

# GRAPHITE

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**T**he graphite market in 2002 was much worse than it was in 2001; and 2003 will be slightly worse than 2002. A wrenching realignment is under way in the major US end-uses, with lesser realignments in Europe. Mine closures will most likely continue, in spite of a long list of such closures since 1993.

Graphite prices quoted in *Industrial Minerals* continued unchanged through 2002 and into early 2003 but were defined more exactly. 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 US Geological Survey's Mineral Commodity Summaries reported average prices for crystalline flake (US imports) was unchanged from 2001, at US\$560/t. The USGS Mexican amorphous graphite price rose from US\$230/t in 2001 to reach US\$240/t in 2002.

*Industrial Minerals* also began listing some new graphite prices in late 2002. These prices in early 2003 were as follows: medium crystalline flake (94%-97% C, +100-80 mesh) was US\$560-640/t, medium crystalline flake (85%-87% C, +100-80 mesh) was US\$230-350/t, fine crystalline flake (94%-97% C, +100 mesh) was US\$450-600/t, and fine crystalline flake (90% C, -100 mesh) was US\$350-400/t.

## **Demand**

A wrenching long-term realignment in 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 the year 200X; 200X is most likely to be 2006, but it 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. Next will be batteries, totalling 5,000 t in 200X (4,000 t in 2000), then expanded graphite-graphite foil-packings, totalling 3,500 t in 200X (5,000 t in 2000). Next, but lagging, will be graphite refractories, totalling 3,000 t in 200X (11,000 t in 2000). Then comes powdered metals, which will be 2,300 t in 200X (2,000 t in 2000).

To continue with the less important end-uses, foundry facings will be 2,000 t in 200X, compared with 3,000 t in 2000. Lubricants will be 1,600 t in 200X (1,600 t in 2000). A potentially large end-use, fuel cells, will only be 1,000 t in 200X. The rubber end-use will be 750 t in 200X (800 t in 2000). Carbon products will be 500 t in 200X (750 t in 2000). Pencils will be 200 t in 200X (520 t in 2000). Other, even smaller end-uses, eg steelmaking, paints, drilling muds, and electrical and mechanical devices, will total 6,500 t in 200X (7,500 t in 2000).

All in all, this is quite a shake-up. Total US consumption will drop to 31,550 t in 200X, compared with 42,750 t in 2000. Europe will see a similar milder end-use shake-up and Asia will see much less change. World graphite refractory needs may be mostly met by China, as is the case now for pencil leads.

To continue the story of the decline of the refractories industry on a positive note, Cookson plc successfully made a rights issue in late August 2002 to raise money to cut its debt. (Cookson had even worse problems in its electronics division than it did in its ceramics division, which includes graphite refractories.)

Some former RHI plants in North America, now closed, had their equipment auctioned off or sold as part of the bankruptcy process. An offer for an entire plant in Missouri was refused, although a whole plant in Maryland was sold to a Canadian firm. National Refractories was also sold in pieces to Resco Products Inc. and Allied Mineral Products Inc. Items bought included some equipment (no plants), the rights to brand names, and customer lists.

The refractory situation in Japan was better but not good. Japan Refractory Association statistics for refractories raw material consumption in the first half of the year for crystalline flake graphite was 8,917 t in 2002 compared with 11,503 t in 2001, and for amorphous graphite 867 t in 2002 compared with 968 t in 2001.

In October 2002, *Industrial Minerals* published a comprehensive article on fuel cells and the materials required for them. Fuel-cell technology is developing rapidly, but automotive applications are in prototype. However, there are other applications, particularly in portable objects such as in laptop computers and video camcorders, also mostly in prototype. The fuel-cell market is projected to be US\$3 billion by 2005; this includes stationary fuel cells. There are five types of fuel cells competing for the mass market, only one of which, the Proton Exchange Membrane fuel cell, uses graphite. Its flow field plates are made of advanced graphite materials. Using graphite drastically reduces the size, weight, and cost of the fuel cell.

### **Supply**

World graphite reserves as of early 2003 total 74.0 Mt of recoverable concentrate, and the reserve base is 270.0 Mt of the same. China accounts for 64.0 Mt of the reserves and 220.0 Mt of the reserve base. Mexico accounts for 3.1 Mt of the reserves and 3.1 Mt of the reserve base. India accounts for 0.8 Mt of the reserves, and 3.8 Mt of the reserve base. Madagascar accounts for 940,000 t of the reserves and 960,000 t of the reserve base. Brazil accounts for 360,000 t of the reserves and 1.0 Mt of the reserve base. Other countries account individually for much less.

Much of these reserves are unlikely to be called on, as the long list of mine closures since 1993 shows. The Uley operation in Australia went into care and maintenance in 1993 (see below). The 15,000 t/y capacity Merelani graphite project in northern Tanzania, owned originally by Samax Resources Ltd and subsequently by Phoenix Minerals Ltd, was closed in 1996 and went

into receivership in early 1998. The 10,000 t/y capacity Graphites de Ancuabe Ltda operation in Mozambique, was closed in late 1999 because of low prices. Tricorona Mineral AB closed its 13,000 t/y capacity Woxna Graphite AB operation in Sweden in mid-2001 and put it up for sale in January 2002. In addition, the SCIAMA operation in Madagascar and Superior Graphite's Mexican mines were closed in 2002, SCIAMA perhaps only temporarily; both capacities are unknown. There have also been some cutbacks in capacity at the Canadian operations of Stratmin and the Brazilian operations of Nacional de Grafite.

