Eight companies in Florida and one in North Carolina produced 87% of the phosphate rock. The balance, 13%, was produced in Idaho, Montana, and Utah. Approximately 93% of the phosphate rock sold or used by U.S. producers was consumed domestically to manufacture wet-process phosphoric acid; about 93% of the wet-process acid or approximately 87% of the total phosphate rock demand was used to manufacture fertilizers. The remaining 13% was for other applications. In 1992, nine facilities processing phosphate rock for phosphoric acid production recovered about 64,000 tons of byproduct fluosilicic acid.

<u>Salient Statistics—United States:</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>
Production ¹	49,817	46,343	48,096	46,965	35,000
Sold or used by producers	49,280	49,754	44,707	45,113	38,000
Imports for consumption	705	451	552	1,530	1,000
Exports	7,842	6,238	5,082	3,723	3,000
Consumption ²	42,143	43,967	40,177	42,920	36,000
Price, average value, dollars per ton, f.o.b. mine ³	21.76	23.20	23.06	22.53	21.50
Stocks, producer, yearend	11,027	8,912	10,168	12,612	11,000
Employment, mine and beneficiation plant	5,600	5,900	5,800	5,600	5,000
Net import reliance ⁴ as a percent of apparent consumption	E	E	E	E	E

Recycling: None.

Import Sources (1989-92): Morocco, 99%; and other, 1%.

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Most favored nation (MFN)</u> <u>1/1/94</u>	<u>Non-MFN⁵</u> <u>1/1/94</u>
Natural calcium phosphates:				
Unground	2510.10.0000		Free	Free.
Ground	2510.20.0000		Free	Free.

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

Government Stockpile: None.

PHOSPHATE ROCK

Events, Trends, and Issues: Production of phosphate rock dramatically decreased in 1993 compared with that of 1992 as sales of phosphate fertilizer products declined. The phosphate industry, faced with lower demand and prices for fertilizer products, was forced to idle and/or close some mines and fertilizer plants in an effort to control production to ensure competitive selling prices.

According to many in the industry, an important way to remain in business is through consolidation or joint ventures. In May 1993, a Florida phosphate company sold its assets to a second company in the same State; on July 1, 1993, two of the major domestic phosphate producers finalized a joint agreement that combined both companies' phosphate rock mining and phosphate fertilizer businesses. The newly formed Florida company is expected to generate an overall operational cost savings of about \$95 million per year. At the same time, some phosphate analysts foresee a further reduction in the number of phosphate companies operating in Florida within the next 1 to 2 years.

The last remaining producer of uranium as a byproduct of manufacturing phosphoric acid closed its uranium recovery and refining operations at New Wales, FL. The yellow cake presently sells for about \$8 per pound on the open market compared to about \$43 per pound in the early 1980's.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁶	Reserve base ⁷
	1992	1993 ⁸		
United States	46,965	35,000	1,200,000	4,440,000
China	23,000	22,000	270,000	270,000
Israel	3,595	3,500	10,000	10,000
Jordan	4,296	4,500	90,000	570,000
Kazakhstan ⁸	7,000	7,000	550,000	550,000
Morocco and Western Sahara	19,184	20,000	5,900,000	21,440,000
Russia ⁸	14,000	13,500	780,000	880,000
Senegal	2,300	2,300	—	160,000
South Africa, Republic of	3,051	3,000	2,500,000	2,500,000
Togo	2,083	2,200	—	60,000
Tunisia	6,400	6,500	—	270,000
Other countries	11,879	11,500	700,000	2,900,000
World total (may be rounded)	144,000	131,000	12,000,000	33,900,000

World Resources: Most of the U.S. and world phosphate rock resources are widely distributed marine phosphorite deposits. Identified resources in north and west Africa and in the Middle East are estimated to be several times greater than present reserves. Large phosphate resources have been identified on the continental shelves and on sea mounts in the Atlantic and Pacific Oceans. Phosphate rock contains fluorine as an integral part of the mineral apatite. Uranium and the rare earths are associated with the apatite mineral of phosphate deposits, and vanadium is associated with the organic fraction of marine phosphorites. Uranium is more abundant in the marine phosphorites, and the rare earths are more abundant in igneous apatites.

Substitutes: There are no substitutes for phosphorus in agriculture.

⁸Estimated. E Net exporter.

¹Marketable.

²Defined as sold or used + imports - exports.

³Marketable phosphate rock, weighted value, all grades, domestic and export.

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

⁵See Appendix B.

⁶Cost less than \$40 per metric ton. Cost includes capital, operating expenses, taxes, royalties, and a 15% return on investment, f.o.b. mine.

⁷See Appendix C for definitions.

⁸Formerly part of the U.S.S.R.; data were not reported separately until 1992.

PLATINUM-GROUP METALS

(Platinum, palladium, rhodium, ruthenium, iridium, osmium)
(Data in kilograms,¹ unless noted)

Domestic Production and Use: Ore containing the platinum-group metals (PGM) was mined, concentrated, and smelted in Montana, and the resultant PGM matte was exported to Belgium for refining and separation of the individual PGM. In addition, refined PGM were recovered as byproducts of copper refining by two companies in Texas and Utah. Secondary metal was refined by about 20 firms, mostly on the east and west coasts. PGM were sold by at least 90 processors and retailers, largely in the Northeast, and were used primarily by the following industries: automotive, electrical and electronic, chemical, and dental and medical. The automotive, chemical, and petroleum-refining industries used PGM mainly as catalysts. The other industries used PGM in a variety of ways that took advantage of their chemical inertness and refractory properties. Mine production of PGM was valued at \$39 million in 1993.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Mine production: ² Platinum	1,430	1,810	1,730	1,840	1,800
Palladium	4,850	5,930	6,050	6,470	6,500
Primary refined production	339	64	216	W	W
Secondary: Nontoll-refined	3,933	5,819	4,806	5,424	5,100
Toll-refined	46,253	625,429	67,543	56,190	51,000
Imports for consumption:					
Refined	111,107	120,631	121,741	129,362	140,000
Total	113,278	125,354	125,661	132,006	143,000
Exports: Refined	23,082	20,148	27,401	31,061	44,000
Total	38,301	55,044	39,624	57,829	86,000
Consumption:					
Reported, sales to industry	78,483	77,487	62,597	66,801	65,000
Apparent ³	101,200	117,000	111,800	109,500	112,300
Price, dealer, average, dollars per ounce:					
Platinum	507	467	371	356	370
Palladium	144	114	87	87	120
Iridium	303	307	283	158	55
Osmium	549	416	400	400	400
Rhodium	1,300	3,565	3,739	2,365	1,200
Ruthenium	62	61	55	29	16
Stocks, industry, yearend	32,543	30,324	24,313	26,946	24,000
Employment, mine	416	455	469	500	400
Net import reliance ⁴ as a percent of apparent consumption	90	88	90	87	88

Recycling: About 5,100 kilograms of PGM was refined from scrap on a nontoll basis. The quantity of toll-refined secondary was considerably larger, amounting to about 51,000 kilograms. Several large collectors purchased used catalytic converters from numerous small collectors, automobile salvage yards, and muffler shops. The outer shell of the converters was recycled, while the catalyst and substrate were shipped to U.S. and foreign companies for extraction of platinum, palladium, and rhodium.

Import Sources (1989-92): Republic of South Africa, 50%; United Kingdom, 15%; Russia, 13%; and other, 22%.

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

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

Government Stockpile: No PGM were purchased in 1993.

Material	Stockpile Status—9-30-93			
	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Platinum	14,079	—	—	—
Palladium	39,334	—	—	—
Iridium	920	—	—	—

PLATINUM-GROUP METALS

Events, Trends, and Issues: An auto catalyst manufacturer reportedly developed a palladium catalytic converter that would eliminate the need for platinum and rhodium. One report indicated that the new catalyst was an "add-on" manifold-based device to be used in conjunction with conventional platinum catalysts.

A company presently mining platinum and palladium in Montana received Federal Government approval to open a new mine near Big Timber, MT. The company must still obtain a State mining permit. Still at issue is the question of water quality in the East Boulder River. Adding a new mine at Big Timber and expansion of an existing mine at Nye, MT, reportedly would result in higher levels of nitrate discharge to the river.

In Canada, a mining company received final environmental approval to start operating its open pit PGM mine located 81 km north of Thunder Bay, Ontario. The principal metal there is palladium.

In the Republic of South Africa, the principal producer closed one of its high cost mines, a move that will reduce its annual production by about 8 metric tons.

The Bureau continued to receive inquiries from individuals seeking to sell large quantities (kilograms) of the osmium isotope 187. There are no known commercial uses for this nonradioactive material and thus no market. The Oak Ridge National Laboratory in Oak Ridge, TN, sells microgram amounts of osmium 187 for scientific purposes.

The Commodity Exchange Inc. (COMEX) stopped trading of platinum and palladium futures contracts in May because of a lack of trading activity. COMEX initially offered the contracts in September 1992.

In another development related to the exchanges, the New York Mercantile Exchange (NYMEX) proposed merging with COMEX. COMEX seat members would receive proprietary trading rights to NYMEX's platinum/palladium contracts. Approval of the merger by both exchanges and the Commodity Futures Trading Commission was pending late in the year.

Average dealer prices for rhodium, iridium, and ruthenium continued to decline. Not since 1989 has the average annual price of rhodium been as low as it was in 1993, about \$1,200 per troy ounce. The demand for rhodium is tied to the world automobile industry, which has been suffering from low demand, particularly in Western Europe.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁵	Reserve base ⁵
	1992	1993 ^a		
United States ²	8,310	8,300	250,000	780,000
Canada	11,058	11,000	250,000	280,000
Russia	112,500	110,000	5,900,000	6,000,000
South Africa, Republic of	145,000	140,000	50,000,000	59,000,000
Other countries	4,100	4,000	31,000	31,000
World total (rounded)	280,000	273,000	56,000,000	66,000,000

World Resources: World resources of PGM are estimated to be 100 million kilograms. U.S. resources are estimated to be 9 million kilograms.

Substitutes: Some automotive companies have experimented with substituting palladium for the higher priced platinum in catalytic converters. Palladium is less resistant to poisoning by sulfur and lead than platinum; however, palladium may be useful in controlling emissions from diesel-powered vehicles.

^aEstimated. W Withheld to avoid disclosing company proprietary data.

¹Multiply by 32.1507 to convert from kilograms to troy ounces.

²Estimates from published sources.

³Mine production plus nontoll secondary production plus net import reliance (see footnote 4).

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

⁵See Appendix C for definitions.

POTASH

(Data in thousand metric tons of K₂O equivalent, unless noted)

Domestic Production and Use: In 1993, the value of production of marketable potash, f.o.b. mine, was about \$280 million, reflecting a decline in price for muriate of potash. Potash production was centered in southwestern New Mexico, where five companies operated six mines at the beginning of the year and four companies operated five mines at the end of the year by conventional underground mining of bedded deposits. This potash was beneficiated mostly by flotation, providing 82% of U.S. total production. In Utah, one company used solution mining to bring underground bedded potash to the surface. The potash was recovered from the brine by solar evaporation and flotation. Another company collected subsurface brines from an interior basin for solar evaporation and flotation. A third company used solar evaporation to concentrate the brines of the North Arm of the Great Salt Lake. In California, one company recovered potash with coproducts borax pentahydrate and saltcake from subsurface brines from an interior basin using mechanical evaporation. The fertilizer industry consumed about 95% of the U.S. potash sales, and the chemical industry used about 5%. About 70% 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, composed about 25% of potash production. Potash was transported by train, truck, and barges to warehouses, wholesalers, and retailers, with some potash being sold from barges used as temporary warehouses. Retailers sold potash and potash blended with other fertilizers in dry or liquid form for distribution over fields in both spring and fall.

Salient Statistics—United States:

	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>
Production, marketable	1,595	1,713	1,749	1,705	1,500
Imports for consumption	13,410	4,164	4,158	4,227	3,950
Exports	446	470	624	663	360
Consumption, apparent	² 4,500	5,410	5,243	5,330	5,120
Price, dollars per metric ton of K ₂ O, average, muriate, f.o.b. mine ³	137	130	131	134	124
Stocks, producer, yearend	307	303	343	283	253
Employment: Mine	890	1,011	1,011	1,004	795
Mill	930	960	990	1,175	910
Net import reliance ⁴ as a percent of apparent consumption	65	68	67	67	71

Recycling: None.

Import Sources (1989-92): Canada, 92%; Israel, 3%; former U.S.S.R., 2%; Germany, 2%; and other, 1%.

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Most favored nation (MFN)</u> <u>1/1/94</u>	<u>Non-MFN⁶</u> <u>1/1/94</u>
	Crude salts, sylvinitic, 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 potash producers stayed in overcapacity for another year. One New Mexico producer shut down in April, and the miners of a German mine struck to keep the mine from being closed. Several producers around the world operated at partial capacity to maintain prices. The Canadian potash industry again operated at about 60% capacity: about 40% for the largest producer and 80% for all the others. The New Mexico producers operated at about 80% capacity for the year.

The largest Canadian potash producer purchased a smaller Canadian potash producer with mines in Saskatchewan and New Brunswick. In the United States, potash shipments by Canadian and U.S. producers were at 1992 levels through July, but there was a strong drop in August. The Midwestern rain and flooding, the Southeastern drought, and a wet, cold autumn are expected to decrease potash consumption for the rest of the year.

POTASH

The U.S. Department of Agriculture's corn set-aside for 1994 was decreased to 5% from 10% because of weather problems, but the grain-futures prices have not risen strongly. The Russian grain harvest was forecast to be more than 20% above last year's harvest. As a result, there may be less demand for U.S. surplus production.

A petition to the U.S. Trade Representative under the 1974 Trade Act, section 406(d), requested the President of the United States to open talks with the potash producers of the former U.S.S.R. to reduce alleged market disruption in the U.S. potash market. Antitrust lawsuits were filed in several U.S. federal courts against the Canadian and some U.S. potash producers. These several lawsuits were consolidated into one suit in a federal court in St. Paul, MN. The potassium nitrate producer in Chile purchased a Chilean prospect for potash and lithium with intentions of developing the property. It is estimated that in 1994 domestic mine production will be 1.4 million tons and that the U.S. apparent consumption will be 5.1 million tons.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁶	Reserve base ⁶
	1992	1993 [*]		
United States	1,705	1,450	80,000	280,000
Belarus	[*] 3,311	2,900	800,000	1,000,000
Brazil	85	100	50,000	600,000
Canada	7,327	7,200	4,400,000	9,700,000
Chile	35	35	10,000	50,000
China	25	25	320,000	320,000
France	1,141	1,050	14,000	35,000
Germany	3,525	3,300	750,000	900,000
Israel	1,296	1,300	52,000	⁶ 600,000
Italy	86	100	20,000	40,000
Jordan	808	820	52,000	⁷ 600,000
Russia	[*] 3,454	2,800	2,800,000	⁶ 2,200,000
Spain	594	600	25,000	40,000
Thailand	—	—	—	100,000
Ukraine	[*] 182	200	25,000	30,000
United Kingdom	530	530	24,000	30,000
World total (may be rounded)	24,018	22,410	9,400,000	16,500,000

World Resources: Estimated domestic potash resources total about 6 billion tons. Most of this lies at depths between 1,800 and 3,000 meters in a 3,100-square-kilometer area of Montana and North Dakota as an extension of the Williston Basin deposits in Saskatchewan, Canada. The Paradox Basin in Utah contains approximately 2 billion tons, mostly at depths of more than 1,200 meters. An unknown, but apparently large, quantity of potash resources lies about 2,100 meters under central Michigan. The U.S. reserve figure above contains 25 million tons of reserves in central Michigan. Estimated world resources total about 250 billion tons. The potash deposits in the former U.S.S.R. contain large amounts of carnallite; but it remain questionable 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 transported short distances to the crop fields.

^{*}Estimated.

¹Source: U.S. Bureau of the Census. The Potash & Phosphate Institute (PPI) reported 4,050,000 tons in 1989.

²Based on the U.S. Bureau of the Census reports of imports from Canada. An alternative calculation of apparent consumption using the PPI report of imports from Canada would be 5,150,000 tons.

³Average prices based on actual sales; excludes soluble and chemical muriates.

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

⁵See Appendix B.

⁶See Appendix C for definitions.

⁷Total reserve base in the Dead Sea is equally divided between Israel and Jordan.

⁸A reserve of 22,300,000 was reported by I. D. Sokolov in Basic Tasks of the Potash Industry up to the Year 2000, Zhurnal Vsesoyuznogo Khimicheskogo Obshchestva Im. D. I. Mendeleeva, v. 32., No. 4, July-Aug. 1987, pp. 383-387.

PUMICE AND PUMICITE

(Data in thousand metric tons, unless noted)

Domestic Production and Use: The estimated value of pumice and pumicite sold or used in 1993 was \$14.9 million. Domestic output came from 12 producers in 6 States. The principal producing States were New Mexico and Oregon, with combined production accounting for about 69% 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:	1989	1990	1991	1992	1993^a
Production, mine ¹	424	443	401	481	492
Imports for consumption	293	280	118	257	180
Exports ^a	7	20	13	11	20
Consumption, apparent	710	703	506	727	652
Price, average value, dollars per ton, f.o.b. mine or mill	19.38	24.13	22.90	30.99	30.27
Stocks, yearend	NA	NA	NA	NA	NA
Employment, mine and mill	55	55	50	50	55
Net import reliance ² as a percent of apparent consumption	40	37	21	34	25

Recycling: Not available.

Import Sources (1989-92): Greece, 74%; Ecuador, 8%; Mexico, 6%; Turkey, 5%; and other, 7%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN³ 1/1/94
	Crude or in irregular pieces, including crushed pumice	2513.11.0000	Free	Free.
	Other	2513.19.0000	0.3¢/kg	1.7¢/kg.

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

Government Stockpile: None.

Events, Trends, and Issues: It is estimated that in 1994 domestic mine production of pumice and pumicite will reach 475,000 tons, with U.S. apparent consumption at approximately 625,000 tons. Imports, mainly from Greece, continue to maintain markets on the East Coast and Gulf Coast States of the United States. However, imports apparently fell below 200,000 tons for the second time in the last 3 years. Prior to 1991, imports had not been less than 200,000 tons since 1983 and 1984.

Although pumice and pumicite was plentiful in the Western United States, changes that occur in laws and public land designations could make many deposits increasingly less accessible to mining. Pumice and pumicite was 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 1993 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.

PUMICE AND PUMICITE

World Mine Production, Reserves, and Reserve Base:

	Mine production ^a		Reserves ^d	Reserve base ^d
	1992	1993		
United States ¹	481	492	Large	Large
Chile	300	300	NA	NA
France	400	375	NA	NA
Germany	160	175	NA	NA
Greece	900	850	NA	NA
Italy	5,000	4,750	NA	NA
Spain	800	800	NA	NA
Turkey	1,500	1,500	NA	NA
Other countries	1,600	1,500	NA	NA
World total (rounded)	11,140	10,750	NA	NA

World Resources: The identified 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.

^aEstimated. NA Not available.

¹Quantity sold and used by producers.

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

³See Appendix B.

⁴See Appendix C for definitions.

