Graphite

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SUMMARY

In 1994, natural flake graphite was produced in Quebec by Stratmin Graphite Inc., and in Ontario mainly by Applied Carbon Technology Inc. (ACT, previously known as Cal Graphite Corporation). Although world demand for graphite was weak during the year, Canada's production increased from 22 808 t in 1993 to 27 000 t in 1994. Shipments also increased, rising from 21 937 t in 1993 to 25 919 t in 1994. At the end of 1994, Stratmin Graphite Inc. was the only producer of natural flake graphite in North America and, according to the company, is the largest producer and exporter in the world of natural flake graphite from a single mine. Stratmin Graphite Inc., also the dominant Canadian producer, shipped 20 219 t in 1994, up from 15 783 t in 1993. On June 14, 1994, ACT closed its mine and concentration plant near Kearney, Ontario. In November, Stratmin Inc., a shareholder of Stratmin Graphite Inc., purchased 18.1 million shares in ACT (representing 49.5% of its outstanding shares) from affiliates of the Pittsburgh-based Hillman Company. After several years of planning, Victoria Graphite Inc., with a deposit near Portland, Ontario, started production on June 1, 1994; mill capacity is 3000 t/y of concentrates. Prices for crystalline flake graphite continued to be soft due to very strong competition.

NATURAL GRAPHITE

Graphite is a natural form of carbon. Natural graphite is a lustrous black carbon mineral, crystallized in the hexagonal system with rhombohedral symmetry. Flake graphite is opaque, flexible and sectile, and exhibits perfect basal cleavage. Natural graphite is unctuous and relatively soft with a hardness of 1-2 on the Mohs scale. It has a black streak on glazed porcelain. Its specific gravity is 2.26 g/cm^3. Graphite is an excellent conductor of heat and electricity and has a high melting temperature of 3500°C. It is extremely resistant to acid, chemically inert, and highly refractory.

Natural graphite is widely distributed throughout the world and is of common occurrence in metamorphic rocks produced by regional or contact metamorphism. Commercially, natural graphite is classified as amorphous, crystalline lump (or vein), and flake. Amorphous graphite is a microcrystalline graphite formed by crystallization of the carbon from organic sediments. The graphite occurs as distorted seams of minute microcrystalline particles intermixed with ungraphitized materials. The graphite content may vary from 15-98%, depending on the degree of metamorphism and the original carbon content in the sediments. Crystalline lump graphite occurs in the form of massive vein or circular accumulations formed probably from hydrothermal origin. Deposits are found in fissures or other cavities in igneous or metamorphic rocks. The size of the particles varies from fine grains to large lumps. The vein deposits vary widely in width from 2 mm to more than 2 m. Flake graphite is found disseminated in metamorphosed siliceous or calcareous sediments such as marble, gneiss and schist. Flake is defined as thin flakes which are classified from coarse to fine and which are graded according to their graphitic carbon content.

OCCURRENCES

Graphite deposits of potentially commercial interest in Canada occur principally in rocks of the Grenville series of eastern Canada. The mineral is found in disseminated crystalline flake and vein forms. Most Canadian graphite deposits are associated with graphite gneiss and crystalline limestones that have been subjected to contact metamorphism associated with tectonic features such as folding, compression and fracturing, and with pegmatitic intrusions. The richest ore zones occur as a succession of veins or lenticular bodies that gradually merge into the adjacent non-graphitic host rock and that are bordered by lenses of lower-grade ore.

Fine-to-coarse flake graphite deposits have been reported mainly in Quebec and Ontario, but also in New Brunswick, Nova Scotia, Saskatchewan, Labrador, and British Columbia.

In Quebec, graphite deposits are located mainly along the Grenville series in several townships of western Quebec: Buckingham, Argenteuil, and Pontiac. The disseminated flake graphite variety is dominant in biotite gneiss and crystalline limestone associated with biotite quartzite, but the vein variety is also reported along the contact of intrusive rocks and crystalline limestone. Occurrences of graphite are associated with metasedimentary rocks that have been subjected to several deformations and where metamorphism has reached amphibolitic or granulitic phases.

Graphite also occurs in Esmanville Township, south of Fermont. Several graphite-rich schist zones, measuring 1-25 m in thickness, are found interlayered with quartz-feldspar gneiss. Some graphite zones locally contain more than 15% graphite in the form of fine and well-crystallized flakes.

