

GRAPHITE

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The graphite market in 2004 looks as if it is going to be positive, after a negative 2003 and 2002. This is primarily the result of substantial longer-term increases in Chinese natural graphite consumption. A wrenching realignment is moving towards completion in the major US end-uses, with lesser realignments in Europe. No major new mine openings have been announced, or re-openings of closed operations, but no mine closures seem likely either.

Graphite prices in *Industrial Minerals* have continued unchanged through March 2004. For example, large crystalline flake (94%-97% C, +80 mesh) was US\$570-750/t, large crystalline flake (90% C, +80 mesh) was US\$480-\$550/t, and medium crystalline flake (90% C, +100-80 mesh) was US\$370-410/t. The USGS average prices for crystalline flake (US imports) were effectively level, moving to US\$560/t in 2003 and US\$565/t in 2002, from US\$520/t in 2001. The USGS Mexican amorphous price rose from US\$115/t in 2002 to US\$120/t in 2003.

Demand

A wrenching long-term realignment in the importance of US natural graphite end-uses is under way. This can be seen by comparing the amount used (consumption) in 2000 in the more important end-uses with the amount to be used in 200X; 200X is most likely 2006, but could be 2005 or 2007. Brake linings will be the leading end-use in 200X, totalling 5,200 t, compared with 6,600 t in 2000. Second, will be expanded graphite/graphite foil-packings, totalling 3,500 t (5,000 t). Next, but lagging, will be graphite refractories totalling 3,000 t (11,000 t).

To continue with the less important uses of natural graphite, foundry facings will be 2,000 t in 200X (3,000 t). Lubricants will remain unchanged, at 1,600 t. Although the potential is large, use in fuel cells may only be 1,000 t, pencils will be 200 t (520 t).

All in all, there will be quite a shake-up in the US. Europe will see a similar milder end-use shake-up and Asia will see much less change; world graphite refractory needs may end up being mostly met by China, as pencil leads are now.

Since there are now several years of data since 2000, it is possible to begin to see how this realignment has proceeded. The true total US consumption in 2003 was around 31,000 t compared to around 50,000 t in 2000, almost the 200X level. It is difficult to make much of a statement about the end uses because of fragmentary and conflicting statistical information. It would appear that refractories end use is still significantly higher than the 200X level, but far below the 2000 level. Brake linings seem to be close to the 2000 level, and

foundry facings seem to be down from the 2000 level but not too far. Lubricants appear to have increased from the 2000 level. Reliable information on the other end uses is lacking. The state and behaviour of the end-use information might mean that the total consumption might drop by another 3,000 t by 200X, unless an end-use such as fuel cells comes on rapidly.

In spite of this minute examination of the US natural graphite market, justified by the availability of at least some consumption by end-use data, a much more important question is the extent and growth of Chinese domestic consumption. Since most graphite is either used directly or indirectly in steelmaking, growth in steel production is important. According to US Geological Survey data, Chinese steel production grew from 124 Mt in 1999 to 149 Mt in 2001, 182 Mt in 2002 and 200 Mt in 2003 (other have estimated 250 Mt in 2003). Steel production in 2004 could rise by a further 12%-16%.

Chinese refractory producers have increased their demand for finer flake 94% C or higher-grade graphite. In addition, some major foreign refractory producers have been building plants in China. Such a one is RHI AG, which began to edge into China with a joint venture plant in the late 1990s. This has now been followed by a wholly-owned plant with a capacity of 40,000 t of basic brick (not carbon-magnesite brick) in Dalian, to come onstream in late 2004; this might be followed by production of graphite-containing refractories such as carbon-magnesite bricks. Pencil factories that use lower purity graphite have also been expanding.

Probably about 30% of Chinese graphite production is used domestically, some of it rather inefficiently and wastefully. Known exports to world markets have been running at 333,000 t in 2000, 372,000 t in 2001, and 322,000 t in 2002. Traders have noticed less Chinese interest in exporting graphite, and no price cuts in the past year. This is probably the result of growth in domestic consumption.

A potential large-volume end-use for natural graphite has appeared, in heat sinks. Developed by GrafTech International from eGraf HS-400 and called SpreaderShield, it is a graphite foil material and is much lighter in weight than comparable copper or aluminium parts, such as fins or base plates. Unlike the heavier metal parts that conduct heat in three directions, it conducts the heat in only two directions but with a thermal conductivity above aluminium and almost equal to copper. The SpreaderShield parts conduct heat away in laptop computers, flat-panel displays, digital video-cameras and wireless phones.

Supply

World graphite supply, as shown in the production table page 5, also includes production, exports plus assumed small domestic consumption (Canada) or tonnage on a concentrate basis (India).

The most important supply question during 2004 is the status of Chinese graphite mining. As has been shown in past reviews, China has immense graphite reserves and even bigger resources. Total Chinese graphite

production in 2003 probably grew by more than 10%, and most producers operated at full capacity. However, over the past year a small number of graphite mines in northern China have closed, partly because of a lack of processing water, increased costs of inputs especially energy, spiralling freight costs, and partly because of overproduction in a difficult world market. The prices of Chinese graphite are now down at rock bottom, at levels where costs sometimes cannot be recovered. On the other hand, prices for finer sizes of crystalline flake, which are usually harder to sell, are rising – certainly an encouraging development for producers. New producers with better reserves and lower costs are coming on stream, as are capacity expansions for existing mines. Qingdao Everest Carbon Co Ltd and associated firms have come on stream with, or rented, additional capacity for coarser sizes of crystalline flake, primarily for the refractories industry, and usually for export. The critical factor in all this is the growth of Chinese natural graphite consumption.

