

GRAPHITE

By Jim F. Lemons, Jr.

Natural graphite is one of the three forms of carbon (the others being charcoal and diamond). It can be classified as disseminated flake, crystalline vein (fibrous or columnar) and amorphous. The flakes when well crystallized have a black metallic luster, whereas the amorphous material is black and earthy with a microcrystalline compactness. Synthetic graphite is produced from petroleum coke and pitch. Graphite is an excellent conductor of heat and electricity and has a high melting point of 3,500° C. It is extremely resistant to acid, chemically inert, and highly refractory. Graphite fibers are rayon-based, polyacrylonitrile-based, pitch-based, or vapor grown. The main use of these carbon fibers is to reinforce polymer composites.

Domestic graphite production information developed by the U.S. Geologic Survey from a voluntary survey of the U.S. producers of natural and synthetic graphite. Of the 191 natural graphite operations surveyed, including those that were idle, 124 responded, representing 65% of the estimated value shown in table 1.

There was no mining of natural graphite in the United States in 1995, thus the source of all raw material is from imports. Imports in 1995 to the United States were 60,700 tons at a value of \$30.1 million. In 1995, the United States consumed 23,500 tons of natural graphite and exported 37,300 tons at a value of \$17.9 million.

Legislation and Government Programs

Stockpile inventories for Sri Lanka graphite remained constant in 1995 at 4,930 tons. The total inventory of all other graphite stocks decreased 10 % from 1994 levels. (See table 2.)

Production

Domestic natural graphite processing plants use imported graphite that are beneficiated, ground, and blended as required to maintain individual company grades. Natural flake graphite was imported principally from Canada, China, and Madagascar. Sri Lanka provided chip and lump. China and Mexico supplied the United States with most of its requirements for amorphous graphite.

Madagascar operations are entirely open pit, but in the Republic of Korea, Mexico, and Sri Lanka, underground mining usually is essential due to the depth and physical characteristics of the deposits. Often crude ores are crushed, ground, classified, and passed through a series of flotation steps. Higher grades are obtained through regrind and refloatation. In some operations, firms make high purity graphite by leaching the concentrate with

strong acids or alkalis. In Sri Lanka, the graphite ore is extracted in lumps and hand cobbled on a sorting patio to remove quartz inclusions.

Table 3 identifies major U.S. plants producing synthetic graphite. Production is estimated as shown in table 4 based upon a canvass of approximately 50% of the industry and a review of recent production trends. The industry shows only a slight increase in total production from 1994 levels.

Consumption

Reported consumption of natural graphite increased 2% from 1994 levels to 39,400 tons. The three major uses of natural graphite were in refractories, brake linings, and in foundries, which together accounted for 53% of reported consumption. (See table 5.)

Graphite is used in both castable refractories, principally in ramming and gunning mixes (principally amorphous) and shaped refractories. Carbon-magnesite bricks are large users of flake in high-temperature and corrosion-prone applications such as in steel furnace linings, ladles, slag-lines, hotpots, nozzles, and blast furnaces. Alumina-graphite refractories are principally used in continuous steel casting, in shrouding tubes, submerged entry nozzles, and also in torpedo ladles. Aluminum- and magnesium-carbon bricks require a higher purity of carbon (94% to 99% minimum carbon content) but accept a smaller mesh (-100 mesh minimum).

In brake linings, graphite is a substitute for asbestos and is finding use in brakes for heavy duty vehicles. The graphite lubricates, transfers the heat of friction away from the lining, and lowers the rate of wear.

Graphite has been used in the past in batteries that furnish small currents over long periods. However, this has largely been replaced by the use of carbon black which is more efficient, and cheaper. There also has been substitution by the use of alkaline-manganese batteries which contain only small amounts of graphite which can now accept greater flexibility in type and size of flake.

Graphite is used in foundries in foundry facing (principally amorphous) or mold wash that allows the metal casting to be easily removed from the mold on cooling.

Prices

Generally prices for flake graphite concentrates are higher than those for microcrystalline (amorphous) graphite. Prices for flake graphite vary depending on the carbon content, the size of the flakes, their distribution, and the ash content. Natural

graphite prices are often negotiated between the buyer and seller and are based on purity and other criteria. Therefore published price quotations such as those in Industrial Minerals are given as a range of prices. (See table 6.)