In Ontario, graphite deposits are found in several townships of Eastern Ontario in rocks of the Grenville Geological Province. Flake graphite occurs disseminated in marble and gneiss. The occurrences of major interest are in semipelitic and pelitic gneiss units within paragneiss sequences. Graphite is present in amounts up to 10%. Accessory minerals consist of biotite, garnet and pyrite; trace elements in these graphitic rocks are nickel, cobalt, boron and vanadium.

CANADIAN PRODUCTION AND DEVELOPMENTS

In 1994, Canada's production of natural flake graphite came mainly from Stratmin Graphite Inc., which operates a mine and concentrator at Lac-des-Îles, Quebec. In Ontario, production came mainly from Applied Carbon Technology Inc., which operated until June a mine and a processing plant near Kearney.

The year was again marked by a decline in exploration and development activity in Canada.

Despite difficult market conditions, Stratmin Graphite Inc.'s mill produced 23 100 t in 1994 and operated at near its capacity of 24 000 t/y concentrates; the company sold 20 219 t of graphite concentrates in 1994. The company is "ISO 9003 certified," which is an internationally recognized standard of quality-product assurance.

Blaming soft graphite prices and financing difficulties, Applied Carbon announced on June 14, 1994, that it was closing its mine and concentration plant near Kearney, Ontario. The concentrator has a design capacity of 25 000-30 000 t/y of graphite concentrates. About half of the production was sold to the refractory industry for which graphite prices were weak. In November, Stratmin Inc. purchased 18.1 million shares in the capital of Applied Carbon, representing 49.5% of the outstanding shares from affiliates of The Hillman Company. A new board of directors has since been appointed. The plant will remain closed until the graphite market regains its strength. Ways to increase the viability of the plant will be studied, and the annual milling capacity of the blending plant located in Brocton, New York, will be increased to 7000 t in 1995 and to 9000 t in 1996.

After several years of planning, Victoria Graphite Inc. started producing flake graphite on June 1, 1994. The mine, which is located at Portland half way between Ottawa and Kingston, has a production capacity of 3000 t/y of graphite concentrates. Its average ore grade is 6% carbon, and the concentrates grade 80-85% graphite. Using physical and chemical methods, the company intends to upgrade the graphite concentrate to +95% carbon, with very low ash and relatively low sulphur content. Research has indicated that Portland graphite is suitable for the production of exfoliated graphite, a product which is used in the manufacture of graphite foil. Graphite foil is a high-value product and demand is increasing, so the company plans to produce graphite salt, exfoliated graphite, and eventually graphite foil.

Mazarin Mining Exploration Inc. of Québec City has updated a feasibility study to develop a graphite deposit near Fermont in northern Quebec. The study, prepared by Cambior inc. in 1991, proposed an open-pit mining operation for six months of the year, which would supply enough ore to feed a 400-t/d concentrator on a year-round basis for an annual production of 23 000 t of graphite concentrate. The total capital cost of the project was estimated by Cambior at $30.6 million. Geological reserves are 8.1 Mt averaging 16.7% carbon. The 20-year mining reserves total 2.5 Mt grading 17.4% carbon after dilution, and they are mineable by open pit with a waste-to-ore ratio of 1.0:1.0. The graphite from the deposit is suitable for all major applications without chemical upgrading. The project is ready for construction and could be in production in about one year.

Indresco Canada Inc. (previously known as Graphicor Resources Inc.), which faced a declining world market and low recoveries from its Diotte orebody, suspended its operations and mothballed its Lac-des-Îles beneficiation plant in December 1991. The company reports that the plant would re-open only if markets improve substantially, which it claims is not expected to happen in the short-to-medium term.

Mart Mining and Exploration Limited indicated it is seeking a partner to facilitate further exploration drilling and beneficiation testing on its deposit in Labrador, which the company reports has probable reserves of 10.5 Mt of ore grading 21.9% carbon and a stripping ratio of 0.9:1.0. Preliminary beneficiation work on the ore has produced a concentrate grading up to 83% carbon with flake size varying from –150 to +71 microns. The deposit is 7 km from a main highway, which is 15 km from the mining towns of Labrador City and Wabush.