QUARTZ CRYSTAL (INDUSTRIAL)

(Data in metric tons, unless noted)

Domestic Production and Use: Domestic production of cultured quartz crystal has been relatively steady for the past 5 years. Lascas¹ production continued in Arkansas. Virtually all quartz crystal consumed in electronic applications was synthetic. Five companies produced cultured quartz crystal using lascas as feed material. Quartz crystal was essential for making piezoelectric filter devices that separated portions of the frequency spectrum and oscillators to a single frequency signal source. Filters and oscillators were used for a wide variety of communication and instrumentation purposes.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Production: Mine ²	454	423	454	778	450
Plant, cultured (as grown)	464	441	441	407	450
Imports for consumption:					
Lascas	NA	NA	NA	NA	NA
Natural electronic ³	NA	NA	NA	NA	NA
Exports:					
Lascas	—	—	—	—	—
Natural electronic ³	NA	NA	NA	NA	NA
Cultured (mostly lumbered) ³	57	39	53	15	26
Shipments from Government stockpile excesses, natural electronic	75	170	44	89	200
Consumption, reported:					
Lascas ⁴	572	527	556	594	600
Natural electronic	(^b)	(^b)	1	(^b)	(^b)
Cultured ⁵	361	340	365	286	310
Price, average value, dollars per kilogram:					
Lascas	1.32	0.85	0.85	0.90	0.90
Cultured (lumbered)	140.97	107.48	66.37	105.67	100.00
Stocks, industry, yearend:					
Lascas (for cultured crystal only)	325	270	283	99	150
Natural electronic (fabricator)	1	1	(^b)	1	1
Cultured (fabricator)	75	97	99	104	100
Employment, mine, processing plant ⁶	10	10	10	10	10
Net import reliance ⁷ as a percent of apparent consumption, lascas	NA	NA	NA	NA	NA

Recycling: None.

Import Sources (1989-92): This information is no longer available.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁸ 1/1/94
Sands:				
Other than natural	2506.10.0010		Free	Free.
Other	2506.10.0050		Free	Free.
Quartzite	2506.21.0000		Free	Free.

QUARTZ CRYSTAL (INDUSTRIAL)

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

Government Stockpile:

Stockpile Status—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Quartz crystal	423	58	423	156

Events, Trends, and Issues: Shipments of quartz crystal from the National Defense Stockpile doubled for the second consecutive year due to more aggressive marketing. Stockpile material was absorbed, in most cases, into the gem and specimen industry, and not the industrial quartz market.

Japan remained both the leading producer and consumer of cultured quartz crystal because of its lower cost per unit and its prominence as a producer of electronic components in which these crystals are used. Specially grown cultured seed crystals have nearly replaced natural seed in most domestic operations. Very small quantities of Brazilian natural quartz are used as seed for growing cultured quartz and for a few direct applications such as deep-well pressure transducers.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ^a	Reserve base ^a
	1992	1993 ^b		
United States ^c 2	778	450	Moderate	Moderate
Brazil	NA	NA	Large	Large
Other countries	NA	NA	NA	NA
World total	NA	NA	NA	NA

World Resources: Limited resources of 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. Other materials, such as dipotassium tartrate, are usable only in specific applications as oscillators and frequency filters.

^aEstimated. NA Not available.

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

²Lascas only; specimen and jewelry material excluded.

³Quantities calculated from pricing information.

⁴Excluding quartz crystal used by the fused quartz industry.

⁵Less than 1/2 unit.

⁶Reported consumption of cultured quartz includes cultured quartz consumed by growers as well as by manufacturers of intermediate products and finished crystal units.

⁷Defined as imports - exports + adjustments for Government and industry stock changes.

⁸See Appendix B.

⁹See Appendix C for definitions.

RARE EARTHS¹

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

Domestic Production and Use: Two companies produced rare-earth ore minerals in 1993, with an estimated value of \$60 million. Bastnasite, a rare-earth fluorocarbonate mineral, was mined as a primary product in California. Monazite, a rare-earth-thorium phosphate mineral, was mined in Florida as a byproduct of processing heavy-mineral sands for titanium and zirconium minerals. A monazite and zircon producer in New Jersey that recovered ore from previously generated tailings closed at the end of 1992. Bastnasite continued to account for most of the rare-earth ore produced domestically. The United States was a leading producer and processor of rare earths and was a major exporter and consumer of rare-earth products. Rare-earth ores and compounds were refined primarily by three companies: one with a plant in California, another with operations in Arizona and Texas, and a third with a plant in Tennessee. Principal uses were in petroleum fluid cracking catalysts, chemical and pollution-control catalysts, metallurgical applications, glass and ceramics, permanent magnets, phosphors, and electronics.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Production:					
Bastnasite concentrates ²	20,787	22,713	16,465	20,699	20,000
Monazite concentrates	W	W	W	W	W
Imports:					
Thorium ore (monazite) (2612.20.0000)	426	440	—	—	—
Rare-earth metals, alloys (2805.30.0000)	353	239	271	352	288
Cerium compounds (2846.10.0000)	251	359	545	806	1,162
Mixed REO's (2846.90.2010)	502	151	892	295	206
Rare-earth chlorides (2846.90.2010)	645	627	1,554	728	1,079
Rare-earth oxide, compounds (2846.90.5000)	5,543	3,742	2,770	3,100	3,872
Ferrocium, alloys (3606.90.3000)	74	83	83	94	98
Exports:³					
Thorium ore monazite (2612.20.0000)	1	—	—	3	—
Rare-earth metals, alloys (2805.30.0000)	510	241	71	44	100
Cerium compounds (2846.10.0000)	1,433	1,730	1,369	1,935	1,453
Other rare-earth compounds (2846.90.0000)	3,262	2,085	1,793	1,306	1,204
Ferrocium, alloys (3606.90.0000)	3,105	1,805	1,864	2,431	4,058
Consumption, apparent⁴	27,700	28,700	22,100	NA	NA
Price, dollars per kilogram, yearend:					
Bastnasite concentrate, REO basis	2.76	2.87	2.87	2.87	2.87
Monazite concentrate, REO basis	1.19	1.19	.93	.41	.39
Mischmetal, metal basis	12.35	11.02	11.02	12.68	12.68
Stocks, producer and processor, yearend	W	W	W	NA	NA
Employment, mine and mill	381	397	411	372	351
Net import reliance^{4,5} as a percent of apparent consumption	23	20	25	NA	NA

Recycling: Small quantities, mostly permanent magnet scrap.

Import Sources (1989-92): Monazite: Indonesia, 89%; and Australia, 11%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁶ 1/1/94
	Thorium ores and concentrates (monazite)	2612.20.0000	Free	Free
	Rare-earth metals, whether or not intermixed or interalloyed	2805.30.0000	70.5¢/kg	\$4.41/kg.
	Cerium compounds	2846.10.0000	7.2% 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)	2846.90.5000	3.7% ad val.	25% ad val.
	Ferrocium and other pyrophoric alloys	3606.90.3000	48.5¢/kg + 2.6% ad val.	\$4.41/kg + 25% ad val.

RARE EARTHS

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).

Government Stockpile:

Stockpile Status—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
REO in sodium sulfate	457	—	—	—

Events, Trends, and Issues: Domestic demand for rare earths in 1993 was estimated to be higher than in 1992. Compared with 1992, rare-earth markets were stronger in most end uses. Domestic producers, however, continued to experience competitive pricing from foreign producers, especially China. The supply of lanthanides and yttrium are abundant, and no shortages are anticipated. Capacity to produce individual rare earths has increased substantially during the last decade; however, supply problems may be encountered if a large demand developed for one of the less abundant rare earths. The demand pattern is expected to continue to shift toward high-purity individual compounds and metals and special mixtures, such as those used in fluorescent and incandescent lighting, glass additives, permanent magnets, fiber optics, high-temperature superconductors, catalysts, magneto-optical storage, pharmaceuticals, and rechargeable batteries. Improved knowledge of the rare earths continues to generate new applications, a trend that is expected to continue.

World Mine Production, Reserves, and Reserve Base:

	Mine production ^a		Reserves ⁷	Reserve base ⁷
	1992	1993		
United States	^b 20,699	^b 20,000	13,000,000	14,000,000
Australia	3,850	4,000	5,200,000	5,800,000
Brazil	880	800	280,000	310,000
Canada	—	—	940,000	1,000,000
China	21,340	20,000	43,000,000	48,000,000
India	2,750	2,750	1,100,000	1,300,000
Malaysia	435	500	30,000	35,000
South Africa, Republic of	715	715	390,000	400,000
Sri Lanka	110	110	12,000	13,000
Thailand	360	360	1,000	1,100
U.S.S.R. ⁹	8,000	8,000	19,000,000	21,000,000
Zaire	60	60	1,000	1,000
Other countries	718	700	21,000,000	21,000,000
World total (rounded)	60,000	58,000	100,000,000	110,000,000

World Resources: Rare earths are relatively abundant in the Earth's crust, but 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, the Republic of South Africa, Sri Lanka, Thailand, and the United States constitute the second largest segment. Xenotime, ion-adsorption clays, loparite, phosphorites, apatite, eudyalite, and spent uranium solutions comprise most of the remaining resources. Total world undiscovered resources of rare earths are believed to be very large relative to expected demand.

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

^aEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹Data includes lanthanides and yttrium, but excludes most scandium. See also Scandium and Yttrium.

²As reported in Unocal Corp. annual reports and as authorized from Molycorp personnel.

³REO equivalent or contents of various materials were estimated. Data from Bureau of the Census.

⁴Monazite concentrate production was not included in the calculation of apparent domestic consumption and net import reliance.

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

⁶See Appendix B.

⁷See Appendix C for definitions.

⁸Comprises only the rare earths derived from bastnasite.

⁹As constituted before Dec. 1991.

RHENIUM

(Data in kilograms of rhenium content, unless noted)

Domestic Production and Use: During 1993, ores containing rhenium were mined by seven companies. 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 15% and 75%, 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 because it improves the strength properties, at high temperatures (1,000° C), of nickel 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 1993 was \$6 million.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Product: Content ¹	17,500	17,500	19,200	16,000	13,000
Imports for consumption	4,700	8,900	14,400	12,000	9,000
Exports			Negligible		
Consumption: Estimated	8,200	7,700	8,900	6,800	5,000
Apparent	W	W	W	W	W
Price, average value, dollars per kilogram:					
Metal powder, 99.99% pure	1,500	1,500	1,500	1,550	1,500
Ammonium perrhenate	1,400	1,400	1,300	1,075	1,100
Stocks, yearend, consumer, producer, dealer	W	W	W	W	W
Employment ²			Small		
Net import reliance ³ 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 (1989-92): Chile, 57%; Germany, 18%; Sweden, 13%; and other, 12%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁴ 1/1/94
	Other inorganic acids, other—rhenium, etc.	2811.19.5050	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	3.7% ad val.	25% ad val.
	Rhenium, etc., (metals) wrought; etc.	8112.99.0000	5.5% ad val.	45% ad val.

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

Government Stockpile: None.

RHENIUM

Events, Trends, and Issues: During 1993, the rhenium metal price decreased. The average price was \$1,500 per kilogram for rhenium metal and \$1,100 per kilogram for ammonium perrhenate. Imports of rhenium decreased for 1993 compared with that of 1992. Chile, Germany, Japan, and Sweden 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 1994 U.S. consumption of rhenium will be about 4,500 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		Reserves ⁵	Reserve base ⁵
	1992 ²	1993		
United States	16,000	13,000	386,000	4,540,000
Canada	3,500	3,000	32,000	1,540,000
Chile	5,000	4,000	1,310,000	2,540,000
Peru	5,000	3,000	45,000	545,000
U.S.S.R. ⁶	2,000	1,000	594,000	771,000
Other countries	200	100	91,000	363,000
World total (may be rounded)	32,000	24,000	2,500,000	10,000,000

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

²Estimated. W Withheld to avoid disclosing company proprietary data.

³Calculated rhenium contained in MoS₂ concentrates. Recovered quantities are considerably less and are withheld.

⁴Less than 100.

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

⁶See Appendix B.

⁷See Appendix C for definitions.

⁸As constituted before Dec. 1991.

RUBIDIUM

(Data in kilograms of rubidium content, unless noted)

Domestic Production and Use: Although rubidium is not recovered from any domestically mined ores, 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 are not available for the domestic rubidium industry. Collected data, such as the production of metal and compounds, and producer stocks, must be withheld to avoid disclosing company proprietary data. Other statistics such as consumption, imports, and exports are not available.

The rubidium market is very small. There is no active trading in the metal and therefore no market price. However, several companies publish prices for rubidium and rubidium compounds. These prices are relatively stable during time periods up to several years in length. The per-unit price for the metal or compounds purchased from these companies varies inversely with the quantity of material purchased. For example, in 1993, one company offered 1-gram ampoules of 99.8% grade rubidium metal at \$40.00. The price for 100 grams of the same material from this company was \$539.00 or \$5.39 per gram. At another company, the price for 1 pound or more ranged from \$315.00 to \$393.75 per pound (\$0.69 to \$0.87 per gram) depending upon the metal's grade.

Recycling: None.

Import Sources (1989-92): The United States is 100% import reliant. Although there is no information on the countries shipping rubidium-bearing material to the United States, it is believed that Canada is the major source of this raw material.

Tariff: Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN¹ 1/1/94
Alkali metals, other	2805.19.0000	6.6% ad val.	25% ad val.

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

Government Stockpile: None.

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: Data on mine production of rubidium are not available. Reserves and the reserve base² for rubidium in North America were estimated at 2 million kilograms and 2.3 million kilograms, respectively.

World Resources: Rubidium forms no known minerals in which it is the predominant metallic constituent. It occurs chiefly as a replacement for potassium, especially in minerals formed late in the crystallization of pegmatites. Meaningful estimates of world rubidium resources have not been made, but lepidolite, a potassium lithium mica, may contain up to 1.35% rubidium, and pollucite, a cesium silicate, may contain up to 3.15% rubidium.

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. Cesium, germanium, tellurium, selenium, silicon, and several other elements and compounds substitute for rubidium in photosensitive materials.

¹See Appendix B.

²See Appendix C for definitions.

RUTILE¹(Data in thousand metric tons of contained TiO₂, unless 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 titanium minerals is zircon. Synthetic rutile was produced at one plant in Alabama. The value of reported U.S. rutile consumption in 1993, including synthetic rutile, was about \$170 million. Two firms, with facilities in Nevada and Oregon, used titanium tetrachloride made from rutile to manufacture titanium metal. Of 11 consuming firms mainly in the Eastern United States, 6 companies used 93% of the rutile consumed to make titanium dioxide (TiO₂) pigment. Welding-rod coatings and miscellaneous applications, which include titanium metal and fiberglass, consumed 7%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production	W	W	W	W	W
Imports for consumption ²	249	259	226	299	310
Exports ³	5	4	4	7	5
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption: Reported ²	346	347	336	438	450
Apparent	W	W	W	W	W
Price, dollars per ton of rutile, yearend:					
Bulk, f.o.b. Australian ports	525	790	545	405	373
Bulk, f.o.b. U.S. east coast	545	565	628	NA	NA
Stocks, mine, distributor and consumer, yearend	145	161	197	160	160
Employment, mine and mill ³	396	405	395	400	381
Net import reliance ⁴ as a percent of apparent consumption	W	W	W	W	W

Recycling: None.**Import Sources (1989-92):** Australia, 60%; Sierra Leone, 22%; Republic of South Africa, 14%; and other, 4%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁵ 1/1/94
	Rutile concentrate	2614.00.6040	Free	Free.
	Synthetic rutile	2614.00.3000	5% ad val.	30% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).**Government Stockpile:****Stockpile Status—9-30-93**

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Stockpile-grade rutile (gross weight)	34.4	0.3	34.4	1.1

RUTILE

Events, Trends, and Issues: U.S. production of rutile was similar to that of 1992. Owing to increased imports from the Republic of South Africa, total imports of natural and synthetic rutile increased by about 4%. Meanwhile, rutile imports from Australia and Sierra Leone were estimated to have decreased by about 27% and 22%, respectively.

The Defense Logistics Agency (DLA) attempted to sell 10,000 short dry tons of rutile held in the National Defense Stockpile (NDS). Although DLA solicited monthly bids on the material during 1993, only 1,198 short tons were removed from the NDS. Under the 1994 Annual Materials Plan, DLA was authorized by Congress to dispose of up to 20,000 short dry tons of rutile held in the NDS.

Mining of rutile is entirely from sand deposits that contain only a small percentage of valuable minerals. While the discarded sand can be readily returned to the mined area, regraded, and seeded to aid restoration of the environment, there has been continuing pressure to curtail sand mining in some areas.

Fewer environmental pollution problems are encountered when pigment is made 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 alternate 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
	1992	1993 ^a		
United States	W	W	300	1,400
Australia	190	200	5,300	42,000
Brazil	1	1	66,000	86,000
India	10	10	4,400	4,400
Italy	—	—	—	21,000
Sierra Leone	138	140	2,000	2,000
South Africa, Republic of	70	70	3,600	4,500
Sri Lanka	3	3	800	800
U.S.S.R. ⁷	8	8	2,500	2,500
World total (may be rounded)	^b 420	^b 430	85,000	165,000

Of the 42-million-ton reserve base in Australia, about 3 million tons on the east coast cannot be mined because of environmental concerns.

World Resources: Identified world resources of rutile (including anatase) total about 200 million tons of contained TiO_2 . Major rutile resources occur in Australia, India, Italy, Sierra Leone, the Republic of South Africa, and the United States. The Brazilian resources are mainly anatase.

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.

*Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹See also Ilmenite and Titanium and Titanium Dioxide.

²Includes synthetic rutile.

³Employment 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.

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

⁵See Appendix B.

⁶See Appendix C for definitions.

⁷As constituted before Dec. 1991.

⁸Excludes U.S. production.

SALT

(Data in thousand metric tons, unless noted)

Domestic Production and Use: Domestic production of salt increased an estimated 5% in 1993, with total value exceeding an estimated \$854 million. Twenty-eight companies operated 67 plants in 14 States. The estimated percentage of salt sold or used, by type, was salt in brine, 47%; rock salt, 35%; vacuum pan, 10%; and solar salt, 8%.

The chemical industry consumed about 44% of total salt sales, with salt brine representing about 88% of the type of salt used for feedstock. Chlorine and caustic soda manufacture was the main consuming sector within the chemical industry. Salt for highway deicing accounted for 21% of U.S. demand. The remaining markets for salt, in declining order, were distributors, 11%; food and agricultural, 7%; general industrial, 7%; primary water treatment, 1%; and other, 9%.

Salient Statistics—United States:¹	1989	1990	1991	1992	1993[*]
Production	35,632	36,794	36,316	36,016	37,700
Sold or used by producers	35,250	36,916	35,902	34,784	38,000
Imports for consumption	5,519	5,969	6,188	5,394	5,700
Exports	1,422	2,266	1,777	992	700
Consumption, apparent	39,347	40,619	40,313	39,186	43,000
Price, average value of bulk, pellets and packaged salt, dollars per ton, f.o.b. mine and plant:					
Vacuum and open pan salt	102.22	110.58	114.75	112.53	111.00
Solar salt	30.73	34.83	27.78	32.56	34.00
Rock salt	18.06	18.52	19.25	19.63	18.00
Salt from brine	6.25	5.36	5.45	4.35	4.25
Stocks, producer, yearend ²	382	122	414	1,232	300
Employment, mine and plant	4,150	4,150	4,150	4,150	4,150
Net import reliance ³ as a percent of apparent consumption	10	9	11	11	12

Recycling: None.

