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GRAPHITE [ADVANCE RELEASE]

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GRAPHITE

By Donald W. Olson

Domestic survey data and tables were prepared by Linda M. White, statistical assistant, and the world production table was prepared by Lisa D. Miller, international data coordinator.

In 2007, there was no reported production of natural graphite, but U.S. production of synthetic graphite was estimated to be 198,000 metric tons (t) valued at about $1.18 billion. U.S. imports and exports of natural graphite were estimated to be 58,600 t and 15,700 t, respectively, while U.S. imports and exports of synthetic graphite were estimated to be 46,000 t and 44,100 t, respectively. U.S. apparent consumption of natural and synthetic graphite was estimated to be 42,900 t and 200,000 t, respectively.

This report includes information on U.S. trade and use of natural graphite and U.S. production, trade, and use of synthetic graphite. Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using the unrounded data.

Graphite is one of four forms of crystalline carbon; the others are carbon nanotubes, diamonds, and fullerenes. Graphite is gray to black in color, opaque, and usually has a metallic luster; sometimes it exhibits a dull earthy luster. Graphite occurs naturally in metamorphic rocks. It is a soft mineral with a Mohs hardness of 1 to 2, and it exhibits perfect basal (one-plane) cleavage. Graphite is flexible but not elastic, has a melting point of 3,927° C, and is highly refractory. It is low in specific gravity. Graphite is the most electrically and thermally conductive of the nonmetals and is chemically inert. All these properties combined make graphite desirable for many industrial applications, and both natural and synthetic graphite have industrial uses.

There are three types of natural graphite—amorphous, flake or crystalline flake, and vein or lump. Amorphous graphite is the lowest quality and most abundant. Amorphous refers to its very small crystal size and not to a lack of crystal structure. Amorphous is used for lower value graphite products and is the lowest priced graphite. The most important deposits of amorphous graphite are found in China, Europe, Mexico, and the United States. Flake or crystalline flake graphite is less common and higher quality than amorphous. Flake graphite occurs as separate flakes that crystallized in metamorphic rock. Flake graphite can be four times the price of amorphous. Good quality flakes can be processed into expandable graphite for many uses, such as flame retardants. The foremost deposits are found in Austria, Brazil, Canada, China, Germany, and Madagascar. Vein or lump graphite is the rarest, most valuable, and highest quality type of natural graphite. It occurs in veins along intrusive contacts in solid lumps, and it is only commercially mined in Sri Lanka (Moores, 2007).

Natural graphite is mined from open pit and underground mine operations. Production from open pit operations is less expensive and is preferred where the overburden can be removed economically. Mines in Madagascar are mostly of this type. In Mexico, the Republic of Korea, and Sri Lanka, where the deposits are deep, underground mining techniques are required.

Beneficiation processes for graphite may vary from a complex four-stage flotation at European and United States mills to simple hand sorting and screening of high-grade ore at Sri Lankan operations. Certain soft graphite ores, such as those found in Madagascar, need no primary crushing and grinding. Typically, such ores contain the highest proportion of coarse flakes. Ore is sluiced to the field washing plant where it undergoes desliming to remove the clay fraction and is subjected to a rough flotation to produce a concentrate with 60% to 70% carbon. This concentrate is transported to the refining mill for further grinding and flotation to reach 85% carbon. It is then screened to produce a variety of products marketed as flake graphite that contain 75% to 90% carbon.

Production

The U.S. Geological Survey (USGS) obtained the production data in this report through a voluntary survey of U.S. synthetic graphite producers. The survey of U.S. synthetic graphite producers collected data from 13 of 26 canvassed producers. Data were estimated for the producers that did not respond to the survey based on responses received in previous years and on industry trends.

No natural graphite was reported mined in the United States in 2007, but 198,000 t of synthetic graphite with an estimated value of $1.18 billion was reported produced and shipped (table 3).

Consumption

The USGS obtained the data in this report through a survey of natural graphite companies in the United States. The survey of natural graphite companies collected data from 67 of 99 canvassed companies and plants. Data were estimated for the companies that did not respond to the survey. This survey represented most of the graphite industry in the United States.