Quinto Mining Corporation holds a 100% interest in a sericite (mica)-graphite-gold deposit near Lumby, British Columbia. The graphite-sericite combination consists of grains that vary in size between 0.3 and 100 microns. Laboratory work has indicated that it will be difficult to separate the graphite from the mica because they are so fine-grained, so the company hopes to sell a mica-graphite final product. Credits can be obtained from gold contained in the deposit. Reserves remain to be determined, but the deposit is reported to be large.

CANADIAN CONSUMPTION AND TRADE

Reported consumption of natural flake graphite in 1993, the latest year for which data are available, amounted to 5089 t. Graphite was used mainly in foundries, but also in the metallurgy and refractory industries.

In 1994, imports of natural graphite were 6427 t and exports were 21 711 t. Most of Canada's trade is with the United States. Crude graphite is used mainly in Ontario (70%) and Quebec (15%).

USES AND SPECIFICATIONS

The uses of natural graphite flow from its physical and chemical properties. It has a high melting temperature, high thermal and electrical conductivity, is chemically inert (resistant to slags), is thermal shock-resistant, has a low coefficient of friction, and has a low absorption coefficient for X rays and electrons.

The principal use for graphite is in the manufacturing of refractory products. This is followed by foundries, lubricants, brake linings, crucibles, and pencils. All of the aforementioned together account for 80% of total usage. Most of the remaining 20% is accounted for by uses such as carbon brushes, batteries, and expandable graphite for the production of graphite foil, for example. It is reported that in Europe refractory producers still use graphite that has a carbon content under 90%. In the United States, most producers use graphite that contains a minimum of 94% carbon. In Japan, the average is 95-99%. In the United States, flake graphite is used mainly in refractories, followed by lubricants, pencils, brake linings, powdered metals, crucibles, and foundries, in decreasing order.

The graphite content of magnesia-carbon refractory bricks, which are large users of flake graphite, varies between 15% and 25% with an average carbon content of 87-90%, and an average flake size of 0.15-0.71 mm. Mag-carbon bricks are used in high-temperature and corrosion-prone applications such as in steel furnace lining, ladles, slag-lines, hotpots, nozzles, and blast furnaces. Graphite is used because of its thermal conductivity and thermal and chemical resistance.

Graphite crucibles are used in steel-making and in the production of nonferrous and precious metals. Here, flake graphite is preferred to microcrystalline graphite because it burns more slowly, has a high attrition resistance, and imparts structural strength through the orientation of the flakes. Average carbon content is 80-90% and average flake size is 0.15 mm.

Lubricants for industrial usage are also made from graphite because of its softness, low friction, inertness, and heat resistance. High-carbon (between 98% and 99%) graphite, 53-106 microns in size, is used.

In the manufacture of lead pencils, natural graphite is used because of its marking properties. The degree of hardness of a pencil is determined by the clay-to-graphite ratio of its lead; softer pencils use more graphite. High-quality pencils use crystalline graphite, while cheaper grades use amorphous graphite. The lead is a mixture of kaolin and bentonite mixed with graphite, and baked.

The use of graphite in brake linings reduces the wear rate. High-carbon crystalline graphite, below 75 microns, is used with a minimum carbon content of 98%, although a concentrate of 90% can be used if abrasive impurities such as silica are at a low level.

Graphite has traditionally been used in dry-cell zinc-carbon batteries due to its electrical conductivity. Fine-grained carbon, 85% below 75 microns, or microcrystalline graphite with a minimum carbon content of 88%, is required. Alkaline batteries require a purer natural graphite, very fine-grain size, with a carbon content of at least 98% or a synthetic grade. Carbon material should be free of metallic impurities such as copper, cobalt, arsenic or antimony.

Electric motor components use a wide variety of graphite, natural or synthetic. Powdered graphite, 150 microns, with a minimum carbon content of 95-99% is required. Lump graphite, low-silica microcrystalline graphite and synthetic graphite are usually suitable.

In powder metallurgy, where steel is reinforced by the absorption of carbon, high-purity graphite is required for the sintering. It also acts as a lubricant and as a source of carbon. Dry powder graphite should be of an average particle size of 5 microns and must have a carbon content of between 96% and 99%.