Foreign Trade

Total exports of natural graphite significantly increased in 1995 to 37,300 tons, much of this growth was to Pacific Rim nations. Imports of natural graphite increased 14% from 1994, to 60,700 tons with a value of \$30.1 million. Imports of graphite electrodes totaled 47,500 tons valued at \$102 million. (See tables 7, 8, and 9.)

World Review

World natural graphite production decreased slightly from 1994 levels, but most countries maintained their share of the world market. (See table 10.)

Norway.—Elkem Skaland A/S located just 400 kilometers inside the Arctic Circle has been sold to a consortium of buyers that include James Durrans & Sons Ltd. of the United Kingdom and George H. Luh GmbH of Germany, both established traders in graphite. In December 1995, extraction began on a new richer seam that yields a 30% carbon which results after processing in medium flake and powder graphite in the range of 85%-92% carbon.¹

Sweden.—Woxna Graphite AB started production of natural crystalline graphite in 1995. The operation is at Edsbyn in central Sweden. Concentration will utilize a former gold mine in Harnas that was closed in the early part of the year.²

Tanzania.—A new graphite plant was brought on-stream by Samax Resources Ltd. at Merelani, near Arusha in northern Tanzania. This plant will be a supplier to U.S. refractory marketing agent Harbison-Walker.³

Current Research and Technology

A new processing technology developed by Mintek of South Africa has enabled the separation of graphite flakes from gangue particles through the use of delamination techniques. Conventional processes involving milling and flotation tend to

include gangue particles that adhere to the flakes or require pebble milling to break up the coarse flakes in order to remove the waste. Tests indicate a product grading 97% to 98% carbon.⁴

Outlook

Graphite electrode consumption in steelmaking has been decreasing since the late 1980's due to increased efficiency by iron and steel producers, increased electrode quality, competition from composite products, and rise of the Direct Current furnace which cuts electrode use by one-half. Applications of natural graphite in lubrication applications also are decreasing due to changes in lubricant compositions and processing technologies. Industry sources, however, predict a growth rate of approximately 2% to 3% for this industry over the near term with most of this growth in transportation applications.⁵

¹Industrial Minerals (London). Skaland Graphite Aims for Seamless Transition, No. 339, Dec. 1995, p. 15.

²_____. Woxna Launches Graphite Operation, IM Annual Review 1995, Supplement to Feb. 1996 issue, No. 341, p. 16.

³_____. Samax Starts Shipping Merelani Flake Graphite, No. 334, July 1995, p. 16.

⁴_____. Graphite Technology Proves Beneficial, No. 330, Mar. 1995, p. 79.

⁵Metal Producing. Report on Forecast by The Freedonia Group Industry, Study No. 504. V. 33, Sept. 1993, p. 12.

OTHER SOURCES OF INFORMATION

U.S. Geological Survey Publications

Graphite. Ch. in Mineral Commodity Summaries, annual Weis, P. L., Graphite, in Brobst, D.A., and Pratt, W.P., eds., United States mineral resources: U.S. Geological Survey Professional Paper 820, pp. 277-283.

Other Sources

Chemical Week.

European Chemical News.

Industrial Minerals (London).

TABLE 1
SALIENT NATURAL GRAPHITE STATISTICS 1/

		1991	1992	1993	1994	1995
United States:						
Production	metric tons	--	--	--	--	--
Apparent consumption 2/	do.	14,200	29,500	34,800	32,900	23,500
Exports	do.	19,400	20,200	17,400	20,300	37,300
Value	thousands	\$11,300	\$12,200	\$11,100	\$13,100	\$17,900
Imports for consumption	metric tons	33,500	49,700	52,200	53,100	60,700
Value	thousands	\$21,700	\$25,500	\$29,900	\$26,900	\$30,100
World: Production	metric tons	771,000	670,000 r/	666,000 r/	725,000 r/	718,000 e/

e/ Estimated. r/ Revised.

1/ Data are rounded to three significant digits.

2/ Domestic production plus imports minus exports.

TABLE 2
U.S. GOVERNMENT STOCKPILE GOALS AND YEAREND
STOCKS OF NATURAL GRAPHITE IN 1995, BY TYPE

(Metric tons)

Type	Goal	National stockpile inventory
Madagascar crystalline flake	(1/)	14,300
Sri Lanka amorphous lump	12,200	4,930
Crystalline, other than Madagascar and Sri Lanka	(1/)	1,360
Nonstockpile-grade, all types	(1/)	333

1/ This commodity no longer has a goal.