Graphite uses have changed dramatically in the past 20 years. U.S. consumption of natural graphite decreased by 4% to 39,200 t in 2007 from 40,700 t in 2006 (table 2). The natural graphite consumption data in table 2 include mixtures of natural and synthetic graphite with the amorphous graphite, and those data are the result of the totaling reported consumption that may include company stocks from previous years. Consequently, the table 2 consumption numbers are different from the computed apparent consumption numbers given in table 1. Consumption of crystalline grade decreased in 2007 by almost 5% to 18,600 t from 19,600 t in 2006, and consumption of amorphous grade decreased slightly to 20,500 t in 2007 from 21,100 t in 2006. These changes in consumption corresponded with a slight decrease in total graphite value in 2007. Brake linings,

refractories, and steelmaking were the three industries that dominated U.S. natural graphite use. Brake linings, lubricants, and refractories accounted for 41% of natural graphite consumption. The production of batteries, foundries, and pencils together made up another 7% of consumption. The refractories industry was the leading consumer of crystalline flake graphite, accounting for almost 35% of crystalline flake graphite used in 2007.

Graphite has properties of both metals and nonmetals, which makes it suitable for many industrial applications. The metallic properties include electrical and thermal conductivity. The nonmetallic properties include high-thermal resistance, inertness, and lubricity. The combination of conductivity and high-thermal stability allows graphite to be used in many applications, such as in batteries, fuel cells, and refractories. Graphite's lubricity and thermal conductivity make it an excellent material for high-temperature applications because it provides effective lubrication at a friction interface while furnishing a thermally conductive matrix to remove heat from the same interface. Electrical conductivity and lubricity allow its use as the primary material in the manufacture of brushes for electric motors. A graphite brush effectively transfers electric current to a rotating armature while the natural lubricity of the brush minimizes frictional wear. Today's advanced technology products, such as friction materials and battery and fuel cells, require high-purity graphite. Natural graphite is purified to 99.9% carbon content for use in battery applications.

Graphite is made up of parallel sheets of carbon atoms in a hexagonal arrangement. It is possible to insert other atoms between the sheets, a process that is called intercalation. The insertion of other atoms makes dramatic changes in the properties of graphite. Lithium ions can be inserted to create graphite anodes for lithium ion batteries. Graphite can be intercalated with sulfuric and nitric acids to produce expanded graphite from which foils are formed that are used in seals, gaskets, and fuel cells (Hawley, 2001).

Refractory applications of graphite included carbon-bonded brick, castable ramming, and gunning mixtures. Carbon-magnesite brick has applications in high temperature corrosive environments, such as iron blast furnaces, ladles, and steel furnaces. Carbon-alumina linings are principally used in continuous steel-casting operations. Alumina- and magnesite-carbon brick requires a particle size of 100 mesh and a purity of 95% to 99% graphite.

Crystalline flake graphite accounted for almost 53% of natural graphite usage in the United States. It was consumed mainly in batteries, brake linings, lubricants, other applications, and refractories. Amorphous graphite is mainly used in brake linings, refractories, steelmaking, and other applications where additions of graphite improve the process or the end product. Lump graphite finds appropriate uses in a number of areas, such as steelmaking, depending on purity and particle size.

Synthetic graphite is used in more applications in North America than natural graphite and accounts for a significant share of the graphite market. The main market for high-purity synthetic graphite is as a carbon raiser additive in iron and steel. This market consumes a significant portion of the synthetic graphite. Other significant uses of all types of graphite are in the manufacture of catalyst supports; low-current, long-life batteries; porosity-enhancing inert fillers; powder metallurgy; rubber; solid carbon shapes; static and dynamic seals; steel; and valve and stem packing. The use of graphite in low-current batteries is gradually giving way to carbon black, which is more economical.

Graphite is used to manufacture antistatic plastics, conductive plastics and rubbers, electromagnetic interference shielding, electrostatic paint and powder coatings, high-voltage power cable conductive shields, membrane switches and resistors, semiconductive cable compounds, and electrostatic paint and powder coatings (George C. Hawley, President, George C. Hawley and Associates, written commun., January 16, 2004).

Prices

Natural graphite prices increased for most types during 2007. Prices for crystalline and crystalline flake graphite concentrates ranged from $410 to $990 per metric ton; prices for amorphous powder ranged from $240 to $260 per ton (table 4). Ash and carbon content, crystal and flake size, and size distribution affect the price of graphite. The European port price of synthetic graphite in 2007 ranged from $3,500 to $12,500 per ton. The average unit value of synthetic graphite exports decreased slightly to $2,891 per ton in 2007 from $2,960 per ton in 2006 (table 5).