In paint manufacture, graphite is used to protect metal surfaces exposed to a corrosive environment and to eliminate the accumulation of static electricity in floor coatings. Microcrystalline graphite of low carbon content, 50-55%, is usually required.

For foundry applications such as mould coating, graphite prevents the adhesion of metals. Foundry

facings are usually made of microcrystalline graphite, between 53 and 75 microns, with a low carbon content of 40-70%.

Iron foundries use microcrystalline graphite as a recarburizer for raising the carbon content of iron melted in electrical furnaces from charges containing large proportions of scrap. A wide variety of material, such as synthetic graphite and coke, may serve as a substitute.

Other uses for natural graphite include paints and polishes, anti-knock compounds, electrical and electronic products, and rubber.

GROWTH AREAS

Growing markets include: (a) exfoliated "expanded" flake graphite rolled into sheet (grafoil, also called flexible graphite foil) for the manufacture of gaskets and seals used in the automotive industry, heat exchangers, and other products; (b) high-alumina and magnesia-graphite bricks for the refractory industry, although growth has been considerably reduced in recent years; (c) zirconia-graphite coatings; (d) flake graphite-silicon carbide refractories; and (e) friction materials. Other growing markets are very high-purity graphite for specialty applications, metal powders, and motor brushes.

FLEXIBLE GRAPHITE

World consumption of grafoil products is estimated at 8000-10 000 t in 1994 (Source: Stratmin); this compares with about 5500 t in 1990 and 5700 t in 1992. In 1994, the grafoil market required some 10 500-14 000 t of flake graphite raw material due to losses in the production processes, i.e., production of high-purity graphite from graphite concentrates using acids and bases to remove impurities, followed by graphite salt ("intercalated graphite"), expanded (exfoliated) graphite, and calendering and rolling graphite into foil. Natural flake graphite normally used to manufacture flexible graphite comes from mines located in Canada, China, Madagascar and Zimbabwe. China is the largest producer of high-purity graphite necessary for the production of graphite salt, and Japan is the largest producer and exporter of graphite salt. Graphite salt is shipped to the producer of grafoil where graphite is expanded, calendered and rolled into foil. The flake quality and, consequently, the prices are dependent upon the flake size distribution, fines content, carbon content, and ash content and distribution. Ash is defined as those elements present other than graphite. The size of ash particles as well as the content has an effect on the quality of the finished flexible graphite product. The ash normally consists of varying amounts of trace elements plus larger quantities of silica, sulphur, iron, aluminum and magnesium. The quality of the graphite raw material is also dependent on the quality and process control of the beneficiation process at the mine site, and must be closely monitored by the flexible graphite producer.

The markets for flexible graphite by use and geographic regions were as follows in 1992:

FLEXIBLE GRAPHITE MARKETS, 1992

Region	Industrial	Automotive
	(t/y)	
North America	500	2 600
Japan	100	1 700
Europe	400	250
Other	100	50
Total	1 100	4 600

Source: UCAR Carbon Company Inc.

World producers of grafoil are, in decreasing order: UCAR Carbon Company Inc., United States; SIGRI GmbH, Germany; Polycarbon Inc. (owned by SIGRI), United States; Hitachi Chemical, Japan; Nippon Carbon, Japan; and Le Carbone Lorraine, France. There are also producers in China and the former Soviet Union. The largest market for grafoil is the automotive industry. The industrial market can be divided as follows: petrochemical, which is the largest; chemical; and nuclear, which is the smallest, but is the one that requires the highest-purity grafoil and, consequently, is the most expensive. It is reported by industry that markets for grafoil in the automotive industry are growing worldwide, and that markets for the chemical industry are growing mainly in Southeast Asia and the Middle East. Prices for flexible graphite varied between US$12 and $22/kg in 1993.

WORLD PRODUCTION, TRADE AND CONSUMPTION

Preliminary figures for 1993 indicated that world production of natural graphite was 741 000 t. According to Stratmin Graphite Inc., approximately 200 000 t was flake graphite. The major producers of graphite were: China, with an estimated 310 000 t; South Korea, 80 000 t; Mexico, 49 000 t; Ukraine, 40 000 t; North Korea, 38 000 t; and Brazil, 29 000 t.