Import Sources (1989-92): Canada, 40%; Mexico, 24%; the Bahamas, 11%; Chile, 7%; and other, 18%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁴
			1/1/94	1/1/94
Iodized salt	2501.00.0000		Free	26% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: A major salt producer in the Netherlands acquired a salt company in Denmark; however, the European Commission initiated an investigation at yearend of the Dutch company claiming that the acquisition resulted in a possible domination of the salt market in Western Europe. The same Dutch salt company also objected to the announced funding of a new salt project at Sexbierum, near Harlingen in the Netherlands. The \$66 million project is contingent on a subsidy from the Dutch economic affairs ministry. Overcapacity and declining salt markets in Europe were cited as the reasons for the objections.

SALT

A new \$40 million salt facility is under construction at Sdom, Israel, that will use solar salt to produce 700,000 tons per year of high-purity salt comparable to that of vacuum pan salt. Besides the high-grade salt to be used for food and chemical uses, other grades of less purity will also be made for deicing and general industrial applications.

A major U.S. chloralkali company that had been involved in bankruptcy proceedings was acquired at yearend by a consortia. The venture would consolidate the chloralkali operations at Acme, NC, Orrington, ME, and Brunswick, GA.

Environmental activists sought to eliminate all chlorine-base compounds used as feedstock in the Great Lakes region of Canada and the United States. A study was conducted by the chloralkali industry that reported the economic impact of the ban would cost \$91 billion in the United States and \$11 billion in Canada, with the closure of 25 chlorine plants and 153 polyvinyl chloride facilities. In addition, the study stated that more than 220,000 jobs would be lost directly or indirectly because of the ban, and that alternative chemicals to replace chlorine-base compounds would require \$67 billion in new plant construction costs and would take 10 to 20 years to complete.

World Production, Reserves, and Reserve Base:

	Production		Reserves and reserve base ⁵
	1992	1993 ^a	
United States ¹ (sold or used)	34,784	38,000	Large. Economic and subeconomic deposits of salt are substantial in principal salt-producing countries. The oceans comprise an inexhaustible supply of salt.
Australia	8,000	8,000	
Canada	11,154	11,100	
China	25,000	25,000	
France	6,600	6,500	
Germany	13,125	13,000	
India	9,503	9,500	
Italy	4,100	4,200	
Mexico	7,600	7,600	
Poland	3,900	3,700	
Russia	3,600	3,400	
Ukraine	4,400	4,200	
U.S.S.R. ⁶	3,000	3,000	
United Kingdom	6,600	6,500	
Other countries	43,488	41,300	
World total	184,854	185,000	

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.

^aEstimated.

¹Excludes Puerto Rico.

²Reported 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 production and salt sold or used.

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

⁴See Appendix B.

⁵See Appendix C for definitions.

⁶As constituted before Dec. 1991. In addition to the former republics of the U.S.S.R. listed, it is believed that Armenia, Azerbaijan, and Turkmenistan also produce salt; however, information is inadequate to formulate reliable estimates of individual country production.

SAND AND GRAVEL (CONSTRUCTION)¹(Data in thousand short tons, unless noted)²

Domestic Production and Use: Construction sand and gravel valued at \$3.5 billion was produced by 4,200 companies from 6,000 operations in 50 States. Leading States, in order of volume, were California, Ohio, Michigan, Texas, Washington, New York, Arizona, Illinois, Colorado, and Minnesota, which together accounted for about 51% of the total output. It is estimated that, of the 947 million tons of construction sand and gravel produced in 1993, about 26% were unspecified uses. Of the remaining total, about 40% was used as concrete aggregates; 30% for road base and coverings and road stabilization; 15% as asphaltic concrete aggregates and other bituminous mixtures; 10% as construction fill; 2% for concrete products such as blocks, bricks, pipes, etc.; 2% for plaster and gunite sands; and the remainder for snow and ice control, railroad ballast, roofing granules, filtration, and other miscellaneous uses. To provide a more accurate estimation of the consumption patterns for construction sand and gravel, the "unspecified uses" are not included in the above percentages. It is recommended that, in any use-pattern analysis, the quantities included in "unspecified uses" be distributed among the reported uses by applying the above percentages.

The estimated output of construction sand and gravel shipped for consumption in the first 9 months of 1993 was about 688 million tons, which represents an increase of 2.2% compared with the same period of 1992. The 9-month estimated total does not include Alaska and Hawaii. Additional production information by quarters for each State, geographic region, and the United States is published in the Quarterly Mineral Industry Survey for Crushed Stone and Sand and Gravel.

Salient Statistics—United States:

	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>
Production	*897,300	910,600	*780,300	919,300	947,000
Imports for consumption	427	1,742	1,465	1,445	1,400
Exports	1,125	468	1,139	1,565	1,400
Consumption, apparent	896,600	911,874	780,626	919,180	947,100
Price, average value, dollars per ton	3.62	3.57	3.60	3.63	3.69
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill*	41,245	41,770	41,430	41,600	42,000
Net import reliance ³ as a percent of apparent consumption	E	E	E	E	E

Recycling: Asphalt road surfaces and cement concrete surfaces and structures were recycled on a limited but increasing basis.

Import Sources (1989-92): Construction sand and gravel: Canada, 59%; the Bahamas, 21%, Antigua and Barbuda, 6%; and other, 14%.

<u>Tariff:</u> Item	<u>Number</u>	<u>Most favored nation (MFN)</u> <u>1/1/94</u>	<u>Non-MFN⁴</u> <u>1/1/94</u>
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.

SAND AND GRAVEL (CONSTRUCTION)

Events, Trends, and Issues: Construction sand and gravel output increased 3% in 1993. It is estimated that 1994 domestic production and U.S. apparent consumption will be about 960 million tons each.

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 due to local zoning regulations and land development. This is expected to continue to cause a movement of sand and gravel operations away from highly populated centers.

World Mine Production, Reserves, and Reserve Base:

	Mine production	
	1992	1993 ^p
United States	919,300	947,000
Other countries	NA	NA
World total	NA	NA

Reserves and reserve base⁵

The reserves and reserve base are controlled largely by land use and/or environmental constraints. Local shortages of sand or gravel are common.

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 plain, river channel, and glacial deposits. Marine deposits are being used presently in 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.

*Estimated. ^pPreliminary. E Net exporter. NA Not available.

¹See also Sand and Gravel (Industrial).

²See Appendix A for conversion to metric units.

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

⁴See Appendix B.

⁵See Appendix C for definitions.

SAND AND GRAVEL (INDUSTRIAL)

(Data in thousand short tons, unless noted)¹

Domestic Production and Use: Industrial sand and gravel valued at nearly to \$402 million was produced by 88 companies from 155 operations located in 39 States. Leading States, in order of volume, were Illinois, California, Michigan, New Jersey, and Texas. Combined production represented 42% of the national total. About 42% of this tonnage was used as glassmaking sand, 20% as foundry sand, 7% as abrasive sand, 6% as hydraulic fracturing sand, 22% for other miscellaneous uses, and 3% for other unspecified uses.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production	29,200	28,400	25,600	27,000	27,900
Imports for consumption	35	73	91	181	43
Exports	2,060	1,155	1,637	1,474	1,713
Consumption, apparent	27,200	27,300	24,100	25,700	26,200
Price, average value, dollars per ton	14.05	15.36	15.25	15.76	14.43
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill ²	1,600	1,600	1,500	1,500	1,600
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 (1989-92): Australia, 39%; Belgium, 35%; Germany, 24%; and other, 2%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN³ 1/1/94
	95% or more silica and not more than 0.6% iron oxide	2505.10.1000	Free	\$1.97/mt.

Depletion Allowance: Industrial sand or pebbles, 14% (Domestic and Foreign).

Government Stockpile: None.

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 published by the U.S. Bureau Of Mines. 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. The Bureau continually seeks to improve the accuracy of its data on world industrial sand and gravel production, and revisions should be expected.

The U.S. 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. 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 (i.e., very favorable freight rates).

Industrial sand and gravel sold or used increased about 3% in 1993 compared to 1992. It is estimated that 1994 domestic production and U.S. apparent consumption will be about 28 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 1993. 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 ^a		Reserves and reserve base ⁴
	1992	1993	
United States	27,000	27,900	Large. Silica is abundant in the Earth's crust. The reserves and reserve base are controlled by the location of population centers.
Argentina	9,370	9,000	
Australia	2,210	2,200	
Austria	2,205	2,100	
Belgium	2,728	2,700	
Brazil	3,858	3,900	
Canada	1,642	1,600	
France	3,860	4,000	
Germany	8,800	9,000	
India	2,980	3,000	
Italy	4,410	4,300	
Japan	4,255	4,100	
Mexico	1,310	1,300	
Netherlands	22,046	22,000	
Paraguay	2,200	2,200	
South Africa, Republic of	1,929	1,800	
Spain	2,400	2,200	
United Kingdom	3,970	4,000	
Other countries	10,000	11,000	
World total (rounded)	117,000	118,000	

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.

^aEstimated. E Net exporter. NA Not available.

¹See Appendix A for conversion to metric units.

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

³See Appendix B.

⁴See Appendix C for definitions.

SCANDIUM

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

Domestic Production and Use: Scandium was not mined domestically in 1993. Byproduct scandium concentrates previously produced in Utah and tailings previously generated by mining fluorite in Montana were processed to recover high-purity scandium oxide. Four processing companies, two in Colorado, one in Illinois, and one in New Jersey, produced refined scandium products. A company in Iowa had technology to produce ultrahigh-purity (99.9999%) scandium oxide. Companies in Arizona, Illinois, and Iowa possessed capacity to produce ingot and distilled scandium metal products. Scandium used in the United States came primarily from domestic sources. The principal uses for scandium were in high-intensity metal halide lamps, analytical standards, electronics, lasers, and research.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
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, 99.0% purity	5,000	3,500	2,000	1,500	1,500
Per kilogram, oxide, 99.9% purity	7,500	7,000	3,500	3,000	3,000
Per kilogram, 99.99% purity	9,000	8,000	6,000	5,000	5,000
Per kilogram, 99.999% purity	10,000	10,000	10,000	10,000	8,000
Per gram, powder, metal ¹	296.00	296.00	296.00	372.00	372.00
Per gram, sublimed, metal ²	248.20	248.20	248.20	312.00	312.00
Per gram, scandium bromide	NA	NA	NA	NA	77.00
Per gram, scandium chloride	NA	NA	NA	NA	119.00
Per gram, scandium fluoride	NA	NA	NA	NA	71.00
Per gram, scandium iodide	NA	NA	NA	NA	74.00
Stocks	NA	NA	NA	NA	NA
Employment	6	6	5	6	8
Net import reliance ³ as a percent of apparent consumption	NA	NA	NA	NA	NA

Recycling: Minor, recovered from laser crystal rods.

Import Sources (1989-92): Not available.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁴ 1/1/94
	Rare-earth metal ores, complex silicates, including scandium ores	2530.90.0050	Free	Free.
	Rare-earth metals, and yttrium, whether or not intermixed or inter-alloyed, including scandium	2805.30.0000	70.5¢/kg	\$4.41/kg.
	Rare-earth compounds, including individual rare-earth oxides, hydroxides, nitrates, and other individual compounds, including scandium oxide	2846.90.5000	3.7%	25% ad val.
	Mixtures of rare-earth oxides except cerium oxide, including scandium oxide mixtures	2846.90.2010	Free	25% ad val.

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

Government Stockpile: None.

SCANDIUM

Events, Trends, and Issues: Prices for scandium oxide stabilized as demand decreased. The availability of low-cost imports from China and limited demand for scandium products contributed to the decline. Domestic consumption was primarily in high-pressure metal halide lamps, research, analytical standards, and semiconductors.

With the creation of the newly independent states (NIS), that comprised the former U.S.S.R., market activity for scandium has been active. Previously, under the strict control of the Soviet Government, only limited quantities of scandium were available to world markets. Scandium's availability increased radically in 1992 under the NIS with metal, alloys, and compounds available from brokers, universities, research facilities, producers, and from stocks held by State governments. Prices quoted from the NIS, overall, have been much higher than domestic market prices. Despite a flurry of activity, actual sales to the relatively small domestic market were negligible.

The unit price for scandium metal and compounds varies inversely with the quantity of the material purchased, especially between the gram and kilogram. Prices for scandium remained mostly stable throughout the 1970's and early 1980's. In 1984, the U.S.S.R., the world's principal source, ceased all exports to meet internal demand for military applications and research. As a result, prices rose sharply, and a U.S. scandium industry developed to meet domestic demand. Since 1985, domestic demand has been supplied from U.S.-produced materials, and U.S. prices have gradually returned to their pre-1984 level.

World Mine Production, Reserves, and Reserve Base: Scandium was produced as a byproduct material in China and the NIS. Foreign mine production data were not available. No scandium was mined in the United States; however, scandium ore is intermittently recovered from tailings and concentrates as needed. Scandium occurs in many ores in trace quantities but has not been found in sufficient quantities to be considered a reserve or a reserve base.⁵ As a result of its low concentration, scandium has been produced exclusively as a byproduct 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 does not have an affinity to combine with the common ore-forming anions and therefore is not commonly found concentrated in nature. It is widely dispersed in the lithosphere and forms solid solutions in more than 100 minerals. In the Earth's crust, scandium is primarily a trace constituent of ferromagnesium minerals. Concentrations in these minerals (amphibole-hornblende, 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 has been noted in wolframite, columbite, cassiterite, beryl, garnet, muscovite, phosphates, and the rare-earth minerals. Recent domestic production has been primarily from the scandium-yttrium silicate mineral, thortveitite, and from byproduct leach solutions from uranium operations.

The principal domestic scandium resource is fluorite tailings from the Crystal Mountain deposit near Darby, MT. Tailings from the mined-out fluorite operations, which were generated from 1952 to 1971, contain thortveitite and associated scandium-enriched minerals. Resources are also contained in the tungsten, molybdenum, and titanium minerals from the Climax molybdenum deposit in Colorado, and in kolbeckite (sterrettite), varisite, and crandallite at Fairfield, UT. Other low-grade domestic resources are present in ores and residues of aluminum, iron, molybdenum, nickel, phosphate, tantalum, tin, titanium, tungsten, zinc, and zirconium.

Foreign resources are known in China, the NIS, Madagascar, and Norway. China's resources are in tin, tungsten, and iron in Fujian, Guangdong, Guangxi, Jiangxi, and Zhejiang Provinces. NIS resources are reportedly in the Kola Peninsula apatites and in uranium-bearing deposits. Madagascar's scandium is concentrated in pegmatites in the Befanomo area. Resources in Norway are contained in the thortveitite-rich pegmatites of the Iveland-Evje region and a deposit to the north near Finnmark. Undiscovered scandium resources are believed to be very large.

Substitutes: In scandium's few applications, such as lighting and lasers, it is generally not subject to substitution.

*Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹250 micron, 99.9% purity, 1989 through 1993 prices converted from 0.5 gram price, from Aesar/Johnson Matthey.

²Dendritic lump, 99.9% purity, 1989 through 1993 price for 99.99% purity, from Aesar/Johnson Matthey.

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

⁴See Appendix B.

⁵See Appendix C for definitions.

SELENIUM

(Data in metric tons of selenium content, unless 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 \$2.8 million. Anode slimes from other primary electrolytic refiners were exported for processing. The estimated consumption of selenium by end use was as follows: electronics, 35%; chemicals and pigments, 20%; glass manufacturing, 30%; and other, including agriculture and metallurgy, 15%. In electronics, high-purity selenium was used primarily as a photoreceptor on the drums of plain paper copiers. In glass manufacturing, selenium was used as a decolorant in container glass and other soda-lime silica glass 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, antidandruff shampoos, and vitamin supplements for humans. Dietary supplements for livestock were the largest agricultural usage. In metallurgical applications, selenium was added to copper, lead, and steel alloys to improve machinability.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production, refinery	253	287	260	243	250
Imports for consumption, metal and dioxide	417	381	343	371	360
Exports, metal, waste, and scrap	372	207	210	175	300
Consumption, apparent ¹	560	530	510	490	460
Price, dealers, average, dollars per pound, 100-pound lots, refined, yearend	7.61	5.82	5.41	5.13	5.10
Stocks, producer, refined, yearend	W	W	W	W	W
Employment	NA	NA	NA	NA	NA
Net import reliance ² as a percent of apparent consumption	55	46	50	48	46

Recycling: There was no domestic production of secondary selenium. Scrap xerographic materials were exported for recovery of the contained selenium. An estimated 100 tons of selenium metal recovered from scrap was imported in 1993.

Import Sources (1989-92): Canada, 37%; Japan, 16%; Belgium, 14%; United Kingdom, 13%; and other, 20%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN³
			1/1/94	1/1/94
	Selenium metal	2804.90.0000	Free	Free.
	Selenium dioxide	2811.29.2000	Free	Free.

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

Government Stockpile: None.

SELENIUM

Events, Trends, and Issues: Overall selenium demand was sluggish in 1993, similar to that of 1992. Domestic production was level with the previous year. In 1992, one domestic refinery began sending semirefined selenium filter cake (90% selenium content) for toll-refining overseas.

The Food and Drug Administration (FDA) ruled to stay the 1987 amendments to the selenium food additive regulations concerning animal feed additives. The amendments provided for an increase in the maximum amount of selenium permitted in animal feed. Several organizations objected to the 1987 ruling on the basis that there were inadequacies in the FDA's finding that there would be no significant impact on the environment from the expected increase in selenium content of animal excretions. The maximum selenium content will revert to the levels permitted before the 1987 amendments.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves ⁴	Reserve base ⁴
	1992	1993 [*]		
United States	243	250	10,000	19,000
Belgium	250	250	—	—
Canada	294	300	7,000	15,000
Chile	50	70	19,000	30,000
Finland	35	30	—	—
Germany	100	100	—	—
India	4	5	1,000	1,000
Japan	570	550	—	—
Mexico	3	5	3,000	4,000
Peru	12	10	2,000	5,000
Philippines	60	80	2,000	3,000
Serbia and Montenegro ⁵	55	40	1,000	1,000
Sweden	25	25	—	—
Zambia	23	15	3,000	6,000
Other countries	NA	NA	23,000	50,000
World total (may be rounded)	⁶ 1,700	⁶ 1,700	70,000	130,000

World Resources: In addition to the reserve base of selenium contained in identified copper deposits of economic grade, 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.

^{*}Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹Calculated using reported shipments, imports of selenium metal, and estimated exports of selenium metal, excluding scrap.

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

³See Appendix B.

⁴See Appendix C for definitions.

⁵Formerly parts of Yugoslavia.

⁶In addition to the countries listed, Australia, China, Kazakhstan, Russia, and the United Kingdom are known to produce refined selenium, but output is not reported, and available information is inadequate for formulation of reliable production estimates.