Foreign Trade

Total graphite exports increased slightly in tonnage to 59,800 t valued at $147 million in 2007 from 58,600 t valued at $124 million in 2006 owing to a 30% decrease and a 21% increase in natural and synthetic graphite exports, respectively (table 5). Total natural graphite imports increased by 11% in tonnage to 58,600 t in 2007 from 52,600 t in 2006, and the value increased by 28% to $37.3 million in 2007 from $29.1 million in 2006 (table 6). Principal import sources of natural graphite were, in descending order of tonnage, China, Canada, Mexico, Brazil, Sri Lanka, and Madagascar, which accounted for about 99% of the tonnage and 90% of the value of total imports. Mexico and China were, in descending order of tonnage, the suppliers of amorphous graphite, and Sri Lanka provided the lump and chippy dust variety. China and Canada were, in descending order of tonnage, the major suppliers of crystalline flake and flake dust graphite. A number of other producing nations supplied several other natural types and grades of graphite to the United States; among the most notable were Canada and China.

World Review

World production of natural graphite increased by 9% in 2007 to an estimated 1.11 million metric tons (Mt) compared with 1.02 Mt in 2006. China maintained its position as the world's leading graphite producer with 800,000 t. India was the second ranked graphite producer with 130,000 t, followed by Brazil, North Korea, and Canada, in decreasing order of tonnage produced. These five countries accounted for 95% of world production, and China alone accounted for about 72% (table 8).

Outlook

An increasing trend in collaboration with Western graphite producers is taking place in the graphite industry. These collaborations combine superior management, processing, and packaging techniques of Western companies with China's production power located in and adjacent to the largest markets. China offers the optimum cost-location balance. China has serious logistics challenges though, such as freight issues and shipping problems, rising container rates, Chinese government prioritized internal transportation, possible renewal of export taxes, and licensing law issues. Despite these challenges, the Chinese graphite industry is thriving and is expected to continue growing (Moores, 2007).

Refractory use trends for graphite closely follow events in the steel industry because graphite is used in the manufacture of refractory brick used in iron and steel furnace linings. The ability to refine and modify graphite is expected to be the key to future growth in the graphite industry. Refining techniques have enabled the use of improved graphite in electronics, foils, friction materials, and lubrication applications (Hand, l997). Graphite-base refractories are also used as continuous casting ware, usually in the form of nozzles to guide molten steel from ladle to mold. Brake linings and other friction materials are expected to steadily use more natural graphite as new automobile production continues to increase and more replacement parts are required for the growing number of vehicles. Natural graphite (amorphous and fine flake) is used as a substitute for asbestos in brake linings for vehicles heavier than cars and light trucks. Flexible graphite products, such as grafoil (a thin graphite cloth), are expected to be the fastest growing market but are expected to use small amounts of natural graphite compared with major end-use markets, such as brake linings and refractories. Products produced by advanced refining technology in the next few years, despite a weak refractory market and competitive pricing from Chinese material, could increase profitability in the U.S. graphite industry.

The predicted increase in manufacture and sales of hybrid and electric vehicles is expected to increase demand for high-purity graphite in fuel-cell and battery applications. Fuel cells are a potential high-growth, large-volume graphite (natural and synthetic) end use but are currently a very small part of consumption. High volumes of graphite are not expected to be consumed in this end use for many years but may be used in the longer term (Taylor, 2006, p. 517). One prediction is that the demand for high-quality, high-carbon graphite could increase to more than 100,000 metric tons per year (t/yr) for fuel-cell and battery applications alone (Crossley, 2000).

Global demand for graphite used in batteries may increase to more than 25,000 t/yr in the next 4 to 5 years. This demand is expected to be spread between two main consuming sectors—alkaline batteries and lithium-ion batteries. Synthetic and natural graphite are used in these batteries. In alkaline batteries, graphite is the conductive material in the cathode. Until recently, synthetic graphite was predominantly used in these batteries. With the advent of new purification techniques and more efficient processing methods, it has become possible to improve the conductivity of most natural graphite to the point where it can be used in batteries. The decision whether to use synthetic or natural graphite will be based on performance and price. The growth of the lithium-ion battery market could have a more dramatic effect on the graphite market as the demand for mobile energy storage systems rises.

There is a common industry trend toward higher purity and consistency in specifications for some specialized and high-tech applications. The trend to produce higher purity graphite using thermal processing and acid leaching techniques continues. High-purity graphite has applications in advanced carbon graphite composites.

The markets for graphite used in rubber and plastics (including Styrofoam coatings) are growing, and continued growth is expected. The U.S. market for graphite in pencils has almost disappeared; pencil "leads" now are imported directly from China (Taylor, 2006, p. 517). These markets, however, use little graphite and are not expected to have a significant impact on future consumption.