Source: Defense National Stockpile Center, Inventory of Stockpile Materials as of Dec. 31, 1995.

TABLE 3
PRINCIPAL PRODUCERS OF SYNTHETIC GRAPHITE IN 1995

Company	Plant location	Product 1/
Amoco Performance Products Co.	Greenville, SC	Cloth, high modulus fibers.
Ashland Petroleum	Ashland, KY	High modulus fibers.
Black Diamond Graphite, Metallics Systems Div.	Sanborn, NY	Unmachined shapes.
Carbone of America	St. Marys, PA	Motor brushes; unmachined shapes; other.
Fiber Materials, Inc.	Biddeford, ME	Other.
Fiber Technology Corp.	Provo, UT	High modulus fibers.
Fortafil Fibers Inc.	Rockwood, TN	Do.
B F Goodrich Co., Engineered Systems Div., Super Temp Operations	Santa Fe Springs, CA	Other.
Grafil Inc.	Sacramento, CA	High modulus fibers.
Hercules Inc.	Salt Lake City, UT	Do.
HITCO Materials Group, B P Chemicals Ltd.	Gardena, CA	Cloth.
Minerals Technology, Inc.; Specialty Minerals Corp.	Easton, PA	Other.
National Electrical Carbon Co.	Fostoria, OH	Unmachined shapes; high modulus fibers.
NAC Carbon Products, Inc.	Punxsutawney, PA	Other.
Polycarbon, Inc.	Valencia, CA	Cloth.
Showa Denko Carbon Inc.	Ridgeville, SC	Electrodes; other.
SGL Carbon Corp.	Morganton, NC	Anodes; crucibles; electrodes; unmachined shapes; other.
Do.	Niagara Falls, NY	Do.
Do.	Ozark, AR	Do.
Superior Graphite Co.	Russellville, AR	Electrodes.
Do.	Hopkinsville, KY	Other.
Textron Specialty Materials	Lowell, MA	High modulus fibers.
The Carbide/Graphite Group, Inc.; Graphite Specialties	Niagara Falls, NY	Anodes; crucibles; motor brushes; electrodes; unmachined shapes; refractories; other.
Do.	St. Marys, PA	Do.
UCAR Carbon Company, Inc.	Clarksburg, WV	Anodes; electrodes; unmachined shapes; other.
Do.	Clarksville, TN	Do.
Do.	Columbia, TN	Do.
Zoltek Corp.	St. Charles, MO	High modulus fibers.

1/ Cloth includes low-modulus fibers; motor brushes include machined shapes; crucibles includes vessels.

TABLE 4
U.S. PRODUCTION OF SYNTHETIC GRAPHITE, BY END USE 1/

End use	1994		1995 e/	
	Quantity (metric tons)	Value (thou- ands)	Quantity (metric tons)	Value (thou- ands)
Anodes	W	W	W	W
Cloth and fibers (low-modulus)	62	\$5,170	58	\$4,800
Crucibles and vessels and refractories	W	W	W	W
Electric motor brushes and machined shapes	W	W	W	W
Electrodes	177,000	467,000	184,000	484,000
Graphite articles 2/	--	41,200	--	40,500
High-modulus fibers	3,490	126,000	3,740	135,000
Unmachined graphite shapes	8,780	42,100	5,760	32,300
Other	20,400	78,000	23,000	80,500
Total	209,000	759,000	217,000	777,000
Synthetic graphite powder and scrap 3/	66,600	34,600	63,400	31,700
Grand total	276,000	794,000	280,000	809,000

e/ Estimated. W Withheld to avoid disclosing company proprietary data; included with "Other."

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

2/ Includes all items for which quantity data are usually unavailable.

3/ Includes lubricants (alone/in greases), steelmaking carbonraisers, additives in metallurgy, and other powder data.