SILICON

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

Domestic Production and Use: Estimated value of silicon metal and alloys (excluding semiconductor-grade silicon) produced in the United States in 1993 was about \$370 million. Ferrosilicon was produced by six companies in seven plants, while production of silicon metal was distributed between seven companies in eight plants. 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 half of the United States. The main consumers of silicon metal were aluminum producers and the chemical industry. Silicon carbide was used as an abrasive in heat and corrosion-resisting hardware.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production	439	418	363	370	370
Imports for consumption	157	217	164	193	212
Exports	32	36	35	38	31
Consumption, apparent	548	588	500	532	560
Price, ¹ average, cents per pound Si:					
Ferrosilicon, 50% Si	49.6	42.4	38.3	36.9	40.6
Ferrosilicon, 75% Si	49.0	39.9	37.0	35.4	40.5
Silicon metal	58.8	54.8	61.5	60.0	66.7
Stocks, producer and consumer, yearend	61	72	64	57	48
Employment, plant*	2,600	2,500	2,300	2,300	NA
Net import reliance ² as a percent of apparent consumption	20	29	27	30	34

Recycling: Insignificant.

Import Sources (1989-92): Brazil, 27%; Canada, 13%; Venezuela, 13%; Norway, 11%; U.S.S.R.,³ 11%; and other, 25%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁴ 1/1/94
	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:			
	Ferrosilicon, more than 2% Mg	7202.29.0010	Free	4.4¢/kg Si.
	Ferrosilicon, other	7202.29.0050	Free	4.4¢/kg Si.
	Silicon, more than 99.99% Si	2804.61.0000	3.7% 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	9% ad val.	45% ad val.

Depletion Allowance: Quartzite, 14% (Domestic and Foreign); gravel, 5% (Domestic and Foreign).

Government Stockpile:

Stockpile Status—9-30-93

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Silicon carbide, crude, metric tons, gross weight	32,891	915	32,891	3,856

Events, Trends, and Issues: Overall demand for silicon increased compared with that of the previous year. Demand for silicon ferroalloys closely follows overall iron and steel production, whereas demand for silicon metal largely reflects the health of the aluminum and chemical industries. Consumption of ferrosilicon and miscellaneous silicon alloys was about 340,000 tons, while consumption of silicon metal was about 220,000 tons. In mid October, the import price for 50%-grade ferrosilicon was \$0.43 to \$0.44 per pound, the import price for 75%-grade ferrosilicon was \$0.435 to \$0.45 per pound, and the import price for silicon metal was \$0.63 to \$0.65 per pound. For the first half-year, total gross ferrosilicon imports decreased by about 30% and silicon metal imports increased by about 50% compared with imports for the first half of 1992.

SILICON

During the year, the International Trade Commission (ITC) and the Department of Commerce (DOC) concluded their antidumping investigations on ferrosilicon imports from Argentina, China, Egypt, Kazakhstan, Russia, Ukraine, and Venezuela. The agencies determined that ferrosilicon imports from these countries, with the exception of Argentina and Egypt, were sold at less than fair value and caused material harm to the domestic industry. The DOC assessed the dumping duty for China at 137.73%; Kazakhstan, Russia, and Ukraine at 104.18%; and Venezuela at 9.55%. Also, Venezuela was assessed a countervailing duty of 22.08%.

In February, the DOC announced Final Scope Rulings—Antidumping Duty Orders on Silicon Metal from China, Brazil, and Argentina. In 1991, the DOC and the ITC had determined that imports of silicon metal, containing between 96% and 99.99% silicon by weight, from these countries were sold at less than fair value in the United States and caused material harm to the domestic industry. The DOC assessed the dumping duty for China at 139.49% and Argentina at 8.65%. The duty for Brazil was assessed against individual producers over a range of 87.79% to 93.2%. In March 1992, petitioners in the original investigation requested that DOC determine that material containing a lower silicon content, between 89% and 96% silicon by weight, because of a higher aluminum content, is covered by the antidumping duty order in effect for silicon metal imports from China. After its formal inquiry, the DOC concluded that silicon metal with a high aluminum content containing between 89% to 96% silicon by weight is within the scope of the class or kind of material subject to the antidumping duty orders on silicon metal from China, Brazil, and Argentina.

In August, the U.S. Trade Representative announced that the Generalized System of Preferences (GSP), which had expired on July 4, 1993, was extended to September 30, 1994. The GSP extension was part of the Budget Reconciliation Act signed by the President. The legislation extending the GSP is retroactive to July 4. Additionally, the legislation removes the statutory prohibition against providing GSP benefits to the countries which made up the former U.S.S.R.³ Under GSP, the United States grants duty-free access to goods from more than 140 developing countries and territories. In Proclamation 6599 of September 30, 1993, the President designated Russia as a beneficiary developing country for purposes of the GSP. GSP status for Russia is part of the Administration's overall efforts to help that country pursue badly needed market reforms. Ukraine and Kyrgyzstan also were being considered for GSP status.

It is estimated that in 1994 domestic production of silicon-containing ferroalloys and metal will be less than 400,000 tons and U.S. apparent consumption will be less than 600,000 tons.

World Mine Production, Reserves, and Reserve Base:

	Mine production ^a		Reserves and reserve base ^b
	1992	1993	
United States	370	370	The reserves and reserve base in most major producing countries are ample in relation to demand. Quantitative estimates are not available.
Brazil	260	250	
Canada	50	50	
China	750	750	
France	140	140	
Kazakhstan	350	350	
Norway	340	350	
Russia	310	300	
Ukraine	250	250	
Other countries	650	680	
World total	3,470	3,490	

World Resources: The world and domestic resources for making silicon metal and alloys are abundant and, in most producing countries, adequate to supply world requirements for many decades.

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.

^aEstimated. NA Not available.

¹Based on U.S. dealer import price.

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

³As constituted before Dec. 1991; for 1992, reported imports of unknown origin, possibly Kazakhstan, Russia, or Ukraine.

⁴See Appendix B.

⁵See Appendix C for definitions.

SILVER

(Data in metric tons¹ of silver content, unless noted)

Domestic Production and Use: Silver produced by about 120 mines in 17 States had an estimated value of \$230 million. The following four States accounted for nearly three-fourths of the 1993 mine production: Nevada, 46%; Idaho, 11%; Arizona, 9%; and Montana, 8%. About one-sixth of the domestic silver production was from silver ores, one-third from gold ores, and one-half from base metal ores. There were 22 principal refiners of commercial-grade silver. The principal silver fabricators were located primarily in the Northeast. 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. Approximately 50% of the refined silver consumed domestically during 1993 was used in the manufacture of photographic products; 20% in electrical and electronic products; 10% in electroplated ware, sterlingware, and jewelry; and 20% in other uses.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Production: Mine	2,008	2,121	1,855	1,804	1,700
Refinery: Primary	1,718	1,939	1,879	2,158	2,000
Secondary (old scrap)	714	454	215	148	200
Imports for consumption ²	3,306	3,355	4,151	4,990	4,500
Exports ²	1,280	1,848	1,681	1,753	1,700
Shipments from Government stockpile excesses	337	107	255	356	300
Consumption, reported: Industrial	NA	NA	NA	NA	NA
Coinage	264	265	285	*300	300
Demand, apparent ³	5,063	4,355	3,832	4,057	4,000
Price, average, New York, dollars per troy ounce	5.50	4.82	4.04	3.94	4.20
Stocks, yearend: Treasury Department ⁴	997	840	1,028	775	700
Industry, COMEX, CBT ⁵	8,339	9,219	9,373	10,059	9,000
Department of Defense	81	31	26	29	30
Employment, mine and mill ⁶	2,800	2,600	1,900	1,600	1,500
Net import reliance ⁷ as a percent of apparent consumption	(⁸)	(⁸)	(⁸)	(⁸)	(⁸)

Recycling: About 200 metric tons of silver was recovered from old scrap in 1993, equivalent to 5% of the apparent demand for refined bullion. About 1,700 metric tons was recovered from new scrap.

Import Sources (1989-92): Mexico, 35%; Canada, 27%; United Kingdom, 9%; Peru, 9%; and other, 20%.

Tariff:

No duties are imposed on imports of unrefined silver or refined bullion.

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

Government Stockpile:

	Stockpile Status—9-30-93			
Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Silver	2,038	—	2,038	266

SILVER

Events, Trends, and Issues: Continuing the trend begun in 1991, several large domestic silver producers halted mining operations in 1993. As in earlier years, operators attributed the closures to the low silver price. As a result, U.S. mine production of silver declined for the third consecutive year. Although mining has been halted at a number of mines since 1991, the impact of these closures on domestic production has been gradual, owing in part to continued processing of previously mined ore.

The Government continued to dispose of the silver held in the National Defense Stockpile, using it for the production of commemorative coins and the Eagle silver bullion coins. In nearly 12 years, from 1982 through late 1993, the Government has reduced the quantity of silver held in the stockpile from nearly 4,300 metric tons to less than 2,000 metric tons.

In 1993, the average silver price increased for the first time in 6 years. Through the first 9 months, the daily price ranged between \$3.54 and \$5.37 per troy ounce. Analysts attributed the price increase to improved economic conditions in the United States and to an increase in speculative activity and investor demand.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁹	Reserve base ⁹
	1992	1993 ^e		
United States	1,804	1,700	31,000	72,000
Australia	1,245	1,200	29,000	33,000
Canada	1,207	1,100	37,000	47,000
Mexico	2,316	2,200	37,000	40,000
Peru	1,570	1,600	25,000	37,000
Other countries	7,203	7,100	120,000	190,000
World total (may be rounded)	15,345	14,900	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.

^eEstimated. NA Not available.

¹1 metric ton (1,000 kilograms) = 32,150.7 troy ounces

²Excludes coinage.

³Defined as refinery production from primary materials + refinery production from old scrap + net imports of bullion. Represents not only the quantity of silver required by the domestic fabricating industry, some of which may be placed in stocks, but also the quantity of silver demanded by U.S. investors.

⁴Balance in Mint only.

⁵Industry: Refiner, fabricator, and dealer. COMEX: Commodity Exchange Inc., New York. CBT: Chicago Board of Trade.

⁶Source: Mine Safety and Health Administration.

⁷Defined as imports - exports + adjustments for Government and industry stock changes.

⁸The United States is a net importer of silver; however, changes in unreported investor stocks preclude calculation of a meaningful net import reliance.

⁹Includes silver recoverable as a byproduct of base metal ores. See Appendix C for definitions.

SODA ASH

(Data in thousand metric tons, unless noted)

Domestic Production and Use: Five companies in Wyoming and one in California composed the U.S. soda ash industry, which was the largest in the world. The six producers, with a combined annual nameplate capacity of 10.7 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. The total estimated value of domestic soda ash produced in 1993 was \$718 million.¹

The reported distribution of soda ash by end use was glass, 49%; chemicals, 24%; soap and detergents, 12%; distributors, 6%; flue gas desulfurization, 3%; pulp and paper, 2%; water treatment, 2%; and other, 2%.

Salient Statistics—United States:		1989	1990	1991	1992	1993*
Production ²		8,995	9,156	9,005	9,379	9,200
Imports for consumption		129	146	134	72	75
Exports		2,648	2,392	2,734	2,955	2,900
Consumption: Reported		6,469	6,527	6,278	6,278	6,496
Apparent		6,516	6,844	6,458	6,359	6,496
Price: Quoted, yearend, soda ash, dense, bulk, f.o.b. Green River, WY, dollars per short ton		93.00	98.00	98.00	98.00	98.00
F.o.b. Searles Valley, CA, same basis		123.00	123.00	123.00	123.00	123.00
Average sales value (natural source), f.o.b. mine or plant, same basis		77.07	82.85	84.18	80.93	78.00
Stocks, producer, yearend		221	287	234	371	250
Employment, mine and plant		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 (1989-92): Canada, 99%; and other, 1%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁴
			1/1/94	1/1/94
	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: An antidumping complaint was filed at midyear with the European Community Commission on behalf of the European soda ash industry regarding imports of soda ash from the United States. The rise of imported U.S. soda ash allegedly was the cause for the announced yearend closures of two synthetic soda ash plants in Cologne and Heilbronn, Germany, and one plant in Couillet, Belgium. The Belgian plant was the first synthetic plant built using the Solvay process, dating back to 1864. All were relatively small and comparatively inefficient when compared with those being modernized, such as those at Bernberg, Germany, and Nancy, France. The closures will result in an annual loss of 900,000 tons of total production capacity throughout Europe. Before the complaint, the United States had been shipping about 800,000 tons to Western Europe, with three of the domestic producers being European owned.

SODA ASH

A company announced plans to construct an underground trona operation in Wyoming that would have an annual capacity of 1.13 million tons of trona. When all the permits and the funds are secured, construction could begin by mid-1995 with production commencing in 1997. The plant was scheduled to produce a soda ash product having an average purity of 97% that could be used by some industries not requiring a high-grade soda ash that presently is made using the monohydrate process.

The U.S. Bureau of Land Management proposed to increase the Federal royalty rate from 5% to 8% on soda ash produced from Federal lands in Wyoming. Although no final decision on the rate had been made by yearend, it was expected that the rate would go to 8% because of the growing interest to maximize revenue received from the use of Federal lands.

In September, five of the six U.S. soda ash companies raised their off-list prices by \$6 but not to exceed the list price of the California and Wyoming material. The increase was required to offset declining revenue received because of stagnant domestic market conditions and reduced export sales to Europe as a result of the antidumping investigation.

World Production, Reserves, and Reserve Base:

	Production		Reserves ^{5 6}	Reserve base ⁸
	1992	1993 ⁹		
Natural				
United States	9,379	9,200	⁷ 23,130,000	⁷ 38,736,000
Botswana	150	150	363,000	NA
Chad	NA	NA	7,000	NA
Kenya	245	245	51,000	NA
Mexico	190	160	180,000	454,000
Turkey	—	—	196,000	235,000
Uganda	NA	NA	16,000	NA
Other countries	—	—	257,000	219,000
World total, natural	9,964	9,755	24,200,000	39,644,000
World total, synthetic	21,103	21,745	—	—
World total	31,067	31,500	—	—

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 trona⁴ 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.

Substitutes: Caustic soda can be substituted for soda ash in certain uses. An alternate source of soda ash presently being solution mined is nahcolite, which is commingled with Colorado oil shale. Commercial development of oil shale mining with byproduct nahcolite and dawsonite recovery is not planned in the near term.

*Estimated. E Net exporter. NA Not available.

¹Does not include values for soda liquors and mine waters.

²Natural only.

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

⁴See Appendix B.

⁵The reported quantities are sodium carbonate only. About 1.8 tons of trona yields 1 ton of sodium carbonate.

⁶See Appendix C for definitions.

⁷From trona, nahcolite, and dawsonite sources.

SODIUM SULFATE

(Data in thousand metric tons, unless noted)

Domestic Production and Use: The domestic natural sodium sulfate industry consisted of three producers operating a total of three plants in California, Texas, and Utah. Total production of natural and synthetic sodium sulfate remained virtually the same compared with that of the previous year. Approximately 50% of total production was a byproduct from facilities that manufacture rayon and various chemicals. The total value of sodium sulfate sold was an estimated \$51 million.

End uses of sodium sulfate were soap and detergents, 44%; pulp and paper, 24%; textiles, 16%; glass, 5%; and miscellaneous, 11%.

Salient Statistics—United States:		1989	1990	1991	1992	1993*
Production:	Natural	340	349	354	337	315
	Synthetic ¹	345	364	366	272	300
Imports for consumption		173	162	157	158	155
Exports		62	62	103	155	100
Consumption, apparent (natural and synthetic)		826	798	778	600	677
Price:	Quoted, sodium sulfate (100% Na ₂ SO 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	91.55	96.63	87.34	77.93	80.00
Stocks, producer, yearend, natural		24	39	35	47	40
Employment, well and plant		300	250	240	240	240
Net import reliance ² as a percent of apparent consumption		17	11	7	E	9

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 (1989-92): Canada, 95%; Mexico, 4%; and other, 1%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN³ 1/1/94
Disodium sulfate:				
	Saltcake (crude)	2833.11.1000	Free	Free.
	Other	2833.11.5000	32.5¢/ton	\$2.95/ton.
	Anhydrous	2833.11.5010	32.5¢/ton	\$2.95/ton.
	Other	2833.11.5050	32.5¢/ton	\$2.95/ton.

Depletion Allowance: 14% (Domestic), 14% (Foreign). For natural only.

Government Stockpile: None.

Events, Trends, and Issues: Domestic sodium sulfate consumption increased because of greater demand by the textile and carpet freshener industries. Although sales to the pulp and paper sector has been declining because some pulp facilities generate their own byproduct saltcake, sodium sulfate consumption by the detergent industry improved slightly because some manufacturers reformulated powdered home laundry products for certain regions of the country to provide a lower priced detergent product than the higher priced superconcentrates or liquid alternatives.

SODIUM SULFATE

A new battery recycling operation in Waynesboro, GA, will come on-stream to produce byproduct sodium sulfate. The facility is expected to recover about 27,000 tons of sodium sulfate annually. An Austrian-based cellulose producer with a rayon operation at Lowland, TN, announced plans to increase byproduct sodium sulfate recovery in 1994. The expansion is anticipated to raise capacity by 25%, from about 33,000 tons to 41,000 tons.

A Canadian sodium sulfate company operating at Ormiston, Saskatchewan, continued to promote its new method to produce soda ash, ammonium sulfate, and caustic soda using natural sodium sulfate as feedstock. Because sales of sodium sulfate have been declining, the company evaluated alternative markets and technology rather than contemplate closure. On March 24, 1992, patent number 5,098,532 was issued to the company detailing the process for producing these sodium-base chemicals from saltcake.

A pilot project to reduce stack gas emissions by 99% was tested at a 3-megawatt power facility at Dunkirk, NY. The process generated byproduct sodium sulfate by using bipolar membranes to regenerate a waste solution produced by the scrubber into acidic components for recycling. A sulfur dioxide stripper is used that separates the effluent into sulfur dioxide and sodium sulfate, which could be sold to various end users.

World Production, Reserves, and Reserve Base:

	Production		Reserves ⁴	Reserve base ⁴
	1992	1993 [*]		
Natural				
United States	337	315	857,000	1,361,000
Argentina	10	10	NA	NA
Canada	280	280	84,000	272,000
Iran	150	150	NA	NA
Mexico	518	500	165,000	227,000
Spain	450	450	180,000	272,000
Turkey	75	75	100,000	NA
Turkmenistan ⁶	200	200	NA	200
Other countries	174	170	100,000	200,000
World total, natural	2,194	2,150	⁶ 3,300,000	⁷ 4,600,000
World total, synthetic	2,103	2,150	—	—
World total	4,297	4,300	—	—

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 the Republic of South Africa. Commercial production from domestic resources is from deposits in California, Texas, and Utah. 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 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.

*Estimated. E Net exporter. NA Not available.

¹Source: Bureau of the Census. Synthetic production data are revised in accordance with recent updated Census statistics.

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

³See Appendix B.

⁴See Appendix C for definitions.

⁵Formerly part of the U.S.S.R. Data are inadequate to formulate reliable estimates for individual countries of the former U.S.S.R.

⁶Excludes Argentina, Iran, and Turkmenistan.

⁷Excludes Argentina, Iran, and Turkey.