The major producing countries, by type of graphite and by decreasing order of importance, are as follows:

- **Flakes: China, Ukraine, Brazil, Canada, Madagascar, Zimbabwe and Norway;**

- **Microcrystalline (amorphous): China, South Korea, Mexico, Czechoslovakia, Austria, North Korea, Russia, and Zimbabwe; and**
- **Lump: Sri Lanka.**

A summary of the largest exporter and importer countries of graphite in recent years is as follows:

MAJOR EXPORTER AND IMPORTER COUNTRIES OF GRAPHITE, IN RECENT YEARS

Country	Exports	Country	Imports
	(000 t/y)		(000 t/y)
China	100-130	Japan	90-95
South Korea	35-45	United States	40-45
Mexico	20	Germany	35-40
Canada	20	United Kingdom	23-25
Madagascar	15	Taiwan	12-15
Zimbabwe	15	Italy	7
Brazil	15	France	6
Austria	7-10	Austria	5
Norway	3		
Germany[1]	2		

[1] Excludes re-exports.

The largest consumers of graphite are the largest producers of steel, base metals and precious metals. Together they consume about 50% of all graphite and are the largest users of flake graphite. Consequently, the largest consumer countries are the former Soviet Union, Japan, the United States, China, Germany, the United Kingdom, Italy, France and Brazil.

PRICES

Published prices for natural graphite provide only a range and do not represent real market prices, which are contracted prices negotiated between suppliers or distributors and consumers. Generally speaking, the prices for flake graphite concentrates are higher than those for microcrystalline (amorphous) graphite, and prices for flake graphite concentrates vary depending on the carbon content, the size of the flakes and their distribution, and the ash content. Published prices of crystalline flake graphite in Europe remained unchanged from the previous year, but amorphous powder continued to decline. Prices in Europe were reported by the industry to be lower than in the United States. The average price of graphite concentrates shipped from Canada in 1994 decreased by nearly 10%.

SUBSTITUTES

Molybdenum disulfide competes with natural graphite as a dry lubricant, but is more sensitive to oxidizing conditions. Finely ground coke mixed with olivine is a potential competitor in foundry-facing applications. Kish, a residue from steel-making, can be transformed into synthetic flake graphite and could become a substitute for flake graphite; however, the technology developed by the U.S. Bureau of Mines in cooperation with the steel industry and Asbury Carbons is still too expensive under the prices paid for natural graphite.

OUTLOOK

Natural graphite has excellent physical and chemical properties, its resource base is large, and it is readily available from several countries. Prices have declined substantially during the past four years and this should restrain the entry of new producers, encourage consumption, and prevent the development of substitutes. For these reasons, growth in consumption should continue. Canadian deposits are of the flake type, relatively easy to upgrade to +90% carbon; many contain graphite that is expandable. Products made from expandable graphite command high prices and the outlook for growth for these products is good. World supply of natural graphite will continue to be abundant. However, requirements by consumers for consistent and high-quality natural flake graphite will continue to increase.

Notes: (1) For definitions and valuation of mineral production, shipment and trade, please refer to Chapter 60. (2) Information in this review was current as of January 14, 1995.

PRICES

"Industrial Minerals"[1] pricing quotation, c.i.f., United Kingdom port, US$ per tonne

		1990	1991	1992	1993	1994
		Dec.	Dec.	Dec.	Dec.	Dec.
Crystalline lump	92-95% C	750 – 1 500	750 – 1 500	750 – 1 500	650 – 850	650 – 850
Crystalline large flake	85-90% C	820 – 1 300	650 – 1 200	400 – 800	400 – 600	400 – 600
Crystalline medium flake	85-90% C	770 – 1 120	450 – 1 000	350 – 750	300 – 500	300 – 500
Crystalline small flake	80-95% C	540 – 900	400 – 600	300 – 550	250 – 500	250 – 500
Amorphous powder	80-85% C	220 – 440	220 – 440	220 – 440	220 – 440	220 – 300
Synthetic (Swiss border per kg)	99.95% C				2.23	2.23