TABLE 5
U.S. CONSUMPTION OF NATURAL GRAPHITE, BY USE 1/

(Thousand metric tons and thousand dollars)

End use	Crystalline		Amorphous 2/		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1993:	23,300	\$34,200	17,600	\$12,000	40,900	\$46,200
1994:						
Batteries	455	1,110	140	438	595	1,550
Brake linings	2,580	3,010	5,710	4,650	8,290	7,600
Carbon products 3/	660	1,890	490	384	1,150	2,270
Crucibles, retorts, stoppers, sleeves and nozzles	1,020	956	6	10	1,030	966
Foundries 4/	659	697	1,500	783	2,160	1,480
Lubricants	568	1,110	1,670	1,080	2,350	2,080
Pencils	1,520	1,650	167	104	1,690	1,750
Powdered metals	1,840	3,930	51	101	1,890	4,030
Refractories	6,730	8,100	2,890	774	9,620	8,880
Rubber	156	397	703	542	859	939
Steelmaking	47	796	1,130	674	1,180	1,470
Other 5/	5,840	8,760	2,190	1,860	8,040	10,600
Total	22,100	32,400	16,600	11,400	38,800	43,600
1995:						
Batteries	W	W	--	--	W	W
Brake linings	2,530	3,580	5,980	4,980	8,510	8,570
Carbon products 3/	544	1,580	281	352	824	1,930
Crucibles, retorts, stoppers, sleeves and nozzles	969	861	10	19	980	880
Foundries 4/	523	473	1,790	877	2,310	1,350
Lubricants	523	985	1,490	1,090	2,020	2,080
Pencils	1,100	1,100	642	600	1,740	1,700
Powdered metals	1,970	4,310	35	56	2,010	4,360
Refractories	5,770	5,310	4,180	3,550	9,950	8,860
Rubber	220	420	583	358	802	778
Steelmaking	125	178	1,100	422	1,220	600
Other 5/	6,330	11,600	2,760	2,310	9,080	13,900
Total	20,600	30,400	18,800	14,600	39,400	45,000

W Withheld to avoid disclosing company proprietary data; included with "Other."

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

2/ Includes mixtures of natural and manufactured graphite.

3/ Includes bearings and carbon brushes.

4/ Includes foundries (other) and foundry facings.

5/ Includes ammunition, antiknock and other compounds, drilling mud, electrical/electronic devices, industrial diamonds, magnetic tape, mechanical products, packings, paints and polishes, seed coating, small packages, soldering/welding, and other end-use categories.

TABLE 6
REPRESENTATIVE YEAREND GRAPHITE PRICES 1/

(Per metric ton)

Type	1994	1995
Crystalline large flake, 85% to 90% carbon	\$400-\$600	\$450-\$550
Crystalline medium flake, 85% to 90% carbon	300- 500	330- 500
Crystalline small flake, 80% to 90% carbon	250- 500	270- 500
Amorphous powder, 80% to 85% carbon	220- 300	220- 300

1/ Prices are normally "Cost, insurance, and freight" (C.i.f.) main European port.

Source: "Industrial Minerals," No. 327, Dec. 1994, p. 62 and No. 339, Dec. 1995, p. 64.

TABLE 7
U.S. EXPORTS OF NATURAL AND ARTIFICIAL GRAPHITE, BY COUNTRY 1/ 2/

Country	Natural 3/		Artificial 4/		Total	
	Quantity (metric tons)	Value 5/	Quantity (metric tons)	Value 5/	Quantity (metric tons)	Value 5/
1994:						
Canada	4,060	\$2,610,000	6,520	\$9,340,000	10,600	\$11,900,000
France	74	26,000	1,030	4,360,000	1,110	4,380,000
Japan	428	483,000	8,130	4,460,000	8,560	4,940,000
Korea, Republic of	94	134,000	5,050	2,700,000	5,140	2,840,000
Mexico	6,650	2,710,000	1,620	889,000	8,270	3,600,000
Netherlands	134	52,000	3,800	1,950,000	3,930	2,000,000
Taiwan	1,300	1,160,000	481	304,000	1,780	1,460,000
Other r/	7,500	5,900,000	11,200	15,500,000	18,700	21,400,000
Total	20,300	13,100,000	37,800	39,500,000	58,100	52,500,000
1995:						
Canada	3,560	2,790,000	4,980	9,810,000	8,540	12,600,000
France	633	215,000	4,700	8,390,000	5,330	8,610,000
Japan	7,290	2,790,000	13,800	5,930,000	21,100	8,720,000
Korea, Republic of	393	323,000	8,680	4,530,000	9,070	4,860,000
Mexico	6,640	2,780,000	1,190	679,000	7,830	3,460,000
Netherlands	266	103,000	6,710	3,290,000	6,980	3,390,000
Taiwan	7,830	3,440,000	993	625,000	8,820	4,060,000
Other	10,600	5,370,000	12,300	15,200,000	22,900	20,700,000
Total	37,300	17,900,000	53,300	48,500,000	90,600	66,400,000

r/ Revised.