Nothing dramatic has occurred in the Canadian graphite industry. Production has been running at 10,000-12,000 t/y, almost all from the Stratmin mine (now owned by Timcal Graphite and Carbon of Switzerland following the 1999 merger of Imerys' graphite operations and Stratmin Graphite Inc). Around 8,000 to 9,000 t/y of Canadian production is exported to the US. Timcal also operates a graphite processing plant at Terrebonne, near Montreal, Quebec. The plant produces expanded graphite or allied products based on domestic graphite and graphite imported from China. Mazarin Mining Corp's Lac Knife project is still on hold; Mazarin has spun it off as Sequoia Minerals Inc, along with some other mineral activities. Crystal Graphite Corp states that it made a 20 t sale of fuel cell grade graphite from its Black Crystal plant and mine near Nelson, British Columbia.

European graphite producers have responded to weak European demand in various ways, principally through temporary closures or operating at reduced capacity. Tricorona Minerals AB's Woxna Graphite AB operation in Sweden remained closed, but Timcal Ltd signed a co-operation agreement with Tricorona for joint development of graphite-based battery and fuel cell products at Timcal's expense, whereby Timcal would acquire 50% ownership of Woxna in payment. In Norway, Skaland Graphite AS, a new name resulting from Leonhard Nilsen & Sonner AS buying the operation from the previous owners, halted production in January 2003 to work down stocks. It resumed production in October 2003. Skaland Graphite is modernising its plant to make new high-performance grades of graphite, responding to the bad refractories market noted here in previous reviews. Within a few years it will switch mining to a new flake graphite deposit at Traelen.

In Austria, Grafitbergbau Kaiserberg GmbH, with a current annual capacity of 6,000 t of product, mined sporadically through 2003, and operated at a low level drawing on stocks for the rest of the time. It exported 500 t; the firm is considering upgrading its ancient processing plant to produce "high value" (probably high-purity) grades. In the Czech Republic, there is little data on graphite operations but, judging from exports, annual production appears to have been at a very low level in recent years, at about 2,000 t.

Outlook

The general outlook for graphite finally looks positive for 2004 after the negative years of 2003 and 2002. This is the result of inevitable longer-term increases in Chinese natural graphite consumption, not because of any hot US demand in any end-use. One observer on the trading end thinks that China might become a net importer of graphite in 2004 and cut supplies the world market; there were no signs of this in 2003 in the US market. In any case, this would most likely be a temporary condition because Chinese reserves can easily support additional production and new mines. The Chinese graphite-consuming steel industry is certainly growing rapidly (see above). Overall, US graphite sales in 2003 were flat, down to 2% from 2002; the individual large-volume uses were mostly in that range, too! Graphite sales in 2004 could be up 2%-5% from 2003.

A major longer-term shift in importance among end-uses for US consumption of natural graphite is under way. As noted, this has resulted in a drop in total consumption and a notable slash in consumption of graphite in refractories.

Natural graphite (mostly flake) is used in carbon-magnesite brick and in alumina-graphite shapes, plus some amounts in crucibles, gunning and ramming mixes, and others. The bricks are used to line basic oxygen steel converters and electric-arc furnaces to withstand extreme conditions and the shapes are used as continuous casting ware in the form of nozzles and such to guide the molten steel from ladle to mould. Consumption in 2003 in this end-use, dropped 10% year-on-year; in 2004, consumption could stay much the same or decline by as much as 5%. Major graphite suppliers have left this market, and future demand for carbon-magnesite bricks and alumina-graphite shapes will be met mostly by imports from China.

Graphite electrodes, extruded and shaped from petroleum coke (not natural graphite), and then graphitised, carry the electricity that heats electric-arc furnaces (almost all steel-producing). The consumption in 2003 for this important end use, the largest for synthetic graphite, was up by about 8%, but 2004 consumption is likely to increase by as much as 12%. Electrode prices have risen by 10% in the past year.

Natural graphite (amorphous and fine flake) is used in brake linings for heavier vehicles, substituting for asbestos, and now competing in turn with newer organic compositions. The 2003 consumption was up about 2%-3% from 2002, and 2004 will be almost the same as 2003.

Graphite powder is mostly used as a carbon-containing additive put into molten steel to raise its carbon content, into brake linings, and into packings, seals, batteries and a few other very minor uses. Powder demand in 2003 was up 20% from 2002 by volume; 2004 is likely to be up by 15%. High-purity powder demand in 2003 was down significantly from 2002.

There are a number of smaller end-uses for graphite. This includes use in lubricants, pencils, powdered metals, foundry facings, plastics and rubber. The stronger uses in this group are in powdered metals, rubber and plastics,

Mining Annual Review 2004

including styrofoam coatings. Pencils are now amongst the weakest end-use, the market having virtually disappeared, with pencil leads now imported directly from China.

The demand for natural graphite improved, particularly in China, in 2003 and early 2004. The drops in supply observed in the past few years appear to have ended.

Graphite information availability continues in good order, both at the USGS and at www.basicsmines.com/graphite

Table Production by country

	1999	2000	2001	2002
China	300,000	430,000	450,000	450,000
Brazil	53,503	71,208	70,091	70,000
Mexico	27,781	30,330	21,442	25,000
India	14,500	14,000	14,000	13,000
Madagascar	16,137	18,000	15,000	12,000
Canada	18,000	20,000	12,000	10,000
Zimbabwe	11,405	11,838	11,836	9,912
Sri Lanka	4,592	5,902	6,585	6,600
Other	55,320	48,350	40,850	36,380
Total	501,240	649,630	641,800	632,900