In spite of these closures, some new projects have been proposed in the past year. Mazarin Inc.'s Lac Knife project in Canada, formerly one of the most likely, is now on hold, probably permanently. The new projects are all long-shots.

The most likely new project is in North Korea, although changes in politics could end it instantly. Korea Resource Corp., a South Korean governmental body, has decided to co-develop the Yongho graphite mine in North Korea, along with Samcholli Corp., its North Korean equivalent. The South Koreans will supply the machinery and equipment, the North Koreans will supply the utilities. The product, perhaps 9,000 t to 10,000 t/y, will be sold in the south, displacing graphite now imported from China. The formerly extensive graphite production in South Korea was almost entirely eliminated by mine closures several years ago.

Eagle Bay Resources NL is looking for joint-venture partner(s) to bring its Uley operation in South Australia back into production. The company states that there have been inquiries about the availability of its product, some initial sales agreements, and a proffered offtake agreement with a major marketer. Freight costs are likely to be critical. Uley's 14,000 t/y capacity flake graphite plant has been on care-and-maintenance since 1993.

Another project is Quinto Technology Inc.'s proposal to develop its graphite and iron-ore property at Lac Gueret in eastern Québec. A few boulders (float) with graphite content have been found. The firm has done a little trenching but no drilling. No financing is in hand, nor is any long-term sales contract(s) from any major customers.

Graftech (formerly Ucar) has announced an expansion of capacity at its low-cost electrode plant at Monterrey in Mexico to 60,000 t/y by April 2003. This will make it the largest graphite electrode plant in the world. The expansion is an important part of the firm's major cost-savings plan to cut US\$80 million in costs. Graftech closed its high-cost plants at Clarksville and Columbia in Tennessee, and in Italy. Graftech will be maintaining its electrode capacity for all plants at 210,000 t/y. Average graphite electrode production costs for the firm will reduce from US\$1,550/t to US\$1,400/t.

### **Outlook**

The general outlook for graphite looks negative for 2003, slightly worse than 2002. Demand from the steel sector probably bottomed in 2002. The sector is

going through a period of buyouts and consolidations that will continue through the remainder of 2003, and this should produce a much healthier industry. The graphite refractory industry had its fears realised in 2002, particularly in regard to plant closures. Overall, graphite sales in 2002 were off at least 8% from 2001 and sales would almost certainly have been even lower, but for certain important end-uses. Potential use in fuel cells has shifted towards the future. There are few signs of hope.

A major, longer-term shift in importance among end-uses for US consumption of natural graphite is under way. This will result in a drop in total consumption and, as already noted, a slash in consumption of graphite in refractories.

Natural graphite (mostly flake) is used in carbon-magnesite brick and in alumina-graphite shapes, plus much smaller amounts in crucibles, gunning and ramming mixes, and other minor applications. 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 as such to guide the molten steel from ladle to mould. The closure of many North American refractory plants in 2001 and 2002, the result of the steel situation, has drastically shrunk demand and will shrink it further. Consumption in 2002 in this major end-use, the largest for natural graphite, dropped to less than half of what it was in 2000; 2003 is likely to see another 15%-20% drop. This is also true for amorphous graphite and its uses. Major graphite-suppliers have left this market. Future demand for carbon-magnesite bricks and alumina-graphite shapes will be met mostly by imports from China.

Graphite electrodes, extruded/shaped and graphitised from petroleum coke, carry the electricity that heats electric-arc furnaces (almost all steel). The consumption in 2002 for this important end-use, the largest for synthetic graphite, was up about 5% from 2001, but 2003 consumption is likely to be a few percent lower than 2002. Hopefully, electrode prices stabilised in late 2002.

At present, only a few small orders for graphite for use in fuel cells dribble in erratically. Fuel cells have been called a very promising potential end-use, but this is not going to happen for some years.

Natural graphite (amorphous and fine flake) is used in brake linings for heavier (nonautomotive) vehicles, substituting for the formerly used asbestos. The 2002 consumption was down about 3%-5% from 2001, and 2003 will be almost the same as 2002.

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 2002 was level with 2001 in volume terms, but up by about 5% in dollar value; 2003 is likely to be up 10% or slightly more in volume, and prices are likely to be up by a similar percentage. High-purity powder demand in 2002 was down 15% from 2001 but prices were level; demand in 2003 may return to the 2001 level and prices are likely to increase.

There are a number of smaller end-uses for graphite. These include use in lubricants, pencils, powdered metals, foundry facings, plastics and in rubber. The stronger end-uses in this group are in powdered metals, rubber, and plastics, including styroform coatings. None has shown dramatic growth, and even the best have grow only moderately. For some applications, such as in lubricants and foundry facings, no growth is normal. One of the weakest markets for graphite is in pencils, and this end-use has now almost disappeared; pencil leads are now imported directly from China.

The demand for natural graphite was as restricted in 2002 as it had been in the previous several years, and it will continue to be circumscribed during 2003. This can be demonstrated by the fate of the refractories industry, particularly in North America and Europe. It is also evident from the decreases in supply, notably the continuing mine closures in 2002, now in Madagascar and Mexico. There have also been some cutbacks in capacity in Canada and Brazil.

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