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

2/ Numerous countries for which data were reported have been combined within the "Other" category under the "Country" list.

3/ Amorphous, crystalline flake, lump and chip and natural, not elsewhere classified. The applicable Harmonized Tariff Schedule (HTS) nomenclature title and code(s) are: "Natural graphite in powder or in flakes"/"Other;" HTS Nos. 2504.10/90.0000.

4/ Includes data from the applicable Harmonized Tariff Schedule (HTS) nomenclatures: "Artificial graphite" and "Colloidal or semicolloidal graphite;" their respective HTS Nos. are 3801.10/20.0000.

5/ Values are F.a.s..

Source: Bureau of the Census.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF NATURAL GRAPHITE, BY COUNTRY 1/ 2/

Country or territory	Crystalline flake and flake dust		Lump and chippy dust		Other natural crude; high-purity; expandable		Amorphous		Total	
	Quantity (metric tons)	Value 3/ (thousands)	Quantity (metric tons)	Value 3/ (thousands)	Quantity (metric tons)	Value 3/ (thousands)	Quantity (metric tons)	Value 3/ (thousands)	Quantity (metric tons)	Value 3/ (thousands)
1994:										
Australia	324	84	--	--	--	--	--	--	324	84
Austria	--	--	--	--	--	--	20	12	20	12
Brazil	--	--	--	--	3,050	4,210	--	--	3,050	4,210
Canada	14,400	9,120	--	--	622	241	--	--	15,000	9,360
China	823	306	--	--	8,070	2,490	2,400	250	11,300	3,050
France	146	154	--	--	105	802	--	--	252	955
Germany	--	--	--	--	127	373	--	--	127	373
Hong Kong	--	--	--	--	--	--	144	22	144	22
India	17	29	--	--	220	257	--	--	237	286
Japan	--	--	--	--	256	1,590	--	--	256	1,590
Madagascar	3,710	2,650	--	--	--	--	--	--	3,710	2,650
Mexico	--	--	--	--	321	257	15,800	2,170	16,100	2,430
Mozambique	--	--	--	--	62	51	--	--	62	51
Norway	17	7	--	--	93	35	--	--	110	42
South Africa	18	34	--	--	31	241	--	--	49	275
Sri Lanka	--	--	718	509	--	--	--	--	718	509
Switzerland	--	--	--	--	54	71	--	--	54	71
United Kingdom	27	99	--	--	4	32	--	--	31	132
Zimbabwe	580	354	--	--	--	--	--	--	580	354
Other 5/	1,020	399	--	--	(4/)	13	--	--	1,020	412
Total	21,000	13,200	718	509	13,000	10,700	18,400	2,460	53,100	26,900
1995:										
Australia	--	--	--	--	--	--	--	--	--	--
Austria	--	--	--	--	--	--	40	29	40	29
Brazil	--	--	--	--	3,100	4,030	--	--	3,100	4,030
Canada	15,200	10,300	--	--	124	30	--	--	15,400	10,300
China	3,450	1,720	--	--	9,930	3,590	2,920	676	16,300	5,990
France	12	38	--	--	41	423	--	--	53	461
Germany	--	--	--	--	155	603	--	--	155	603
Hong Kong	--	--	--	--	(4/)	11	396	40	396	51
India	38	63	--	--	256	259	--	--	294	322
Japan	--	--	--	--	4,700	2,080	--	--	4,700	2,080
Madagascar	4,180	2,690	--	--	--	--	--	--	4,180	2,690
Mexico	--	--	--	--	--	--	14,500	2,080	14,500	2,080
Mozambique	--	--	--	--	--	--	--	--	--	--
Norway	--	--	--	--	--	--	--	--	--	--
South Africa	117	87	--	--	55	224	--	--	172	311
Sri Lanka	--	--	746	455	--	--	--	--	746	455
Switzerland	--	--	--	--	(4/)	9	--	--	(4/)	9
United Kingdom	15	80	--	--	(4/)	7	--	--	15	87
Zimbabwe	581	278	--	--	--	--	--	--	581	278
Other 5/	122	384	--	--	--	--	--	--	122	384
Total	23,700	15,600	746	455	18,400	11,300	17,900	2,830	60,700	30,100

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

2/ The information framework from which data for this material were derived originated from Harmonized Tariff Schedule (HTS) base data.