c.i.f. Cost, insurance and freight; C Carbon.
[1] "Industrial Minerals," December 1990, December 1991, December 1992, December 1993 and December 1994.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
25.04	Natural graphite				
2504.10.10	In powder	8.6%	6%	Free	Free
2504.10.20	In flakes	3.7%	2.5%	Free	Free
2504.90	Other	Free	Free	Free	Free
69.02	Refractory bricks, blocks, tiles and similar refractory ceramic constructional goods, other than those of siliceous fossil meals or similar siliceous earths				
6902.90.10	Other, containing by weight 85% or more of carbon or graphite	6.3%	4.5%	2.0%	Free
6902.90.90	Other	Free	Free	Free	1.4%
69.03	Other refractory ceramic goods (for example, retorts, crucibles, muffles, nozzles, plugs, supports, cupels, tubes, pipes, sheaths and rods), other than those of siliceous fossil meals or of similar siliceous earths				
6903.10	Containing by weight more than 50% of graphite or other forms of carbon or of a mixture of these products				
6903.10.10	Crucibles and covers therefor	6.3%	Free	2.0%	1.4%
6903.10.91	Other, containing by weight 85% or more of graphite or other forms of carbon	6.8%	4.5%	2.7%	1.4%
6903.10.99	Other	Free	Free	Free	1.4%
8545.20	Carbon or graphite brushes	9.5%	6.5%	3.0%	1.1%[a]

Sources: Customs Tariff, effective January 1995, Revenue Canada; Harmonized Tariff Schedule of the United States, 1995.
[a] Equipment, originating in Canada, intended for use in the repair or maintenance of certain motor vehicles is subject to accelerated rate reductions.

TABLE 1. IMPORTS[1] OF CRUDE GRAPHITE AND GRAPHITE-RELATED PRODUCTS, 1993 AND 1994

Item No.		1993		1994 p	
		(tonnes)	($000)	(tonnes)	($000)
2504.10	Natural graphite in powder or flake				
	United States	1 985	2 323	2 287	2 690
	Switzerland	17	38	163	541
	China, People's Republic of	102	69	212	138
	Mexico	–	–	112	92
	Sri Lanka	44	55	79	58
	Other countries	48	77	51	94
	Total	2 196	2 564	2 904	3 615
2504.90	Natural graphite, n.e.s.				
	United States	4 339	828	3 325	799
	China, People's Republic of	–	–	23	63
	Germany	–	–	174	27
	Mexico	–	–	1	2
	United Kingdom	64	24	–	–
	Total	4 403	853	3 523	894
6902.90	Refractory bricks, etc., n.e.s. (containing by weight more than 50% carbon or graphite)				
	United States	12 675	9 174	27 651	12 263
	Japan	1 940	4 751	670	2 032
	United Kingdom	1 853	1 474	1 391	1 475
	Belgium	202	266	715	1 216
	France	136	395	438	848
	Germany	222	515	471	225
	Brazil	–	–	18	54
	Denmark	–	–	50	37
	Switzerland	–	–	4	19
	Hungary	–	–	27	15
	Sweden	42	23	4	11
	Spain	–	–	3	10
	Other countries	385	531	–	–
	Total	17 455	17 132	31 442	18 213
6903.10	Refractory ceramic goods, n.e.s., more than 50% of graphite or other forms of carbon, etc. (including crucibles)				
	United States	..	1 222	14	1 516
	France	..	523	3	310
	Germany	..	583	3	284
	Japan	..	360	6	278
	United Kingdom	..	536	1	131
	Belgium	–	–	1	75
	Other countries	..	228	...	5
	Total	..	3 455	28	2 602
8545.20	Carbon or graphite brushes				
	United States	247	6 695	217	5 874
	Japan	7	176	19	403
	Germany	5	248	7	385
	Brazil	8	117	11	236
	France	...	22	4	115
	United Kingdom	...	41	...	66
	Taiwan	2	26	...	20
	Sweden	1	16	...	20
	Mexico	–	–	...	17
	Switzerland	...	10	...	13
	Other countries	...	19	1	22
	Total	270	7 374	261	7 178

Sources: Natural Resources Canada; Statistics Canada.
– Nil; .. Not available; ... Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary.
1 Imports from "other countries" may include re-imports from Canada.
Note: Numbers may not add to totals due to rounding.

TABLE 2. EXPORTS OF NATURAL GRAPHITE, 1993 AND 1994

Item No.		1993		1994p	
		(tonnes)	($000)	(tonnes)	($000)
2504.10	Natural graphite in powder or flake	20 482	16 518	21 054	17 035
2504.90	Natural graphite, n.e.s.	1 019	561	657	362

Source: Statistics Canada.
n.e.s. Not elsewhere specified; p Preliminary.