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TABLE 1
SALIENT NATURAL GRAPHITE STATISTICS[1]

		2003	2004	2005	2006	2007
United States:						
Apparent consumption[2]	metric tons	30,000	17,600	42,400	30,400	42,900
Exports:						
Quantity	do.	22,200	46,100	22,100	22,200	15,700
Value	thousands	$19,500	$24,900	$15,900	$16,000	$19,100
Imports for consumption:						
Quantity	metric tons	52,300	63,700	64,500	52,600	58,600
Value	thousands	$24,400	$29,900	$34,700	$29,100	$37,300
World, production	metric tons	999,000	1,020,000	1,040,000	1,020,000 r	1,110,000 e

eEstimated. rRevised. do. Ditto.

[1]Data are rounded to no more than three significant digits.

[2]Domestic production plus imports minus exports.

TABLE 2
U.S. CONSUMPTION OF NATURAL GRAPHITE, BY END USE[1]

	Crystalline		Amorphous[2]		Total	
End use	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
2006:						
Batteries	W	W	--	--	W	W
Brake linings	W	W	5,170 r	$3,910 r	W	W
Carbon products[3]	312	$831	W	393	W	W
Crucibles, retorts, stoppers, sleeves, nozzles	W	W	W	W	W	W
Foundries[4]	W	W	W	W	760	$485
Lubricants[5]	670 r	800 r	W	W	W	W
Pencils	W	W	W	W	W	W
Powdered metals	194 r	432 r	66	159	260 r	591 r
Refractories	7,000	3,940	4,000	2,960	11,000	6,890
Rubber	47	81	W	W	W	W
Steelmaking	W	W	W	W	W	7,500
Other[6]	8,370	8,950	1,750	1,500	10,100 r	10,400
Total r	19,600	19,200	21,100	17,600	40,700	36,800
2007:						
Batteries	W	W	--	--	W	W
Brake linings	489	929	4,050	3,100	4,540	4,030
Carbon products[3]	284	775	W	326	W	1,100
Crucibles, retorts, stoppers, sleeves, nozzles	W	W	W	W	W	W
Foundries[4]	W	W	474	323	W	W
Lubricants[5]	624	774	W	W	W	W
Pencils	W	W	W	W	W	W
Powdered metals	258	433	W	W	W	W
Refractories	6,490	3,190	W	W	W	W
Rubber	W	W	W	W	W	W
Steelmaking	W	W	W	W	W	7,410
Other[6]	8,820	9,660	2,150	2,410	11,000	12,100
Total	18,600	18,200	20,500	17,900	39,200	36,100

rRevised. W Withheld to avoid disclosing company proprietary data; included in "Total." -- Zero.

[1]Data are rounded to no more than three significant digits.

[2]Includes mixtures of natural and manufactured graphite.

[3]Includes bearings and carbon brushes.

[4]Includes foundries (other) and foundry facings.

[5]Includes ammunition and packings.

[6]Includes antiknock and other compounds, drilling mud, electrical/electronic devices, industrial diamonds, magnetic tape, mechanical products, paints and polishes, small packages, soldering/welding, and other end-use categories.

TABLE 3
SHIPMENTS OF SYNTHETIC GRAPHITE BY U.S. COMPANIES, BY END USE[1]

End use	Quantity (metric tons)	Value (thousands)
2006:		
Anodes	W	W
Cloth and fibers (low modulus)	W	$174,000
Crucibles and vessels, refractories	W	W
Electric motor brushes and machined shapes	W	W
Electrodes	132,000	495,000
High-modulus fibers	8,160	172,000
Unmachined graphite shapes	8,530	86,800
Synthetic graphite powder and scrap[2]	W	W
Other	W	9,430
Total	190,000	1,030,000
2007:		
Anodes	W	W
Cloth and fibers (low modulus)	W	189,000
Crucibles and vessels, refractories	W	W
Electric motor brushes and machined shapes	849	W
Electrodes	137,000	595,000
High-modulus fibers	W	W
Unmachined graphite shapes	8,930	96,700
Synthetic graphite powder and scrap[2]	W	W
Other	W	9,170
Total	198,000	1,180,000

W Withheld to avoid disclosing company proprietary data; included in "Total."
[1]Data are rounded to no more than three significant digits.
[2]Includes lubricants (alone/in greases), steelmaking carbon raisers, additives in metallurgy, and other powder data.