3/ Customs values.

4/ Less than 1/2 unit.

5/ Includes Belgium (1995), Czech Republic (1995), Italy (1995), Kazakstan (1995), the Republic of Korea (1995), the Netherlands (1995), Poland, and Taiwan.

Source: Bureau of the Census, adjusted by the U.S. Geological Survey.

TABLE 9
U.S. IMPORTS FOR CONSUMPTION
OF GRAPHITE ELECTRODES, BY COUNTRY 1/ 2/

Country	Quantity (metric tons)	Value 3/ (thousands)
1994:		
Canada	11,900	\$28,400
Germany	2,950	8,400
Italy	6,260	10,000
Japan	7,840	20,600
Mexico	10,200	14,700
Other 4/	6,490	12,800
Total	45,700	95,000
1995:		
Canada	11,200	30,900
Germany	2,420	7,430
Italy	8,230	14,700
Japan	8,020	21,700
Mexico	11,600	16,100
Other 4/	6,080	11,000
Total	47,500	101,800

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

2/ The applicable "Harmonized Tariff Schedule" (HTS) code and nomenclature title are: (HTS 8545.11.0000); "Electric Furnace Electrodes."

3/ Customs values.

4/ Includes data for countries reflecting less than 1,000 metric tons for yearly imports.

Source: Bureau of the Census.

TABLE 10
GRAPHITE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country	1991	1992	1993	1994	1995 e/
Argentina	85	20	20 e/	25 e/	25
Austria	19,750	19,796	4,146	12,300 r/	12,000
Brazil (marketable) 3/	26,965	29,414	29,472	35,965 r/	36,000
Burma 4/	36	--	--	--	--
Canada (exports of natural graphite)	6,200	17,400	18,700	21,711 r/	22,000
China e/	289,000	300,000	310,000	360,000 r/	350,000
Czech Republic e/	XX	XX	27,000	25,000	25,000
Czechoslovakia 5/	47,000	20,000	XX	XX	XX
Germany (marketable)	15,807	11,963	8,363	8,000 e/	8,000
India (run-of-mine) 6/	69,922	72,996	82,398 r/	91,721 r/	90,000
Korea, North e/	35,000	38,000	38,000	38,000	40,000
Korea, Republic of	76,791	8,412 r/	5,910 r/	4,300 r/	4,000
Madagascar	14,079	8,910	8,000 e/	8,000 e/	10,000
Mexico:					
Amorphous	35,315	30,500	42,600	43,000 e/	44,000
Crystalline flake	1,943	985	960	1,000 e/	1,000
Namibia e/	200	200	--	--	--
Norway e/	6,930 7/	7,000	6,500	5,200 r/	5,000
Romania	6,000 e/	2,300	2,000 e/	2,070	2,100
Russia e/	XX	15,000	10,000	8,000	8,000
Sri Lanka	6,381	3,307	5,163	2,950 r/	3,000
Turkey (run-of-mine) 8/	25,867	20,978	20,000 e/	20,000 e/	20,000
Ukraine e/	XX	50,000	40,000	30,000	30,000
U.S.S.R. e/ 9/	75,000	XX	XX	XX	XX
Zimbabwe	12,903	12,346	7,142	7,890 r/	8,000
Total	771,000	670,000 r/	666,000 r/	725,000 r/	718,000

e/ Estimated. r/ Revised. XX Not applicable.

1/ World totals, U.S. data, and estimated data have been rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through June 13, 1996.

3/ Does not include the following quantities sold directly without beneficiation, in metric tons: 1991--7,298; 1992--8,957; 1993--9,960; 1994--10,000 (estimated); and 1995--10,000 (estimated).

4/ Data are for fiscal years beginning Apr. 1 of that stated.

5/ Dissolved Dec. 31, 1992. All production in Czechoslovakia for 1991-92 came from what is now the Czech Republic.

6/ Indian marketable production is 10% to 20% of run-of-mine production.

7/ Reported figure.

8/ Turkish marketable production averages approximately 5% of run-of-mine production. Almost all is for domestic consumption.

9/ Dissolved in Dec. 1991.