TABLE 3. REPORTED CONSUMPTION[1] OF GRAPHITE IN CANADA, 1988-93

	1988a	1989	1990	1991	1992	1993p
			(tonnes)			
Natural graphite						
Foundry facing	2 729r	1 723	1 892	1 603	2 366	3 036
Refractories	673	643	415	274	97	75
Other uses[2]	1 522	1 625	2 876	2 186	2 188	1 978
Synthetic graphite						
Foundry facing	3 898r	3 782r	2 680	1 267	1 893	1 730
Other uses[3]	7 002	5 634r	4 287	918	929	442
Total	15 824r	13 407	12 150	6 248	7 473	7 261

Source: Natural Resources Canada.
p Preliminary; r Revised.
a Increase in number of companies being surveyed.
1 Reported from NRCan survey on the consumption of nonmetallic minerals by Canadian manufacturing plants.
2 Includes brake linings, chemicals, abrasives, primary steel and other end uses. 3 Includes abrasives, batteries, bearings and brake linings, cement, chemicals, primary steel and other uses.

TABLE 4. WORLD GRAPHITE PRODUCTION, BY COUNTRY[1]

Country	1989	1990	1991	1992	1993[e]
			(tonnes)		
Argentina[e]	100[a]	100	100	90	100
Austria	15 307	22 705[r]	19 750[r]	19 547	19 500
Brazil (marketable)[2]	31 650	28 890	26 965	29 414[r]	29 000
Burma (Myanmar)[3]	–	45	36[r]	–	–
Canada (exports of natural graphite)	6 000	10 200	6 200	17 400	18 800
China[e]	490 000[r]	455 000[r]	289 000[r]	300 000[r]	310 000
Czech Republic[4]	–	–	–	–	20 000
Czechoslovakia[5]	66 000[r]	39 000[r]	47 000[r]	20 000[r,e]	–
Germany	15 800[r,e]	19 314[r]	15 807[r]	11 963[r]	10 000
India (run-of-mine)[6]	58 000	61 000	69 922	70 000[e]	64 000
Korea, North[e]	35 000	35 000	35 000	38 000	38 000
Korea, Republic of					
Amorphous	100 282	98 987	75 239	75 000[e]	72 000
Crystalline flake	1 186	703	1 552	8 412[r]	8 000
Madagascar	15 863	18 036	14 079	8 910[r]	8 000
Mexico					
Amorphous	38 304	22 553	35 315	47 053[r]	49 440
Crystalline flake	1 942	2 365	1 943	985[r]	1 000
Namibia[e]	–	–	200	200	200
Norway	1 800	5 000[e]	6 930	5 000[r,e]	5 000
Romania	10 000	6 000[r,e]	6 000[r,e]	2 300	2 000
Russia	–	–	–	15 000[e]	10 000
Sri Lanka	4 163	5 469	6 381	3 307[r]	4 000
Turkey (run-of-mine)[7]	11 873	18 712	25 867	20 978[r]	20 000
Ukraine	–	–	–	50 000[e]	40 000
U.S.S.R.[e,8]	84 000	80 000	75 000	–	–
United States	w	–	–	–	–
Zimbabwe	18 147	16 383	12 903	12 346[r]	12 000
Total	1 005 417[r]	945 462[r]	771 189[r]	775 905[r]	741 040

Source: U.S. Bureau of Mines.
– Nil; [e] Estimated; [r] Revised; w Withheld to avoid disclosing company proprietary data.
[a] Reported figure.
[1] Table includes data available through May 31, 1994. [2] Does not include the following quantities sold directly without beneficiation, in metric tonnes: 1989, 13 005 t (revised); 1990, 8400 t revised); 1991, 7298 t (revised); 1992, 8957 t (revised); and 1993, 9000 t (estimated). [3] Data are for fiscal years beginning April 1 of that stated. [4] Formerly part of Czechoslovakia. [5] Dissolved December 31, 1992. All production in Czechoslovakia from 1989-92 came from what is now the Czech Republic. [6] Indian marketable production is 10-20% of mine production. [7] Turkish marketable production averages approximately 5% of run-of-mine production. Almost all is for domestic consumption. [8] Dissolved in December 1991.