TABLE 4
REPRESENTATIVE YEAREND GRAPHITE PRICES[1]

(Dollars per metric ton)

Type	2006	2007
Crystalline large, 94% to 97% carbon, +80 mesh	800-950	880-990
Crystalline large, 90% carbon, +80 mesh	570-655	570-655
Crystalline medium, 94% to 97% carbon, +100-80 mesh	730-810	800-900
Crystalline medium, 90% carbon, +100-80 mesh	440-495	440-495
Crystalline medium, 85% to 87% carbon, +100-80 mesh	420-475	420-475
Crystalline fine, 94% to 97% carbon, +100 mesh	600-750	650-800
Crystalline fine, 90% carbon, -100 mesh	410-475	410-475
Amorphous powder, 80% to 85% carbon	240-260	240-260
Synthetic 99.95% carbon[2]	3,000-10,000	3,500-12,500

[1]Prices are normally cost, insurance, and freight main European port.
[2]Swiss border for 2006 and European port for 2007.

Sources: Industrial Minerals, no. 471, December 2006, p. 74; no. 483, December 2007, p. 76.

TABLE 5

U.S. EXPORTS OF NATURAL AND ARTIFICIAL GRAPHITE, BY COUNTRY[1, 2]

	Natural[3]		Artificial[4]		Total	
Country	Quantity (metric tons)	Value[5] (thousands)	Quantity (metric tons)	Value[5] (thousands)	Quantity (metric tons)	Value[5] (thousands)
2006:						
Canada	1,960	$1,630	8,900	$14,500	10,900	$16,100
China	308	282	2,500	9,250	2,810	9,530
France	69	244	3,900	25,200	3,970	25,500
Germany	118	144	1,230	3,240	1,340	3,380
Hong Kong	1,450	504	180	691	1,630	1,200
Italy	683	484	723	2,210	1,410	2,700
Japan	6,440	3,040	2,830	11,800	9,260	14,800
Korea, Republic of	1,620	998	2,440	8,310	4,060	9,310
Mexico	597	909	4,610	6,420	5,200	7,330
Taiwan	759	523	1,330	3,460	2,090	3,980
United Kingdom	4,830	3,010	1,020	2,930	5,850	5,930
Other	3,410	4,190	6,760	19,800	10,200	24,000
Total	22,200	16,000	36,400	108,000	58,600	124,000
2007:						
Canada	1,210	1,140	7,780	11,800	8,990	13,000
China	533	687	5,600	19,200	6,130	19,900
France	10	27	4,220	23,000	4,230	23,000
Germany	193	401	1,250	3,890	1,450	4,290
Italy	269	395	1,100	4,020	1,370	4,410
Japan	3,840	2,780	3,030	13,100	6,870	15,900
Korea, Republic of	1,470	1,800	2,700	8,550	4,170	10,300
Mexico	1,280	1,400	4,990	6,250	6,270	7,650
Netherlands	276	224	936	2,430	1,210	2,660
Taiwan	181	261	1,840	4,760	2,020	5,020
United Kingdom	3,090	3,840	1,260	3,870	4,350	7,710
Other	3,310	6,190	9,420	26,700	12,700	32,900
Total	15,700	19,100	44,100	128,000	59,800	147,000

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Numerous countries for which data were reported have been combined in "Other."

[3]Amorphous, crystalline flake, lump and chip, and natural, not elsewhere classified. The applicable Harmonized Tariff Schedule of the United States (HTS) nomenclatures are "Natural graphite in powder or in flakes" and "Other," codes 2504.10.0000 and 2504.90.0000.

[4]Includes data from the applicable HTS nomenclatures "Artificial graphite" and "Colloidal or semicolloidal graphite," codes 3801.10.0000 and 3801.20.0000.

[5]Values are free alongside ship.

Source: U.S. Census Bureau.

TABLE 6

U.S. IMPORTS FOR CONSUMPTION OF NATURAL GRAPHITE, BY COUNTRY[1, 2]