STONE (CRUSHED)¹(Data in million short tons, unless noted)²

Domestic Production and Use: Crushed stone valued at \$6.0 billion was produced by 1,600 companies operating 4,000 active quarries in 48 States. Leading States, in order of production, were Texas, Illinois, Pennsylvania, Florida, Kentucky, Virginia, Ohio, North Carolina, Georgia, and Missouri, together accounting for about 50% of the total output. It is estimated that, of the 1.2 billion tons of crushed stone produced in 1993, about 30% were unspecified uses. Of the remaining total, about 81% was used as construction aggregates mostly for highway and road construction and maintenance; 15% for chemical and metallurgical uses including cement and lime manufacture, 3% for agricultural purposes; and 1% for special uses and products. To provide a more accurate estimation of the consumption patterns for crushed stone, the "unspecified uses" are not included in the above percentages. It is recommended that, in any use-pattern analysis, the quantities included in "unspecified uses" be distributed among the reported uses by applying the above percentages. Of the total crushed stone produced in 1993, about 71% was limestone and dolomite; 15% granite; 8% traprock; and the remaining 6% were shared, in descending order of quantity, by sandstone and quartzite, miscellaneous stone, calcareous marl, shell, marble, volcanic cinder and scoria, and slate.

The estimated output of crushed stone shipped for consumption in the first 9 months of 1993 was 899 million tons, which represents an increase of about 7% compared with the same period of 1992. The 9-month estimated total does not include Alaska and Hawaii. Additional production information by quarters for each State, geographic region, and the United States is published in the Quarterly Mineral Industry Survey for Crushed Stone and Sand and Gravel.

Salient Statistics—United States:	1989	1990	1991	1992	1993³
Production	1,213	*1,222	1,103	*1,162	1,223
Imports for consumption	4	5	6	8	8
Exports	4	5	2	4	4
Consumption, apparent	1,213	*1,222	1,107	*1,158	1,227
Price, average value, dollars per ton	4.39	4.58	4.70	4.82	4.92
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill ³	77,280	76,450	74,780	75,000	76,000
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 (1989-92): Canada, 52%; Mexico 30%; the Bahamas 15%; and other, 3%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁵
			1/1/94	1/1/94
	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.

STONE (CRUSHED)

Events, Trends, and Issues: Crushed stone output increased 5.3% in 1993. It is estimated that 1994 domestic production and U.S. apparent consumption will be about 1.28 billion tons each.

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
	1992 ^a	1993 ^p	
United States	1,162	1,223	Adequate except special types and local shortages.
Other countries	NA	NA	
World total	NA	NA	

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.

^aEstimated. ^pPreliminary. NA Not available.

¹See also Stone (Dimension).

²See Appendix A for conversion to metric units.

³Excluding office staff.

⁴Defined 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.

⁵See Appendix B.

⁶See Appendix C for definitions.

STONE (DIMENSION)¹(Data in thousand short tons, unless noted)²

Domestic Production and Use: Dimension stone totaling 1.17 million tons valued at \$169 million was produced by 198 companies at 292 quarries in 36 States. Dimension stone was used in ashlar, 20%; rough blocks for monuments, 15%; dressed monumental, 14%; dressed slab and block for buildings, 13%; and other, 38%. Leading producing States were Georgia, Indiana, and Vermont, which together accounted for 40% of the output. Of the total, 49% was granite, 29% was limestone, 11% was sandstone, 3% was slate, 3% was marble, and 5% was other.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production: Tonnage	1,238	1,186	1,139	1,169	1,169
Value, million dollars	211	210	197	193	169
Imports for consumption, value, million dollars	525	586	475	404	385
Exports, value, million dollars	35	54	65	55	55
Consumption, apparent, value, million dollars	701	742	607	542	499
Price	Variable, depending on type of product				
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill ³	3,000	3,000	3,000	3,000	3,000
Net import reliance ⁴ as a percent of apparent consumption (based on value)	70	72	68	64	66
Granite only:					
Production	662	628	632	655	615
Imports for consumption	850	730	610	514	NA
Exports (rough and finished)	114	116	133	131	NA
Consumption, apparent	1,398	1,242	1,109	1,038	NA
Price	Variable, depending on type of product				
Stocks, yearend	NA	NA	NA	NA	NA
Employment, quarry and mill ³	1,500	1,500	1,500	1,500	1,500
Net import reliance ⁴ as a percent of apparent consumption (based on tonnage)	53	49	45	37	NA

Recycling: Small amounts of dimension stone are recycled principally by restorers of old stone work.

Import Sources (1989-92) (based on value): Dimension stone: Italy, 57%; Spain, 11%; Canada, 6%; Taiwan, 3%; and other, 23%. Granite only: Italy, 66%; Canada, 18%; Spain, 9%; and other, 7%.

Tariff: Dimension stone tariffs ranged from free to 7.5% ad valorem for most favored nations in 1993 according to type, size, value, and degree of preparation.

STONE (DIMENSION)

Depletion Allowance: 14% (Domestic and Foreign); 5% if used for rubble and other nonbuilding purposes.

Government Stockpile: None.

Events, Trends, and Issues: Dimension stone imports decreased 5% to a value of \$385 million in 1993. Value of imports exceeded that of production for the 10th successive year.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves and reserve base ⁶
	1992	1993 ^e	
United States	1,169	1,169	Adequate except for certain special types and local shortages.
Other countries	NA	NA	
World total	NA	NA	

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

Substitutes: Substitutes for dimension stone include concrete, steel, aluminum, resin agglomerated stone, and plastics.

^eEstimated. NA Not available.

¹See also Stone (Crushed).

²See Appendix A for conversion to metric units.

³Excluding office staff.

⁴Defined 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.

⁵See Appendix C for definitions.

STRONTIUM

(Data in metric tons of contained strontium,¹ unless 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, 67%; pyrotechnics and signals, 11%; ferrite ceramic magnets, 12%; and other uses, 10%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production, strontium minerals	—	—	—	—	—
Imports for consumption:					
Strontium minerals	12,000	21,500	14,600	19,700	12,000
Strontium compounds	11,300	11,800	9,550	13,000	14,000
Exports, ² compounds	3,200	700	1,080	650	160
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	76	86	77	68	75
Stocks, consumer, yearend, celestite only	W	W	W	W	W
Net import reliance ³ as a percent of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1989-92): Strontium minerals: Mexico, 99%; Spain, 1%. Strontium compounds: Mexico, 80%; Germany, 18%; and other, 2%. Total imports: Mexico, 91%; Germany, 7%; and other, 2%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁴ 1/1/94
	Celestite	2530.90.0010	Free	Free.
	Alkaline earth metals (strontium and barium)	2805.22.1000	3.7% ad val.	25% ad val.
	Compounds:			
	Strontium nitrate	2834.29.2000	4.2% ad val.	25% ad val.
	Strontium carbonate	2836.92.0000	4.2% ad val.	25% ad val.
	Strontium oxide, hydroxide, peroxide	2816.20.0000	4.2% ad val.	25% ad val.

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

Government Stockpile:**Stockpile Status—9-30-93**

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Celestite ¹	5,340	—	5,340	—

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 \$0. 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 Defense Logistics Agency increased efforts to dispose of the remaining material in 1993.

Detailed information on celestite and strontium carbonate production in China was published for the first time. During a 5-year period in the 1980's, 20 to 30 strontium compound operations were built, mostly in the Sichuan Province. This represents more strontium producers than in the rest of the world combined, but these operations are small. Total annual capacity is only 10,000 to 20,000 tons, less than at most single strontium carbonate plants in other countries.

China also operates the only strontium carbonate plant in the world that uses strontianite, a strontium carbonate mineral, as its raw material. Most Chinese production is exported, but as color television markets and production expand in China, more of this material will be required for domestic consumption.

World Mine Production, Reserves, and Reserve Base:⁶

	Mine production		Reserves ⁶	Reserve base ⁶
	1992	1993 ⁶		
United States	—	—	—	1,360,000
Algeria	5,400	5,400		
Argentina	1,200	1,200		
China	NA	35,000		
Iran	30,000	30,000		
Mexico	80,000	85,000	Other:	Other:
Pakistan	1,500	1,500	6,800,000	10,600,000
Spain	54,000	55,000		
Turkey	70,000	70,000		
U.S.S.R. ⁷	NA	NA		
United Kingdom	1,000	—		
World total (may be rounded)	⁸ 243,100	⁸ 283,100	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 believed 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 magnet. Substituting for strontium in pyrotechnics would be impractical because the desired brilliance and visibility are imparted only by strontium and its compounds.

*Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹The strontium content of celestite is 43.88%; this amount was used to convert units of celestite.

²Export data are obtained from the Port Import/Export Reporting Service of the Journal of Commerce.

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

⁴See Appendix B.

⁵Metric tons of strontium minerals.

⁶See Appendix C for definitions.

⁷As constituted before Dec. 1991.

⁸Excludes China and the former U.S.S.R.

⁹Excludes the former U.S.S.R.

SULFUR

(Data in thousand metric tons of sulfur, unless noted)

Domestic Production and Use: In 1993, sulfur in all forms was produced at 171 operations in 32 States, Puerto Rico, and the U.S. Virgin Islands for a total shipment value of nearly \$400 million. Texas and Louisiana accounted for 47% of domestic production. Ten companies with 65 operations represented 71% of elemental sulfur production. Frasch sulfur, produced by three companies operating four mines in Texas and Louisiana, accounted for 21% of domestic production of sulfur in all forms. Recovered elemental sulfur was produced as a byproduct at petroleum refineries, natural gas processing plants, and coking plants in 26 States, Puerto Rico, and the U.S. Virgin Islands by 58 companies with 151 individual plants. Sulfur was also produced in the form of sulfuric acid, pyrites, hydrogen sulfide, and sulfur dioxide in 12 States by 11 companies with 16 operations. Sulfur shipped for domestic consumption was obtained mainly from domestic sources: recovered, 55%; Frasch, 15%; and combined byproduct sulfuric acid, primary pyrites, hydrogen sulfide, and sulfur dioxide, 10%. The remaining 20% of the sulfur was obtained by importing Frasch and recovered sulfur and sulfuric acid. About 90% of the sulfur was converted to sulfuric acid prior to end use. Agricultural chemicals (fertilizers) were 60% of sulfur demand; chemicals, organic and inorganic, 12%; metal mining, 6%; and petroleum refining, 4%. Other uses, accounting for 18% of demand, were widespread because most products produced by industry require sulfur in one form or another during some stage of their manufacture.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production: Frasch	3,888	3,726	2,869	2,320	2,200
Recovered elemental	6,510	6,536	6,645	7,048	7,100
Other forms	1,194	1,298	1,306	1,295	1,300
Total	11,592	11,560	10,820	10,663	10,600
Shipments, all forms	11,449	11,457	11,108	10,989	10,300
Imports for consumption:					
Frasch and recovered	2,260	2,571	3,020	2,725	2,000
Sulfuric acid, sulfur content	410	552	603	649	1,000
Exports:					
Frasch and recovered	1,024	972	1,196	966	520
Sulfuric acid, sulfur content	48	53	49	46	50
Consumption, apparent, all forms	13,047	13,555	13,486	13,351	12,600
Price, reported average value, dollars per ton of elemental sulfur, f.o.b., mine and/or plant	86.62	80.14	71.45	48.14	32.00
Stocks, producer, yearend	1,301	1,423	1,194	809	1,300
Employment, mine and/or plant	3,300	3,200	3,100	3,200	3,100
Net import reliance ¹ as a percent of apparent consumption	1	15	19	20	15

Recycling: About 3 million tons, sulfur content, of spent acid was reclaimed from petroleum refining and chemical processes.

Import Sources (1989-92): Frasch and recovered: Canada, 58%; Mexico, 41%; and other, 1%. Sulfuric acid: Canada, 71%; Mexico, 9%; Germany, 6%; Japan, 5%; and other, 9%. Total sulfur imports: Canada, 60%; Mexico, 36%; and other, 4%.

Tariff: Item	Number	Most favored nation (MFN)	Non-MFN²
		1/1/94	1/1/94
Sulfur, crude or unrefined	2503.10.0000	Free	Free.
Sulfur, all kinds, other	2503.90.0000	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.

SULFUR

Events, Trends, and Issues: Sulfur recovered during petroleum refining continued its upward trend, but sulfur recovered from natural gas processing was slightly lower than in 1992. As a result, recovered sulfur production was about the same in 1993 as it was the previous year. Frasch sulfur production was about 5% lower because of reduced production at two mines in Texas. One mine in Texas ceased production late in the year because of resource depletion following more than 60 years of production from the same deposit. Plans to close another mine, off the Louisiana coast, were announced.

Native sulfur production continued to decrease throughout the world as did demand and prices. Production at the remaining Frasch operation in Mexico was curtailed, and production in Poland was well below capacity once again. Canada, the world's largest sulfur exporter, began production from a new sour gas field in Alberta, but low offshore demand forced producers to pour to block rather than sell material at extremely low prices.

Posted prices lost much of their significance because Tampa Frasch prices were no longer considered a good indication of what actual contract prices were negotiated. Prices continued to decline to the point that the posted price for the U.S. west coast was \$0 to \$1 per ton. Because of reduced Frasch output and Canadian stockpiling, supply was beginning to tighten and prices to firm at yearend.

Domestic sulfur production is expected to remain relatively stable in 1994, with apparent consumption for 1994 estimated at about 12 million tons.

World Production, Reserves, and Reserve Base:

	Production—all forms		Reserves ³	Reserve base ³
	1992	1993 ^e		
United States	10,663	10,600	140,000	230,000
Canada	7,246	7,600	158,000	330,000
China	5,970	6,000	100,000	250,000
France	1,155	1,200	10,000	20,000
Iraq	570	600	130,000	500,000
Italy	480	500	10,000	15,000
Japan	2,635	2,800	5,000	15,000
Mexico	1,600	1,000	75,000	120,000
Poland	3,060	2,500	130,000	300,000
Saudi Arabia	2,000	2,000	100,000	130,000
Spain	910	1,000	50,000	300,000
U.S.S.R. ⁴	7,250	7,500	250,000	750,000
Other countries	9,780	9,700	220,000	550,00
World total (may be rounded)	52,409	53,000	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.

^eEstimated.

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

²See Appendix B.

³See Appendix C for definitions.

⁴As constituted before Dec. 1991. This commodity is believed to be produced in Azerbaijan, Belarus, Estonia, Kazakhstan, Russia, Turkmenistan, Ukraine, and Uzbekistan; however, information is inadequate to formulate reliable estimates of individual country production.

TALC AND PYROPHYLLITE

(Data in thousand metric tons, unless noted)

Domestic Production and Use: The total estimated crude ore value of 1993 domestic production was \$26 million. There were 20 talc-producing mines in 8 States in 1993. Companies in Montana, New York, Texas, and Vermont accounted for 98% of domestic production. Ground talc was consumed in ceramics, 35%; paint, 18%; paper, 20%; roofing, 9%; plastics, 5%; cosmetics, 5%; and other, 8%. Two firms in North Carolina and one firm in California accounted for 100% of domestic pyrophyllite production, which was unchanged from that of 1992. Consumption was in ceramics, refractories, and insecticides, in decreasing order of tonnage.

Salient Statistics—United States:	1989	1990	1991¹	1992¹	1993¹
Production, mine	1,253	1,267	1,037	997	928
Sold by producers	1,145	1,101	864	817	800
Imports for consumption	78	65	67	80	79
Exports	319	238	178	175	168
Shipments from Government stockpile excesses	—	—	—	(²)	—
Consumption, apparent	1,012	1,054	926	902	839
Price, crude or ground, dollars per ton	28-358	20-325	11-308	15-325	13-400
Stocks, producer, yearend	40	80	80	80	80
Employment, mine and mill	886	880	880	880	800
Net import reliance ³ as a percent of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (1989-92): Canada, 55%; China, 21%; Australia, 12%; and other, 12%.

Tariff: Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁴ 1/1/94
Crude, not ground	2526.10.0000	0.04¢/kg	0.6¢/kg.
Ground, washed, powdered	2526.20.0000	2.4% 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—9-30-93 (Metric tons)

Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Talc, block and lump	981	—	981	—
Talc, ground	988	—	988	—

TALC AND PYROPHYLLITE

Events, Trends, and Issues: Production and sales decreased 7% and 2%, respectively, from those of 1992. Apparent consumption decreased 7% in 1993. Exports decreased 4% from those of 1992. Belgium, Canada, Japan, and Mexico were the major importers of U.S. talc. Imports for consumption decreased slightly from those of 1992. Canada, China, and Australia supplied approximately 95% of the imported talc.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁵	Reserve base ⁵
	1992	1993 ^a		
United States ¹	997	928	136,000	544,000
Brazil	480	460	14,000	54,000
China	2,650	2,600	Large	Large
India	510	500	4,000	9,000
Japan	1,123	1,100	132,000	200,000
Korea, Republic of	760	750	14,000	18,000
Other countries	2,344	2,512	Large	Large
World total	8,864	8,850	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.

^aEstimated. E Net exporter.

¹Excludes pyrophyllite.

²Less than ½ unit.

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

⁴See Appendix B.

⁵See Appendix C for definitions.

TANTALUM

(Data in thousand kilograms of tantalum content, unless noted)

Domestic Production and Use: There has been no significant tantalum-mining industry since 1959, with the exception of small unreported quantities of tantalum-bearing concentrates produced in 1989-92. 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, 60%, mainly tantalum capacitors. The value of tantalum consumed in 1993 was estimated at about \$140 million.

Salient Statistics—United States:

	1989	1990	1991	1992	1993 ^c
Production, mine	(1)	(1)	(1)	(1)	—
Imports for consumption, concentrate, tin slags, and other ²	NA	NA	NA	NA	NA
Exports, concentrate, metal, alloys, waste, and scrap ^a	195	200	180	150	200
Consumption: Reported, raw material ^a	NA	NA	NA	NA	NA
Apparent	376	390	370	375	415
Price, tantalite, dollars per pound ³	36.80	31.17	30.06	28.19	26.41
Stocks, industry, processor, yearend	NA	NA	NA	NA	NA
Employment, processor ^a	450	NA	NA	NA	NA
Net import reliance ⁴ as a percent of apparent consumption	86	86	86	85	86

Recycling: Combined prompt industrial and obsolete scrap consumed represented about 14% of apparent consumption.

Import Sources (1989-92): Germany, 37% (majority of imports of unknown origin); Australia, 14%; Canada, 8%; Brazil, 6%; and other, 35%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN ⁶ 1/1/94
	Synthetic tantalum-columbium concentrates	2615.90.3000	Free	30% ad val.
	Tantalum ores and concentrates	2615.90.6060	Free	Free.
	Tantalum oxide	2825.90.6090	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	3.7% ad val.	25% ad val.
	Alloys and metal	8103.10.6090	3.7% ad val.	25% ad val.
	Tantalum, wrought	8103.90.0000	5.5% ad val.	45% ad val.

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

Government Stockpile: The uncommitted inventories shown below include a negligible quantity in nonstockpile-grade metal, 460,000 kilograms in nonstockpile-grade minerals, and 37,000 kilograms in both metal and minerals with status (inventory) not yet determined. The stockpile also contained 65,000 kilograms in tantalum oxide with status not yet determined.

