BISMUTH

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Bismuth indicative quotations for 1-2 t lots remained very stable during 2003, at US$2.80-3.10/lb. Spot material continued to be readily available, particularly from China, in the range US$2.50-2.80/lb.

China's consumption of all major metals grew month-by-month through the year, and this kept lead, tungsten, and tin mines busy, thereby generating bismuth as a by-product. In the third and fourth quarters of 2003, China's imports of major metal ores containing bismuth grew rapidly, yet spot bismuth availability levelled off, because Chinese exports being restricted by strong demand for bismuth on the domestic market in line with China's burgeoning economy.

Meanwhile Western consumption remained stable, and in balance with worldwide supply.

Occurrence

China continues to be the world's leading miner, refiner and exporter of bismuth. Peru, followed by China, then Canada, has the largest resource base. Unlike Western sources, where bismuth is largely a by-product of lead and copper concentrates, China's output is from polymetallic ores in which tungsten is the primary constituent, although bismuth is also as a by-product in tin and zinc mining. China does, however, possess one of the world's few primary bismuth mines. Korea, Japan and Australia are also other Pacific region producers. In central Asia, bismuth is produced in Kazakhstan as a by-product of lead mining.

The principal Western mine sources of bismuth are located in South and Central America, and parts of Africa. Mexico and Peru are the largest producers. The Tosna mine in Bolivia remains moth-balled, and stable higher prices in excess of US$3.50/lb are needed for the project to be considered viable.

Extraction

Bismuth is occasionally found in elemental form, but more usually as an oxide or carbonate. It is essentially produced as a by-product from smelting lead or copper ores. Lead bullion typically contains 10% Bi. When copper ores are smelted, most of the bismuth is partially volatilised in the flue dusts and, to a lesser extent, in the matte and slag. The Betts process (electro-refining) or the Kroll-Betterton process (slag formation using calcium and magnesium) concentrates the bismuth. The Betts process is used in Canada, Korea and

Japan. The Kroll-Betterton process is favoured in Europe, Mexico, Canada and Australia.

In China, where bismuth is mainly associated with tungsten, the ores are beneficiated and gravity separation, magnetic or differential flotation techniques are used to produce the concentrates which are smelted in reverberatory furnaces to produce a crude bismuth for refining. The Chinese also convert concentrates from Russia, South America, South Africa and Kazahkstan.

In 1999, the US Geological Survey revised its estimate of reserves (bismuth content of lead and copper deposits) and the reserve base (economic reserves plus marginal and sub-economic reserves) as shown in Table 1.

Applications

There have been no significant new applications for bismuth in the past 5 years. There are three main applications: in chemicals, alloys and metallurgical additives.

Bismuth as a replacement for lead continues to be mentioned, but this is only realistic in higher added-value applications.

The use of bismuth vanadate in yellow pigments has remained stable since most metallic paints still contain lead. Pharmaceuticals, where stomach remedies are dominant, only consume small tonnages.

Bismuth's use in fusible alloys and lead-free solders is growing, particularly in Japan, following a change in legislation, and its use in free-machining in steel is steady in Europe and the US. No data are available from the Chinese steel sector.

Consumption

The US market for bismuth has declined by 10% compared with consumption in the two preceding years, but it is expected to recover in 2004 as lead replacement continues to increase. In Japan, the use of bismuth in ferrides for electronic ceramics continues to grow. It is difficult to obtain information on China's domestic demand for bismuth but it is the country to watch, and consumption there is expected to break the 2,000 t level in 2004.

Price/outlook

At the time of writing (May 2004), bismuth prices had recovered from around US$2.80/lb to a range of between US$3.20-3.60/lb. Prices should level off during June-August, the traditional slow demand period in Europe, and prices could even weaken, with the average annual price settling in the US$3.30-3.50/lb range. Chinese domestic prices, meanwhile, have increased, and are now around US$3.50-3.70/lb.

For future supply, much will depend on the competition for market share between the numerous Chinese smelters. New applications for bismuth are

possible, but if prices approach US$4.00/lb, lead replacement applications will become less viable.

Table 1

Country	Reserves (t Bi)	Reserves base (t Bi)
US	9,000	14,000
Australia	18,000	27,000
Bolivia	10,000	20,000
Canada	5,000	30,000
China	20,000	40,000
Japan	9,000	18,000
Kazakhstan	5,000	10,000
Mexico	10,000	20,000
Peru	11,000	42,000
Others	15,000	35,000
Total	112,000	256,000

Source: US Geological Survey

Table 2 US consumption (t)

	1996	1997	1998	1999	2000	2001	2002	2003
Fusible Alloys	401	593	741	823	889	997	985	669
Metallurgical Activities	231	252	335	340	346	373	383	742
Chemicals	855	655	884	855	861	829	814	650
Others	333	30	32	31	34	45	45.3	18.3
Total	1,520	1,530	1,992	2,049	2,130	2,240	2,230	2,080

Source: US Geological Survey.