Country	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)
2006:										
Brazil	3,550	$4,330	--	--	118	$252	--	--	3,670	$4,580
Canada	8,650	5,100	--	--	1,030	4,550	--	--	9,690	9,650
China	16,500	5,920	--	--	141	577	4,850	$1,400	21,500	7,890
Germany	--	--	--	--	129	587	--	--	129	587
Japan	4	5	--	--	81	912	--	--	85	917
Madagascar	609	355	--	--	--	--	--	--	609	355
Mexico	1,250	421	--	--	--	--	14,800	2,280	16,000	2,700
Sri Lanka	--	--	501	$1,160	--	--	--	--	501	1,160
United Kingdom	58	50	--	--	272	899	--	--	330	948
Other[4]	27	18	--	--	36	289	--	--	63	307
Total	30,700	16,200	501	1,160	1,810	8,070	19,600	3,680	52,600	29,100
2007:										
Brazil	2,470	2,870	--	--	349	564	--	--	2,820	3,440
Canada	12,000	7,030	--	--	948	5,760	--	--	12,900	12,800
China	24,200	9,740	--	--	517	1,900	3,280	629	28,000	12,300
Germany	12	12	--	--	124	734	--	--	136	746
Japan	5	5	--	--	186	1,330	--	--	190	1,340
Madagascar	572	371	--	--	--	--	--	--	572	371
Mexico	2,530	766	--	--	--	--	9,900	1,350	12,400	2,120
Sri Lanka	--	--	1,090	2,430	--	--	--	--	1,090	2,430
United Kingdom	36	30	--	--	340	1,250	--	--	376	1,280
Other[4]	--	--	--	--	92	497	--	--	92	497
Total	41,800	20,800	1,090	2,430	2,560	12,000	13,200	1,980	58,600	37,300

-- Zero.

[1]Data are rounded to no more than 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 of the United States base data.

[3]Customs values.

[4]Includes Austria, Belgium, the Czech Republic (2006), India, Italy, the Republic of Korea (2006), the Netherlands, Sweden, Switzerland, and Ukraine (2006).

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

TABLE 7
U.S. IMPORTS FOR CONSUMPTION
OF GRAPHITE ELECTRODES, BY COUNTRY[1, 2]

Country	Quantity (metric tons)	Value[3] (thousands)
2006:		
Canada	8,230	$28,100
China	16,600	27,900
Germany	3,930	12,700
India	3,080	7,010
Italy	1,180	1,350
Japan	14,500	53,700
Mexico	39,000	63,700
Poland	1,380	1,990
Russia	4,530	4,960
Spain	1,610	3,200
Ukraine	2,190	939
Other[4]	1,930	2,520
Total	98,200	208,000
2007:		
Canada	12,500	51,100
China	26,500	44,600
Germany	1,900	11,700
India	1,360	3,390
Italy	1,230	2,050
Japan	18,000	81,400
Mexico	22,600	46,000
Poland	1,650	2,830
Russia	9,670	11,000
Ukraine	1,520	489
Other[4]	800	2,230
Total	97,600	257,000

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]The applicable Harmonized Tariff Schedule of the United States (HTS) nomenclature is "Electric furnace electrodes," code 8545.11.0000.

[3]Customs values.

[4]Includes data for countries that ship less than 1,000 metric tons per year to the United States.

Source: U.S. Census Bureau.

TABLE 8
GRAPHITE: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons)

Country	2003	2004	2005	2006	2007[e]
Austria	100	--	--	--	--
Brazil, marketable	70,739	76,332	77,494 [r]	76,194 [r]	76,200 [p]
Canada[e]	25,000	28,000	28,000	28,000	28,000
China[e]	710,000	700,000	720,000	720,000	800,000
Czech Republic[e]	9,000	5,000	3,000	3,000	3,000
Germany, marketable	2,840	3,155	2,638	-- [r]	--
India, run-of-mine[e, 3]	110,000	120,000	130,000	120,000	130,000
Korea, North[e]	25,000	30,000	32,000	30,000 [r]	30,000
Korea, Republic of	58	247	39	68 [r]	60
Madagascar[e]	15,000	15,000	15,000	15,000	15,000
Mexico, amorphous	8,730	14,769	12,357	12,500 [e]	12,500
Norway[e]	2,400	2,300	2,300	2,300	2,000
Romania	--	500 [e]	500 [e]	-- [r]	--
Sri Lanka[e]	3,387 [4]	3,400	3,000	3,200	3,300
Sweden[e]	850	800	800	800	800
Turkey, run-of-mine[5]	942 [4]	1,000	1,100	1,200 [4]	1,500
Ukraine[e]	7,500	7,500	7,500	7,500	7,500
Uzbekistan[e]	60	60	60	60	60
Zimbabwe[e]	7,675 [4]	10,267 [4]	6,000	5,000	5,000
Total	999,000	1,020,000	1,040,000	1,020,000 [r]	1,110,000

[e]Estimated. [p]Preliminary. [r]Revised. -- Zero.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through May 8, 2008.

[3]Indian marketable production is 10% to 20% of run-of-mine production.

[4]Reported figure.

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