	Stockpile Status—9-30-93			
Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Tantalum:				
Carbide powder	13	—	—	—
Metal	110	—	—	—
Minerals	1,259	—	—	—

TANTALUM

Events, Trends, and Issues: Overall demand for tantalum improved in 1993 aided by increased consumption of tantalum capacitor-grade powder in the electronics sector. U.S. sales of tantalum capacitors for the first half-year were up by about 25% compared with that of the similar period in 1992. However, the amount of tantalum capacitor-grade powder consumed per capacitor continued to decline. The published spot price for tantalite ore, which began the year within a range of \$28 to \$30 per pound of contained pentoxide fell to \$25.50 to \$26.50 in late March where it remained through early October. Industry sources indicated that tantalum mill products continued to be sold at an average of about \$170 per pound, depending on specification, and that tantalum capacitor-grade powder continued to be sold at an average of about \$145 per pound.

In August, the U.S. Trade Representative announced that the Generalized System of Preferences (GSP), which had expired on July 4, 1993, was extended until September 30, 1994. The GSP extension was part of the Budget Reconciliation Act signed by the President. The legislation extending the GSP is retroactive to July 4. Additionally, the legislation removes the statutory prohibition against providing GSP benefits to the countries which made up the former U.S.S.R.⁶ Under GSP, the United States grants duty-free access to goods from more than 140 developing countries and territories.

In Proclamation 6599 of September 30, 1993, the President designated Russia as a beneficiary developing country for purposes of the GSP. GSP status for Russia is part of the Administration's overall efforts to help that country pursue badly needed market reforms. Ukraine and Kyrgyzstan also were being considered for GSP status.

It is estimated that in 1994 domestic mine production will be zero and U.S. apparent consumption will be about 420,000 kilograms.

World Mine Production, Reserves, and Reserve Base:

	Mine production ⁷		Reserves ⁸	Reserve base ⁸
	1992	1993		
United States	(¹)	—	—	Negligible
Australia	185	170	4,500	9,100
Brazil	60	60	900	1,400
Canada	45	—	1,800	2,300
Malaysia	—	—	900	1,800
Nigeria	2	2	3,200	4,500
Thailand	1	1	7,300	9,100
Zaire	14	14	1,800	4,500
Other countries ⁹	46	43	1,400	1,800
World total (may be rounded)	353	290	22,000	35,000

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, Egypt, Malaysia, Nigeria, Thailand, and Zaire. The United States has about 1.36 million kilograms of tantalum resources in identified deposits, most of which were considered uneconomic at 1993 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.

⁰Estimated. NA Not available.

¹A small unreported quantity was produced.

²Metal, alloys, synthetic concentrates; exclusive of waste and scrap.

³Average value, contained tantalum pentoxides, 60% basis.

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

⁵See Appendix B.

⁶As constituted before Dec. 1991.

⁷Excludes production of tantalum contained in tin slags reported by the Tantalum-Niobium International Study Center (TIC) as 160,000 kilograms in 1992; data not available for 1993.

⁸See Appendix C for definitions.

⁹Excludes any production from Bolivia, China, and countries in the former U.S.S.R.

TELLURIUM

(Data in metric tons of tellurium content, unless noted)

Domestic Production and Use: Tellurium and tellurium dioxide of commercial grades were recovered from anode slimes at one electrolytic copper refinery in the United States. 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 chiefly in the production of free-machining steels. It was also 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 1993, iron and steel products remained the largest end use, followed by nonferrous metals, chemicals, and other uses.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production refinery	W	W	W	W	W
Imports for consumption:					
Unwrought, waste, and scrap ¹	43	34	29	48	60
Exports	NA	NA	NA	NA	NA
Consumption, apparent	W	W	W	W	W
Price, dollars per pound, 99.7% min. ²	34	31	32	35	32
Stocks, producer, refined, yearend	W	W	W	W	W
Employment	NA	NA	NA	NA	NA
Net import reliance ³ as a percent of apparent consumption	W	W	W	W	W

Recycling: There was no secondary production of tellurium. However, some tellurium may have been recovered from selenium-base photoreceptor scrap exported for recycling.

Import Sources (1989-92): Canada, 23%; United Kingdom, 23%; Belgium, 15%; Philippines, 8%; and other, 31%.

Tariff: Item	Number	Most favored nation (MFN)	Non-MFN⁴
		1/1/94	1/1/94
Metal	2804.50.0000	Free	25.0% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: U.S. production and shipments approached 1992 levels. Tellurium sales to the steel and brass industries and to chemical manufacturers remained steady. Bismuth-telluride thermoelectric demand grew in 1993.

Cadmium telluride photovoltaic (PV) cells have exhibited some of the highest energy conversion ratios for terrestrial cells in tests performed by the National Renewable Energy Laboratory (NREL). The NREL, part of the Department of Energy, is involved in a cooperative program with U.S. manufacturers to help the U.S. PV industry maintain and extend its lead in national and international markets.

Associated with the rise in electronic uses for tellurium is the question of availability. There was activity in 1993 to find other sources of the metal outside of the United States.

TELLURIUM

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves ⁵	Reserve base ⁵
	1992	1993 ⁶		
United States	W	W	3,000	6,000
Canada	22	20	700	1,500
Japan	57	60	—	—
Peru	12	10	500	1,600
Other countries	NA	NA	16,000	29,000
World total (may be rounded)	⁵ NA	⁶ NA	20,000	38,000

World Resources: The reserve base includes only tellurium contained in copper deposits. Significant quantities are contained in economic gold and lead deposits, but not recovered. Deposits of coal, copper, and other metals that are undeveloped or of subeconomic grade contain several times the amount of tellurium in identified economic copper deposits. However, it is likely that only tellurium contained in copper ores 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 and germanium in electronic applications.

*Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹Beginning in 1989, 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.

²Yearend prices quoted by the sole producer.

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

⁴See Appendix B.

⁵See Appendix C for definitions. Tellurium contained in copper resources only.

⁶In addition to the countries listed, Australia, Germany, Kazakhstan, the Philippines, Russia, and the United Kingdom are known to produce refined tellurium, but output is not reported, and available information is inadequate for formulation of reliable production estimates.

THALLIUM

(Data in kilograms of thallium content, unless noted)

Domestic Production and Use: Thallium is a byproduct 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, thallium metal was not recovered domestically in 1993. The estimated value of thallium consumed in 1993 was \$184,000. Research and development in the use of thallium-base superconductor formulations consumed about 50% of the thallium in 1993. The balance was used principally in electronics, alloys, glass manufacturing, and pharmaceuticals.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Imports for consumption ¹	1,173	450	1,013	838	370
Exports	NA	NA	NA	NA	NA
Consumption ^a	950	700	850	900	800
Price, metal, dollars per kilogram ²	170	180	190	230	230
Net import reliance ³ as a percent of apparent consumption	100	100	100	100	100

Recycling: None.

Import Sources (1989-92): Belgium 92%; Canada, 4%; United Kingdom, 3%; and other, 1%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁴ 1/1/94
	Unwrought waste and scrap	8112.91.6000	5.5% ad val.	25% ad val.

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

Government Stockpile: None.

Events, Trends, and Issues: Research and development in the use of thallium-base superconductor formulations continued throughout 1993.

Thallium metal was sold at various price levels during the year according to its purity. Metals traders reported that the average price of thallium metal in 100-kilogram lots was \$230 per kilogram for 99.99%-pure thallium metal.

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.

THALLIUM

World Mine Production, Reserves, and Reserve Base:⁶

	Mine production		Reserves ⁶	Reserve base ⁶
	1992	1993 ^e		
United States	(⁷)	(⁷)	32,000	118,000
Other countries	<u>15,000</u>	<u>14,500</u>	<u>345,000</u>	<u>526,000</u>
World total (may be rounded)	15,000	14,500	380,000	640,000

World Resources: World resources of thallium contained in zinc resources are about 17.2 million kilograms, most of which is in Europe, Canada, and the United States. An additional 635 million kilograms is in the world's coal resources.

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.

⁶Estimated. NA Not available.

¹Unwrought and waste and scrap, including thallium contained in compounds.

²Estimated price of 99.99%-pure metal.

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

⁴See Appendix B.

⁵Based on the estimated thallium content of zinc ores.

⁶See Appendix C for definitions.

⁷Thallium contained in domestic nonferrous ores, estimated at 450 to 500 metric tons per year, is not currently extracted.

THORIUM

(Data in metric tons of thorium oxide (ThO₂) equivalent, unless noted)

Domestic Production and Use: Thorium-bearing monazite was recovered by one company in Florida as a byproduct of mining titanium and zirconium minerals. Monazite was recovered as a byproduct during processing exclusively for its rare-earth content. None of the monazite produced domestically was processed in the United States for its thorium content. Essentially, all thorium compounds and alloys consumed by the domestic industry were derived from imports, stocks of previously imported materials, or materials purchased from U.S. Government stockpiles. About 19 companies processed or fabricated various forms of thorium for nonenergy uses, such as ceramics, carbon arc lamps, magnesium-thorium alloys, refractories, and welding electrodes. The value of thorium metal, alloys, and compounds used by the domestic industry was estimated to be about \$500,000.

Salient Statistics—United States:	1989	1990	1991	1992	1993^a
Production, refinery ¹	NA	NA	NA	—	—
Imports: Thorium ore and concentrates (monazite),					
gross weight	774	800	—	—	—
Compounds	33	19	43	14	11
Exports: Thorium ore and concentrates (monazite),					
gross weight	2	—	—	5	—
Compounds	8	<1	3	<1	—
Shipments from Government stockpile					
excesses	—	2	—	—	—
Consumption, reported ^a	57	66	54	40	NA
Price, yearend, dollars per kilogram					
Nitrate, welding-grade ²	NA	NA	NA	5.46	5.46
Nitrate, mantle-grade ³	W	16.55	19.94	21.36	22.25
Oxide, yearend: 99.0% purity ⁴	W	55.00	63.80	63.80	65.00
99.99% purity	—	—	—	107.00	107.00
Stocks, industrial, yearend	NA	NA	NA	NA	NA
Employment, mine	—	—	—	—	—
Net import reliance ⁵ as a percent of					
apparent consumption	NA	NA	NA	NA	NA

Recycling: None.

Import Sources (1989-92): Monazite: Indonesia, 89%; and Australia, 11%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN^a
			1/1/94	1/1/94
	Thorium ores and concentrates			
	(monazite)	2612.20.0000	Free	Free.
	Thorium compounds	2844.30.1000	7.8% 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—9-30-93			
Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Thorium nitrate	3,219	—	2,946	—
(thorium oxide equivalent)	1,540	—	1,409	—

Events, Trends, and Issues: A large oversupply of thorium continued to grow as a byproduct of processing monazite for its rare-earth content. Costs associated with monitoring and disposing of radioactive thorium increased. Domestic consumption was forecast to remain below 70 tons of equivalent thorium oxide. A decline in the use of thorium in most uses is expected.

THORIUM

Costs associated with thorium's natural radioactivity remained the principal deterrent to its development. Expenses incurred with handling, storing, monitoring, shipping, and properly disposing of thorium materials escalated in 1993. The base disposal cost at Barnwell, SC, increased to \$59 per cubic feet. Public concerns and potential liabilities have also impacted thorium's use.

In the United States, companies continued to switch to substitutes or cease production. The decline started in 1990 when a California specialty ceramic producer ceased production because of environmental compliance and disposal problems. In the same year, a major monazite processor in Tennessee switched to a thorium-free rare-earth chloride feed material, citing increased disposal costs as the principal reason for the conversion. In 1991, the world's principal thorium-alloy producer phased out production at its plant in the United Kingdom. Also in 1991, the principal domestic producer of thoriated incandescent lamp mantles began use of a nonradioactive substitute at its facilities in Kansas. The trend continued in 1992 as a Texas processor ceased sales of thorium nitrate (liquid) noting the potential liabilities in the event of a spill were unacceptable.

Real and potential costs related to compliance with State and Federal regulations, proper disposal, and monitoring of thorium's radioactivity, have limited its commercial value. It is forecast that thorium's use will continue to decline significantly unless a low cost disposal or transmutation process is developed.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		Reserves ⁷	Reserve base ⁷
	1992	1993		
United States	—	—	158,000	298,000
Australia	NA	NA	300,000	340,000
Brazil	NA	NA	16,000	18,000
Canada	NA	NA	100,000	100,000
India	NA	NA	292,000	300,000
Malaysia	NA	NA	4,500	4,500
Norway	NA	NA	166,000	183,000
South Africa, Republic of	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

Thorium 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 increased. No new demand, however, is expected. Reserves exists primarily in recent and paleo-beach 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. Most resources are contained in beach 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, the Republic of South Africa, and the United States.

Substitutes: Yttrium compounds have replaced thorium in incandescent lamp mantles. Although yttrium is 15% lower in brightness, it is less brittle and nonradioactive. A magnesium alloy containing lanthanides, zirconium, and yttrium can substitute for magnesium-thorium alloys in aerospace application. Research to develop nonradioactive substitutes continues in the industry.

*Estimated. NA Not available. W Withheld to avoid disclosing company propriety data.

¹All domestically consumed thorium was derived from imported materials.

²Source: U.S. Department of Defense, Defense Logistics Agency. Based on sales from the National Defense Stockpile.

³Source: Rhône-Poulenc Basic Chemical Co., f.o.b. port of entry, duty paid, ThO₂ basis, 1990-91. Rhône-Poulenc Canada Inc., f.o.b. Ontario, Canada, duty unpaid, 1992-93.

⁴Source: Rhône-Poulenc Basic Chemicals Co., f.o.b. port of entry, duty paid.

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

⁶See Appendix B.

⁷See Appendix C for definitions.

TIN

(Data in metric tons of tin content, unless noted)

Domestic Production and Use: In 1993, small quantities of tin concentrates were produced from a placer deposit in Alaska. Production of tin at the only U.S. tin smelter, at Texas City, TX, stopped in 1989. Twenty-five firms consumed about 86% of the primary tin. The major uses were as follows: cans and containers, 32%; electrical, 22%; construction, 10%; transportation, 11%; and other, 25%. The estimated value of primary metal consumption in 1993, based on the New York composite price, was \$315 million.

Salient Statistics—United States:		1989	1990	1991	1992	1993*
Production: Mine				Negligible		
Smelter		1,000	—	—	—	—
Secondary (old scrap)		11,011	13,200	13,096	8,797	8,500
Imports for consumption: Metal		33,988	33,810	29,102	27,314	33,000
Ore		216	—	1	—	—
Exports, ingots, pigs, and bars ¹		904	658	970	1,888	2,300
Shipments from Government stockpile excesses		2,775	2,145	6,195	6,310	6,000
Consumption, reported: Primary		36,609	36,770	35,138	34,953	37,000
Secondary		9,854	8,395	9,667	10,137	8,000
Consumption, apparent		47,592	45,494	48,700	43,631	45,914
Price, average, cents per pound:						
New York market		397	288	259	283	244
New York composite		520	386	363	402	385
London ²		382	281	254	277	232
Kuala Lumpur		387	276	248	272	256
Stocks, consumer and dealer, yearend		14,668	17,304	13,812	10,714	10,000
Employment, mine and primary smelter ³		80	5	5	5	5
Net import reliance ³ as a percent of apparent consumption		77	71	74	80	81

Recycling: About 14,000 tons of purchased old and new tin scrap, including tin alloys, was recycled in 1993. Of this, about 8,500 tons was old scrap. More than one-sixth of the tin consumed in the United States was produced from old scrap at detinning plants and 119 secondary nonferrous metal processing plants.

Import Sources (1989-92): Brazil, 24%; Bolivia, 22%; China, 16%; Indonesia, 15%; and other, 23%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁴
			1/1/94	1/1/94
	Ore and concentrate	2609.00.0000	Free	Free.
	Metal, unwrought	8001.10.0000	Free	Free.
	Waste and scrap	8002.00.0000	Free	Free.
	Tin alloys	8001.20.0000	Free	Free.

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

Government Stockpile:

Stockpile Status—9-30-93				
Material	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Pig tin	147,692	—	147,692	6,310

TIN

Events, Trends, and Issues: The price of tin declined throughout most of the year, prompted mainly by a continuing world oversupply of about 40,000 tons.

Concern over the continuation of low tin prices was widespread among tin producers. In July, the tin price reached a 25-year low on the London Metal Exchange. Most major world producers had a break-even point substantially above the prevailing tin price. Most producers announced production cutbacks or mine shutdowns.

In June, the American Society for Testing and Materials, Philadelphia, PA, announced a modification to the existing Standard Specification for Pig Tin (B339). Since the change, tin users may order "Grade A Tin for the Manufacture of Tinplate"; this specification set a new, lower lead impurity level of 0.020% maximum, compared with 0.050% maximum, under the normal Grade A specification. This change was in response to industry concerns, developing over the previous year, about possible deleterious effects of lead in tinplate.

In March, the Steel Can Recycling Institute (SCRI), based in Pittsburgh, PA, announced that henceforth it will be called the Steel Recycling Institute. The name change reflected a broadening of its mission to encompass not only steel cans (which had been its sole focus since its 1988 founding), but all steel products ranging from appliances to cars. Since SCRI's 1988 inception, the steel can recycling rate grew from 15% to over 40% in 1993. The overall steel recycling rate had been over 60% for more than 20 years, and in 1993 stood at 66%.

In May, National Defense Stockpile officials released their Fiscal Year 1994 annual materials plan after it had been formally submitted to Congress as required by law. The plan reflected the second year of acquisitions and disposal operations at levels authorized by Public Law 102-484. The plan for tin called for disposals of up to 12,000 tons in Fiscal Year 1994.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁵	Reserve base ⁵
	1992	1993 ^a		
United States	Negligible	Negligible		
Australia	6,000	6,000	210,000	600,000
Bolivia	15,000	15,000	450,000	900,000
Brazil	30,000	30,000	1,200,000	2,500,000
China	43,000	43,000	1,600,000	1,600,000
Indonesia	25,000	25,000	750,000	820,000
Malaysia	14,000	14,000	1,200,000	1,200,000
Peru	6,000	6,000	20,000	40,000
Portugal	7,000	7,000	70,000	70,000
Russia	10,000	10,000	300,000	300,000
Thailand	15,000	14,000	940,000	940,000
Zaire	2,000	2,000	510,000	510,000
Other countries	6,000	2,000	180,000	620,000
World total (may be rounded)	⁶ 179,000	⁶ 175,000	7,000,000	10,000,000

World Resources: U.S. resources of tin, located primarily in Alaska, were insignificant compared with those of the rest of the world. Sufficient world resources, located 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 plastic for bronze; plastics for bearing metals that contain tin; and lead and sodium for some tin chemicals.

^aEstimated.

¹Excludes reexports.

²Tin was suspended from London Metal Exchange trading in October 1985. Trading resumed in June 1989.

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

⁴See Appendix B.

⁵See Appendix C for definitions. Reserves and reserve base figures for several countries were adjusted this year based on new information obtained largely through the International Strategic Minerals Inventory Summary Report - Tin (U.S. Geological Survey Circular 930-J).

⁶Excludes U.S. production.

TITANIUM AND TITANIUM DIOXIDE¹

(Data in metric tons, unless noted)

Domestic Production and Use: Titanium sponge metal was produced by two firms in Nevada and Oregon. Ingot was made by the two sponge producers and by nine other firms in seven States. Twenty-eight companies produced titanium mill products or castings mainly in the east-central region. In 1993, about 75% of the titanium metal was used in jet engines, airframes, and space and missile applications. The remaining 25% was used in the chemical-processing industry, power generation, marine and ordnance, medical, and other nonaerospace applications. The value of sponge metal consumed was about \$130 million, assuming an average selling price of about \$3.75 per pound.

In 1993, titanium dioxide (TiO₂) pigment, valued at about \$2.4 billion, was produced by 5 companies at 11 plants in 9 States. In 1992, TiO₂ was used in paint, varnishes, and lacquers, 45%; paper, 26%; plastics, 18%; rubber, 2%; and other, 9%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production, sponge	25,225	24,679	13,366	W	W
Imports for consumption, sponge	903	1,093	612	684	1,000
Exports, all metal forms	13,342	15,816	12,130	8,019	7,300
Shipments from Government stockpile excesses	—	—	—	—	—
Consumption of sponge metal, reported*	24,927	23,207	13,594	14,165	15,800
Price, sponge, reported sales, dollars per pound, yearend	5.00	4.75	4.75	3.75	3.75
Stocks, sponge, industry yearend*	2,114	3,267	2,852	1,929	2,900
Employment, reduction plants*	850	850	850	350	350
Net import reliance, ² sponge only, as a percent of apparent consumption	4	E	4	W	W
Titanium dioxide:					
Production	1,006,581	978,659	991,976	1,137,038	1,158,000
Imports for consumption	166,346	147,592	166,094	169,260	172,000
Exports	212,197	202,288	211,854	270,422	258,000
Consumption, apparent	947,259	925,447	935,829	999,811	1,071,173
Price, rutile, list, dollars per pound, yearend	1.03	1.01	0.99	0.94	0.94
Stocks, producer, yearend	62,205	61,721	72,108	108,173	109,000
Employment*	4,300	4,500	4,500	4,500	4,600
Net import reliance ² as a percent of apparent consumption	7	E	E	E	E

Recycling: New scrap metal recycled by the titanium industry was about 16,900 tons in 1993. In addition, estimated use of titanium in scrap and in ferrotitanium made from scrap by the steel industry was 3,600 tons; by the superalloy industry, 520 tons; in other alloying uses, 738 tons; and by miscellaneous other uses, 80 tons. Old scrap reclaimed was about 200 to 400 tons. There was no known recycling of TiO₂.

Import Sources (1989-92): Sponge metal: Japan, 69%; China, 20%; United Kingdom, 4%; and other, 7%. Titanium dioxide pigment: Canada, 29%; Germany, 15%; United Kingdom, 13%; France, 13%; and other, 30%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN³ 1/1/94
	Waste and scrap metal	8108.10.1000	Free	Free.
	Unwrought metal	8108.10.50	15.0% ad val.	25.0% ad val.
	Wrought metal	8108.90.60	15.0% ad val.	45.0% ad val.
	Titanium dioxide pigments	3206.10.00	6.0% ad val.	30.0% ad val.
	Titanium oxides	2823.00.0000	6.0% ad val.	30.0% ad val.

Depletion Allowance: Not applicable.

TITANIUM AND TITANIUM DIOXIDE

Government Stockpile: In addition to the quantities shown below, the stockpile contained 9,857 tons of nonstockpile-grade sponge metal.

Material	Stockpile Status—9-30-93			
	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Titanium sponge metal	23,555	—	—	—

Events, Trends, and Issues: Reported consumption of titanium sponge increased about 12% from 1992. However, demand was much lower than the high levels reached in 1989 and 1990. Depressed demand by military and commercial aerospace continued for a third consecutive year. Owing to poor market conditions, several domestic producers of titanium mill products closed production facilities. Amid the closures, one domestic producer commissioned a 10,000-ton-per-year sponge facility based on vacuum distillation technology.

Apparent domestic consumption of U.S. pigment increased about 7% compared with 1992. Domestic TiO₂ pigment production increased by about 2%, and the United States continued to be a net exporter of TiO₂ pigments. Global production capacity decreased slightly because of plant closures, but was well above global demand. Several companies had plans to increase capacity in Asia, however the expansions were delayed or suspended until market conditions improve.

Increased environmental regulations have affected many sulfate-process TiO₂ pigment plants that have discharged acid waste into ocean tributaries. Several producers invested in acid recycling or acid treatment facilities to comply with new regulations and eliminate acid waste. Other producers have replaced or plan to replace sulfate-process plants with chloride-process plants.

World Sponge Metal Production and Sponge and Pigment Capacity:

	Sponge production		Capacity 1993	
	1992	1993*	Sponge	Pigment
United States	W	W	29,500	1,330,000
Australia	—	—	—	150,000
Belgium	—	—	—	80,000
Canada	—	—	—	74,000
China [†]	2,000	2,000	3,000	40,000
Finland	—	—	—	80,000
France	—	—	—	230,000
Germany	—	—	—	350,000
Italy	—	—	—	80,000
Japan	14,554	14,200	28,800	320,000
Spain	—	—	—	65,000
U.S.S.R. [‡]	20,000	20,000	62,000	100,000
United Kingdom	2,000	1,000	—	275,000
Other countries	—	—	—	525,000
World total	[§] 38,554	[§] 37,200	123,300	3,699,000

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. The sources for pigment production were ilmenite, slag, and rutile.

Substitutes: There is no substitute 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 TiO₂ pigment.

*Estimated. E Net exporter. W Withheld to avoid disclosing company proprietary data.

[†]See also Ilmenite and Rutile.

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

[§]See Appendix B.

[¶]As constituted before Dec. 1991.

[§]Excludes U.S. production.

TUNGSTEN

(Data in metric tons of tungsten content, unless noted)

Domestic Production and Use: In 1993, one mine in California produced tungsten concentrate. The mine operated at an annual rate well below capacity. End uses of tungsten included metalworking, mining, and construction machinery and equipment, 71%; electrical and electronic machinery and equipment and transportation, 10%; lamps and lighting, 9%; chemicals, 5%; and other, 5%. The total estimated value of primary tungsten materials consumed in 1993 was \$145 million.

<u>Salient Statistics—United States:</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>
Production, mine shipments	W	W	W	W	W
Imports for consumption, concentrate	7,896	6,420	7,837	2,477	2,000
Exports, concentrate	203	139	21	38	20
Government stockpile shipments, concentrate	466	—	—	—	—
Consumption: Reported, concentrate	7,725	¹ 5,878	¹ 5,309	4,313	3,100
Apparent, all forms	10,474	² 8,438	² 11,797	7,459	6,800
Price, concentrate, dollars per mtu WO ₃ , ³ average:					
U.S. spot market, Metals Week	54	42	61	56	44
European market	61	54	59	58	35
Stocks, producer and consumer, yearend concentrate	1,271	1,093	1,804	746	700
Employment, mine and mill	139	119	57	47	33
Net import reliance ⁴ as a percent of apparent consumption	84	81	91	86	84

Recycling: During 1993, the quantity of scrap reprocessed into intermediates was about 2,000 tons, representing approximately 30% of apparent consumption of tungsten in all forms.

Import Sources (1989-92): China, 49%; Bolivia, 8%; Peru, 7%; Germany, 6%; and other, 30%.

<u>Tariff:</u>	<u>Item</u>	<u>Number</u>	<u>Most favored nation (MFN)</u> <u>1/1/94</u>	<u>Non-MFN⁵</u> <u>1/1/94</u>
	Ore and concentrate	2611.00.0000	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	10.5% ad val.	58.0% ad val.
	Ammonium tungstate	2841.80.0010	10.0% ad val.	49.5% ad val.
	Tungsten carbide	2849.90.3000	10.5% ad val.	55.5% ad val.

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

Government Stockpile: During the first 9 months of 1993, there were no disposals of tungsten materials from the stockpile. The inventory shown below includes the following quantities of nonstockpile-grade tungsten (tons): ore and concentrate, 10,060; ferrotungsten, 533; metal powder, 151; and carbide powder, 51.

<u>Stockpile Status—9-30-93</u>				
<u>Material</u>	<u>Uncommitted inventory</u>	<u>Committed inventory</u>	<u>Authorized for disposal</u>	<u>Disposals Jan.-Sept. 93</u>
Ore and concentrate	34,635	1	—	—
Metal powder	861	—	—	—
Ferrotungsten	918	—	—	—
Carbide powder	922	—	—	—

Events, Trends, and Issues: Apparent consumption of tungsten products declined by about 9% during 1993 compared with that of 1992, reflecting a continued reaction to a weak U.S. market. Demand for cemented carbide end-use products remained relatively strong. Demand in most other end-use sectors decreased.

U.S. imports of tungsten materials during the first half of 1993 further shifted from concentrate to intermediates, continuing a trend which began in 1991 after a 151% tariff was placed on imports of concentrate from China. During the first half of 1993, concentrate represented only a 45% share of the combined imports of concentrate and intermediates compared with an 87% share in 1990. Since the tariff began, most concentrate was imported from Bolivia, Peru, and Portugal, but declining prices in 1993 forced

TUNGSTEN

these producers either to close their mines or to reduce production. Consequently, the share of U.S. tungsten imports that were Chinese intermediates increased significantly.

During 1993, several structural changes occurred in the U.S. tungsten industry. In one change, a major U.S. carbide producer purchased a controlling interest in a German company that manufactured cutting tools. In another, a U.S. manufacturer of carbide cutting and wear-resistant components was purchased by a U.S. company that manufactured machine tool equipment systems and related products. Finally, a company that had processed concentrate to ammonium tungstates discontinued operation in 1993, subsequently selling a portion of its equipment to another U.S. processor. Counter to these actions, one major U.S. processor terminated a 1992 agreement that would have resulted in the purchase of its tungsten carbide business by a German firm.

In 1993, China reportedly began a more centralized procedure for obtaining licenses to export tungsten concentrates and intermediate products. This was intended to more effectively control the production, pricing, and distribution of these materials. Chinese production of concentrate reportedly declined in 1993, and this was likely related not only to the centralization action but also to the discontinuation of Government subsidies to tungsten mines and to the lower worldwide demand for tungsten.

Effective October 18, 1993, Russia was extended the trade benefits of the duty-free Generalized System of Preferences (GSP). Tungsten materials affected by this GSP status included imports of concentrates, ferrotungsten, carbide powder blends, and certain forms of waste and scrap.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁶	Reserve base ⁶
	1992	1993 ⁵		
United States	W	W	150,000	210,000
Australia	200	200	5,000	129,000
Austria	1,600	100	10,000	15,000
Bolivia	1,100	900	53,000	105,000
Brazil	250	200	20,000	20,000
Burma	375	400	15,000	34,000
Canada	—	—	260,000	493,000
China	17,000	15,000	1,020,000	1,370,000
France	—	—	20,000	20,000
Korea, Republic of	400	—	58,000	77,000
Portugal	1,200	400	26,000	26,000
Russia	5,500	5,000	250,000	355,000
Thailand	200	200	30,000	30,000
Other countries	3,730	3,100	347,000	440,000
World total (may be rounded)	31,555	25,500	2,300,000	3,300,000

World Resources: More than 90% of the world's estimated tungsten resources are located outside the United States, with about 41% located in China. In addition to China and the United States, countries with significant resource potential are Australia, Austria, Bolivia, Brazil, Burma, Canada, North and South Korea, Peru, Portugal, Russia, Spain, Thailand, and Turkey.

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.

*Estimated. W Withheld to avoid disclosing company proprietary data.

¹Excludes 2 months of withheld data.

²Delay in recording material imported at yearend 1990 believed to have caused significant statistical distortion. Consumption estimated to be about 10,100 metric tons for each year.

³A metric ton unit (mtu) of tungsten trioxide (WO₃) contains 7.93 kilograms of tungsten.

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

⁵See Appendix B.

⁶See Appendix C for definitions.

VANADIUM

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

Domestic Production and Use: The U.S. vanadium industry consisted of nine firms, but only six had active operations. Raw materials included Idaho ferrophosphorus slag, petroleum residues, spent catalysts, utility ash, and vanadium-bearing iron slag. The chief use of vanadium was as an alloying agent for iron and steel. Vanadium was also important in the production of aerospace titanium alloys and as a catalyst for the production of maleic anhydride and sulfuric acid. About 103 domestic plants reported consumption in 1993. Major end-use distribution was as follows: transportation, 31%; machinery and tools, 26%; building and heavy construction, 21%; and other, 22%.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production:					
Mine, recoverable basis	W	W	W	W	W
Mill, recovered basis ¹	W	W	W	W	W
Petroleum residues, recovered basis	2,389	2,308	2,250	1,352	1,500
Imports for consumption:					
Ores, slag, residues	3,157	3,826	882	838	850
Vanadium pentoxide, anhydride	92	83	133	206	160
Oxides and hydroxides, other	227	597	110	103	100
Aluminum-vanadium master alloys (gross weight)	200	292	73	50	45
Ferrovanadium	487	244	420	592	500
Exports:					
Vanadium pentoxide, anhydride	1,171	819	700	26	50
Oxides and hydroxides, other	1,080	976	1,105	1,113	1,000
Aluminum-vanadium master alloys (gross weight)	—	378	141	60	50
Other compounds	385	848	648	1,140	900
Ferrovanadium	399	271	144	213	200
Shipments from Government stockpile	—	—	—	—	—
Consumption: Reported	4,646	4,081	3,293	4,073	4,100
Apparent ²	W	W	W	W	W
Price, average, dollars per pound V ₂ O ₅	6.17	4.21	2.85	2.28	2.00
Stocks, producer and consumer, yearend	1,736	1,082	935	1,084	900
Employment, mine and mill	690	530	490	430	430
Net import reliance ³ as a percent of apparent consumption	W	W	W	W	W

Recycling: Some tool steel scrap was recycled primarily for its vanadium content. Vanadium was also recycled as a minor component of scrap iron and steel alloys, which were recycled principally for their iron content. An increasing amount of vanadium was also recycled from spent chemical process catalysts.

Import Sources (1989-92):⁴ Republic of South Africa, 35%; European Community (EC), 11%; South America and Mexico, 21%; Canada, 15%; and other, 18%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁵ 1/1/94
Slag	2619.00.9030		Free	Free.
Ash and residues	2620.50.0000		Free	Free.
Vanadium pentoxide anhydride	2825.30.0010		16.0% ad val.	40% ad val.
Vanadium oxides and hydroxides, other	2825.30.0050		16.0% ad val.	40% ad val.
Vanadates	2841.90.1000		11.2% 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.
Waste and scrap	8112.40.3000		Free	Free.

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

VANADIUM

Government Stockpile:

Material	Stockpile Status—9-30-93			
	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Vanadium pentoxide	651	—	—	—

Events, Trends, and Issues: After falling to less than \$7.00 per kilogram of vanadium content, the price of ferrovanadium (FeV) in Europe and Japan was steady at \$7.80 to \$8.00 per kilogram. FeV prices in the United States likewise stabilized in fourth quarter 1993 at \$4.40 to \$4.50 per pound of vanadium content after falling to around \$4.35. The \$8.00 per kilogram price tag translates to a raw material vanadium pentoxide (V_2O_5) price of about \$1.20 per pound. However, converters must pay \$1.30 to \$1.35 per pound for V_2O_5 . The narrow margin between the price of FeV and V_2O_5 represents a loss for most converters. Meanwhile, V_2O_5 prices continued to drift downward. Under these circumstances, the world's largest vanadium producer, located in the Republic of South Africa, discontinued V_2O_5 production for an indefinite period of time. The South African plant has a capacity of 26 million pounds per year. At the time of closing, the plant was operating at the rate of only 7 million pounds per year. While the V_2O_5 plant is idle, the company will continue to ship vanadium-bearing slag. Another South African vanadium producer doubled its capacity to produce "Nitrovan" and added a new facility to produce ferrovanadium at its plant located in Brits. The company is now fully integrated, with FeV output based on its own production of V_2O_5 from its own mine, which has the capacity to produce 12 million pounds per year. With the added FeV production capability, the company has stopped selling V_2O_5 on the open market.

World Mine Production, Reserves, and Reserve Base:

	Mine production		Reserves ⁶	Reserve base ⁶
	1992	1993 ^e		
United States	W	W	45,000	4,000,000
Australia	—	—	30,000	350,000
Brazil	—	—	—	24,000
China	4,700	5,000	2,000,000	3,000,000
Finland	—	—	—	100,000
Russia	7,000	8,000	5,000,000	7,000,000
South Africa, Republic of	15,000	15,000	3,000,000	12,000,000
Other countries	—	—	—	1,000,000
World total (may be rounded)	⁷ 26,700	⁷ 28,000	10,000,000	27,000,000

World Resources: World resources of vanadium exceeded 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.

^aEstimated. W Withheld to avoid disclosing company proprietary data.

¹Produced from domestic materials.

²Includes processing losses from low-grade imports.

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

⁴The EC, Canada, and Austria produced vanadium alloys and chemicals solely from imported raw materials.

⁵See Appendix B.

⁶See Appendix C for definitions.

⁷Excludes U.S. production.

VERMICULITE

(Data in thousand metric tons, unless noted)

Domestic Production and Use: One company, with mining and processing facilities in South Carolina, remained the largest producer of vermiculite concentrate. Three other companies each had an active operation for producing concentrate; two were in South Carolina, and the third was in Virginia. Most of the vermiculite concentrate was shipped to 33 exfoliating plants in 18 States. The end uses for exfoliated vermiculite were estimated to be agriculture, 55%; insulation, 23%; lightweight concrete aggregates, including concrete, plaster, and cement premixes, 15%; and other, 7%.

Salient Statistics—United States:	1989*	1990	1991	1992	1993*
Production ¹	249	*209	180	190	185
Imports for consumption*	50	45	38	40	40
Exports*	18	18	10	8	5
Consumption, apparent, concentrate	281	*236	208	222	220
Consumption, exfoliated	195	142	136	140	135
Price, average value, concentrate, dollars per ton, f.o.b. mine	122	*91	W	W	W
Stocks, producer, yearend	NA	NA	NA	NA	NA
Employment, mine and mill*	240	230	230	230	230
Net import reliance ² as a percent of apparent consumption	11	12	13	14	16

Recycling: Insignificant.

Import Sources (1989-92):* Republic of South Africa, 97%; China, 2%; and Brazil, 1%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN³ 1/1/94
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		4.9% ad val.	30% ad val.

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

Government Stockpile: None.

VERMICULITE

Events, Trends, and Issues: The value of sold and used vermiculite concentrate from four operations was concealed to avoid disclosing company proprietary data. In previous years, the largest end use of vermiculite was in lightweight aggregates. However, during the past few years, horticultural applications has been the dominant end user.

One company has been developing and marketing aqueous dispersions, which contain chemically exfoliated vermiculite. These dispersions were being used in products that require properties such as high heat or flame resistance, sealing capability, etc.

World Mine Production, Reserves, and Reserve Base:

	Mine production*		Reserves ⁴	Reserve base ⁴
	<u>1992</u>	<u>1993</u>		
United States ¹	190	185	25,000	100,000
Russia	60	60	NA	NA
South Africa, Republic of	170	170	20,000	80,000
Other countries ⁶	<u>55</u>	<u>60</u>	<u>5,000</u>	<u>20,000</u>
World total ⁶	475	475	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.

*Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹Concentrate sold and used by producers.

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

³See Appendix B.

⁴See Appendix C for definitions.

⁶Excludes countries for which information is not available.

YTTRIUM¹(Data in metric tons of yttrium oxide (Y₂O₃) content, unless noted)

Domestic Production and Use: In 1993, the rare earth yttrium was mined by two companies as a constituent of the minerals monazite and bastnasite. Monazite, a rare-earth phosphate mineral, was mined in Florida as a byproduct of processing heavy-mineral sands for titanium and zirconium minerals. Monazite was the principal source of domestically mined yttrium. Bastnasite, a rare-earth fluorocarbonate mineral, was mined as a primary product in California. The yttrium content of bastnasite is small and represents a minor source of the element. Most yttrium used by the domestic industry was imported as compounds or derived from imported yttrium concentrate. Two U.S. companies processed ore and concentrates to produce refined yttrium compounds or intermediate concentrates that were exported. One company operated a plant in Tennessee, and another company operated in Texas.

Yttrium was primarily used as a phosphor in color televisions and computer monitors, trichromatic fluorescent lights, temperature sensing, 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 also used in heating element alloys, laser crystals, laser glass, superalloys, and high-temperature superconductors.

Salient Statistics—United States:

	1989	1990	1991	1992	1993*
	W	W	W	W	W
Production, mine					
Imports for consumption:					
In monazite	9	—	—	—	—
In xenotime and yttrium concentrate ²	NA	NA	NA	NA	NA
Exports, in ore and concentrate	NA	NA	NA	NA	NA
Consumption, apparent	NA	NA	NA	NA	NA
Stocks, processor, yearend	NA	NA	NA	NA	NA
Employment ³	381	397	411	372	351
Net import reliance ⁴	100	100	100	100	100
Price, dollars: ⁵					
Monazite concentrate, per metric ton	616-695	618-695	494-532	207-241	200-233
Yttrium concentrate, per kilogram, 60% REO	32-33	32-33	32-33	32-33	NA
Yttrium oxide, per kilogram, 99.0% to 99.99% purity	116	116	116	15-116	16-16
Yttrium metal, per kilogram, 99.0% to 99.9% purity	550	550	550	140-550	135-350

Recycling: Small quantities, primarily from laser crystals and synthetic garnets.

Import Sources (1989-92): Monazite: Indonesia, 89%; and Australia, 11%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN ⁸ 1/1/94
	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	70.5¢/kg	\$4.41/kg.
	Rare-earth compounds, including yttrium oxide, yttrium nitrate, and other individual compounds	2846.90.5000	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.

YTTRIUM

Events, Trends, and Issues: Yttrium pricing continued to be competitive as low-cost yttrium compounds from China dominated world markets. The U.S. economy continued to show slow growth in 1993. Demand for yttrium in most applications increased.

Yttrium was consumed primarily in the form of high-purity compounds, especially the oxide and nitrate. Demand for yttrium is forecast to increase through the end of the decade, especially in alloys and ceramics.

Yttrium-bearing deposits are being evaluated in several countries. A company in Australia received environmental approval to mine and process rare earths. A decision on the project is expected in mid-1994. If approved, the deposit would be a major world principal producer of yttrium and the other rare earths.

World Mine Production, Reserves, and Reserve Base:

	Mine production ⁷		Reserves ⁸	Reserve base ⁸
	1992	1993 ⁹		
United States	W	W	120,000	130,000
Australia	55	55	102,000	110,000
Brazil	18	15	400	1,500
Canada	—	—	3,300	4,000
China	500	500	220,000	240,000
India	50	50	36,000	38,000
Malaysia	20	20	13,000	21,000
South Africa, Republic of	14	14	4,400	5,000
Sri Lanka	2	2	240	260
Thailand	9	10	600	600
U.S.S.R. ⁹	88	88	9,000	10,000
Zaire	1	1	570	630
World total (rounded)	¹⁰ 760	¹⁰ 750	510,000	560,000

World Resources: Large resources of yttrium in monazite and xenotime are available worldwide in placer and beach-sand deposits 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 ceramics, yttrium is not subject to substitution by other elements.

*Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹See also Rare-Earths and Scandium.

²Xenotime, an yttrium phosphate mineral, is chemically treated to produce yttrium concentrate.

³Total employment at a rare-earth mine in California and at heavy-mineral sands operations in Florida and New Jersey. Employees were not assigned to specific commodities in calculating employment.

⁴Essentially all yttrium consumed domestically was imported or refined from imported ores and concentrates.

⁵Monazite concentrate price derived from Metals Bulletin; yttrium concentrate prices from Industrial Minerals (London); yttrium oxide and metal prices from Concord Trading Corp., Molycorp Inc., and Rhône-Poulenc Basic Chemicals Co.

⁶See Appendix B.

⁷Includes yttrium contained in rare-earth ores.

⁸See Appendix C for definitions.

⁹As constituted before Dec. 1991.

¹⁰Excludes U.S. mine production.

ZINC

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

Domestic Production and Use: Based on the price of metal, the value of zinc mine production in 1993 was \$510 million. The 25 leading mines accounted for 99% of mine output, with the top 5 producing 72%. More than 90% of the total mine output was produced in Alaska, Missouri, New York, and Tennessee. Four primary and 10 secondary smelters produced slab zinc. About 67% of the slab zinc consumption was in Illinois, Indiana, Michigan, New York, Ohio, and Pennsylvania. Of the total slab zinc consumed, galvanizing accounted for 47%; zinc-base alloys, 21%; brass and bronze, 13%; and other, 19%. About 126,000 tons of zinc in compounds and dusts was consumed, mainly by the chemical, agricultural, rubber, and paint industries. Major coproducts of zinc mining and smelting were lead, cadmium, silver, and sulfur.

Salient Statistics—United States:		1989	1990	1991	1992	1993^a
Production:	Mine, recoverable	276	515	518	524	505
	Primary slab zinc	260	263	253	272	255
	Secondary slab zinc ¹	98	96	122	128	120
	Zinc from old scrap	117	109	119	132	125
Imports for consumption:						
	Ore and concentrate	41	47	45	45	35
	Slab zinc, scrap, and compounds	790	723	637	740	682
Exports:	Slab zinc, scrap, and compounds	136	128	112	120	130
	Ore and concentrate	79	220	382	388	380
Shipments from Government stockpile		—	—	—	—	11
Consumption:	Apparent, slab zinc	1,060	992	933	1,035	1,120
	Apparent, all forms	1,311	1,240	1,165	1,276	1,360
Industrial demand		1,004	1,049	835	964	1,040
Price, average, cents per pound:						
	Domestic producers	82.0	74.6	52.8	58.4	46.0
	London Metal Exchange, cash	77.6	66.5	50.7	56.2	44.0
Stocks, slab zinc, yearend		91	87	79	75	77
Employment:	Mine and mill ^a	2,350	2,500	2,100	2,300	2,200
	Smelter primary ^a	1,500	1,500	1,500	1,500	1,400
Net import reliance ² as a percent of industrial demand		61	³ 41	³ 24	³ 30	³ 26

Recycling: In 1993 an estimated 350,000 tons of zinc in waste and scrap, including 125,000 tons in old scrap, was recovered in the form of slab zinc, brass, zinc-base alloys, dust, oxide, and other chemicals. Another 55,000 tons of zinc in scrap was exported, whereas 35,000 tons was imported.

Import Sources (1989-92): Ore, concentrate: Mexico, 41%; Canada, 30%; Peru, 20%; and other, 9%. Metal: Canada, 63%; Mexico, 9%; Australia, 5%; Peru, 5%; Spain, 5%; and other, 13%. Combined total: Canada, 61%; Mexico, 11%; Peru, 6%; Australia, 5%; Spain, 4%; and other, 13%.

Tariff:	Item	Number	Most favored nation (MFN) 1/1/94	Non-MFN⁴ 1/1/94
	Ore and concentrate	2608.00.0030	1.7¢/kg on lead content	3.7¢/kg on zinc content.
	Unwrought metal	7901.11.1000	1.5% ad val.	5.0% ad val.
	Alloys, casting-grade	7901.12.1000	19.0% ad val.	45.0% ad val.
	Alloys	7901.20.0000	19.0% ad val.	45.0% ad val.
	Waste and scrap	7902.00.0000	2.1% ad val.	11.0% ad val.
	Hard zinc spelter	2620.11.0000	1.5% ad val.	5.0% ad val.
	Zinc oxide	2817.00.0000	Free	5.5% ad val.

ZINC

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

Government Stockpile:

Material	Stockpile Status—9-30-93			
	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Zinc	332	3	332	11

Events, Trends, and Issues: Domestic zinc mine production was slightly lower than that recorded in the previous year. This was partially due to the temporary closure of the Greens Creek Mine in Alaska. During the year, modifications were made to the grinding circuit of the mill at the Red Dog Mine in Alaska in order to bring production closer to the design capacity of 42,000 tons per month of zinc concentrates. Alaska again accounted for about one-half of the U.S. total mine output. Domestic exports of zinc in concentrates were markedly lower in 1993.

Virtually all U.S. and world zinc prices were tied to London Metal Exchange (LME) pricing in 1993. With large increases in world metal stocks as the year progressed, zinc prices dropped substantially through September.

The National Defense Stockpile Center was authorized to dispose of 68,000 tons of zinc in fiscal year 1993, but disposed of only 11,000 tons.

World Mine Production, Reserves, and Reserve Base:

	Mine production ⁵		Reserves ⁶	Reserve base ⁶
	1992	1993 [*]		
United States	552	530	16,000	50,000
Australia	1,028	1,000	17,000	65,000
Canada	1,312	1,200	21,000	56,000
China	670	700	5,000	9,000
Mexico	279	270	6,000	8,000
Peru	601	580	7,000	12,000
Other countries	2,695	2,700	72,000	130,000
World total (may be rounded)	7,140	7,000	140,000	330,000

World Resources: Conventional identified zinc resources of the world are about 1.8 billion tons. Zinc-bearing coals, mostly in the central United States, also have a resource potential of millions of tons of zinc that might be recovered during coal beneficiation.

Substitutes: Aluminum, plastics, and magnesium are major competitors as diecasting material. Aluminum, steel, and plastics substitute for galvanized sheet uses. 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 competitors of zinc in chemical, electronic, and pigment uses.

*Estimated.

¹Recovered from both new and old scrap.

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

³Figures for these years are lower than in the 1980's because of a sharp rise in exports of concentrates.

⁴See Appendix B.

⁵Zinc content of concentrate and direct shipping ore.

⁶See Appendix C for definitions.

ZIRCONIUM

(Data in metric tons, unless noted)

Domestic Production and Use: Zirconium metal was extracted from imported zircon sand by the traditional two domestic producers, one in Oregon and the other in Utah. Nuclear fuel rod cladding accounted for most of zirconium's use. Zircon sand was produced at two mines in northeastern Florida. Primary zirconium chemicals were produced by the Oregon metal producer and at a plant in New Jersey; secondary chemicals were produced by nearly a dozen other companies as well. Zirconia (metal oxide) was produced from zircon sand at traditional plants in Alabama, New Hampshire, New York, and Ohio, and by the metal producer in Oregon. Natural zirconia, the mineral baddeleyite, was imported as well. Zircon refractories and foundry sands were produced and used by companies throughout the United States, especially in the production of finished metal and glass products.

Salient Statistics—United States:	1989	1990	1991	1992	1993*
Production: Zircon (ZrO ₂ content) ¹	76,952	66,347	67,041	70,301	W
Imports of zirconium (ZrO ₂ content):					
Ore and concentrate ²	49,203	17,409	23,209	27,802	48,650
Metal, alloys, waste, and scrap	675	554	702	745	880
Oxide	1,667	1,766	1,536	1,947	1,940
Exports of zirconium (ZrO ₂ content):					
Ore and concentrate	32,384	19,627	20,366	19,412	23,910
Metal, alloys, waste, and scrap	1,796	1,738	1,866	2,309	2,040
Consumption, ore and concentrate, apparent (ZrO ₂ content)	94,684	66,763	72,689	77,968	W
Prices:					
Zircon, dollars per metric ton:					
Domestic ³	468	349	340	215	W
Imported, f.o.b. U.S. east coast	365	363	340	255	200
Zirconium sponge, dollars per pound	12-18	9-12	9-12	9-12	9-12
Stocks, zircon, consumer and dealer, yearend, foundries excluded	32,133	28,081	23,765	21,572	W
Employment, mine and mill	445	NA	NA	NA	NA
Net import reliance ⁴ as a percent of apparent consumption	19	1	8	12	W

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 old chemical processing equipment, scrap generated during metal production and fabrication, and in the form of various alloys. Zircon foundry mold cores and spent or rejected (broken) zirconia refractories such as kiln furniture and setter plates are oftentimes recycled as well.

Import Sources (1989-92): Zirconium ore and concentrate: Australia, 62%; South Africa, Republic of, 38%; and other, less than 1%. Zirconium, wrought, unwrought, unwrought alloys, waste, and scrap: France, 55%; Canada, 11%; United Kingdom, 9%; Germany, 9%; Japan, 8%; the former U.S.S.R., 5%; other, 3%.

Tariff:	Item	Number	Most favored nation (MFN)	Non-MFN⁵
			1/1/94	1/1/94
	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.
	Waste and scrap	8109.10.3000	Free	Free.
	Other unwrought, powders	8109.10.6000	4.2% ad val.	25% ad val.
	Other wrought, alloys	8109.90.0000	5.5% ad val.	45% ad val.

ZIRCONIUM

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

Government Stockpile: In addition to the ore in the National Defense Stockpile (see Events, Trends, and Issues section), the U.S. Department of Energy held approximately 545 tons of zirconium in various forms.

Material	Stockpile Status—9-30-93			
	Uncommitted inventory	Committed inventory	Authorized for disposal	Disposals Jan.-Sept. 93
Baddeleyite	14,507	—	—	—

World Mine Production, Reserves, and Reserve Base:

	Mine production ^a (metric tons zircon concentrate)		Reserves ^b (million metric tons ZrO ₂ content)	Reserve base ^c
	1992	1993		
United States	108,156	W	3.2	3.6
Australia	300,000	300,000	23.3	25.9
Brazil	19,000	20,000	1.0	1.1
China ^d	15,000	15,000	.5	1.0
India	18,000	20,000	2.1	2.4
Russia	3,000	3,000	NA	NA
South Africa, Republic of	230,000	230,000	13.8	15.3
Ukraine	75,000	75,000	NA	NA
U.S.S.R. ^{e 7}	—	—	4.0	6.0
Other countries	40,000	40,000	.9	2.9
World total (rounded)	808,000	⁸ 703,000	49.0	58.0

World Resources: Resources of zircon in the United States included about 14 million tons associated with titanium resources in heavy-mineral sand deposits occurring mainly in the Atlantic and Gulf Coast States. Phosphate and sand and gravel deposits may yield substantial amounts of zircon as a byproduct in the future. Eudialyte and gittinsite are complex zirconium silicate minerals that have a potential for zirconia production. Specific deposits and processes currently are under investigation in the United States, Canada, and Greenland. Identified world resources of zircon exceed 60 million tons.

Substitutes: Chromite and olivine can be used in place of zircon for some foundry applications, but are generally not preferred; extremely high prices and/or unavailability usually cause the conversion. 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 service, while titanium and synthetic materials may substitute in some chemical plants, though with shortened service life or increased cost.

^aEstimated. NA Not available. W Withheld to avoid disclosing company proprietary data.

¹ZrO₂ content of zircon is typically 65%.

²Zirconium ores, baddeleyite, and concentrates thereof.

³Calculated average value of total reported mine shipments.

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

⁵See Appendix B.

⁶See Appendix C for definitions.

⁷As constituted before Dec. 1991.

⁸Excludes U.S. production.

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 (mt)	= 2,204.6 pounds, avoirdupois or 1,000 kilograms
1 pound (lb)	= 453.6 grams
1 short ton (st)	= 2,000 pounds, avoirdupois
1 short ton unit (stu)	= 1% of 1 short ton or 20 pounds, avoirdupois
1 troy ounce (tr oz)	= 1.09714 avoirdupois 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:

Azerbaijan
Cambodia
Cuba
Laos

North Korea
Tajikistan
Uzbekistan
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 most public libraries or can be purchased from the United States Government Printing Office, Washington, DC 20402.

APPENDIX C

A Resource/Reserve Classification for Minerals¹

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.

Staff members of the U.S. Bureau of Mines and the U.S. Geological Survey collect information about the quantity and quality of all mineral resources, but from different perspectives and with different purposes. In 1976, a team of staff members from both agencies 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.

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

¹ Based on U.S. Geological Survey Circular 831, 1980.

assume proven technology and current economics. The reserve base includes those resources that are currently economic (reserves), marginally economic (marginal reserves), and some of those that are currently subeconomic (subeconomic resources). The term "geologic reserve" has been applied by others generally to the reserve-base category, but it 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.

Cumulative production	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability range	
	Measured	Indicated		Hypothetical	(or) Speculative
ECONOMIC	Reserves		Inferred reserves	+	—
MARGINALLY ECONOMIC	Marginal reserves		Inferred marginal reserves		
SUB- ECONOMIC	Demonstrated subeconomic resources		Inferred subeconomic resources		
Other occurrences	Includes nonconventional and low-grade materials				

FIGURE 2. -- Reserve Base and Inferred Reserved Base Classification

Cumulative production	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability range	
	Measured	Indicated		Hypothetical (or)	Speculative
ECONOMIC	Reserve		Inferred	+ —	
MARGINALLY ECONOMIC			reserve		
SUB- ECONOMIC	base		base		
Other occurrences	Includes nonconventional and low-grade materials				

U.S. BUREAU OF MINES PUBLICATIONS

Minerals Yearbook—Annual publications that review the mineral industry of the United States and foreign countries. Contains statistical data on materials and minerals and includes 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.

Annual Reports—Yearly reports covering the individual commodities, states, and countries appearing in the *Minerals Yearbook*.

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.

State Mineral Summaries—Provides estimated data, based on 9-month reporting, and summaries of mineral activity at the State level for the previous year. These summaries have been prepared in cooperation with State Geological Surveys or related agencies.

Minerals Today—Bimonthly magazine that provides timely information on commodities with data and analyses that are germane to policy issues of current interest.

Mineral Issues—Reports that identify and evaluate mineral policy issues to assist Government and private sector analysts and decisionmakers.

Mineral Perspectives—Reports that present timely data on mineral developments in foreign geographic areas.

Bulletins—Reports that describe major Bureau investigations or studies that are considered to have permanent value.

Information Circulars—Reports that primarily compile, review, abstract, and discuss various activities and developments in the minerals industry.

Reports of Investigations—Describe the principal features and results of minor investigations or phases of major investigations to inform the minerals industry and the public about progress in original Bureau research.

New Publications—Bureau of Mines—Bimonthly list of new Bureau of Mines publications.

WHERE TO OBTAIN BUREAU PUBLICATIONS

- *Mineral Industry Surveys* and *New Publications—Bureau of Mines* can be obtained free of charge by contacting the U.S. Bureau of Mines at (412) 892-4338.
- *Minerals Today*, *Annual Reports* in the *Minerals Yearbook* series, and special studies such as *Mineral Commodity Summaries*, *State Mineral Summaries*, and *Mineral Perspectives* are sold by the U.S. Government Printing Office, Washington, D.C.
- *Bulletins*, *Information Circulars*, *Reports of Investigations*, and special studies are sold by the National Technical Information Service, Springfield, Virginia.

