

# BISMUTH

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The only significant development during the year was the resumption of production to full capacity at the Torreon refinery of Industrias Peñoles in Mexico at the end of the March quarter. As a result the world market price drifted gently from US\$4/lb at the start of the year to a low point just above US\$3/lb in August. The underlying strength of demand and further caution at the potential for disruption to supplies led to a recovery to US\$4/lb by the end of the year.

## Occurrence and Extraction

The principal mine sources of bismuth in the Western world are located in South and Central America. Peru and Mexico have continued to be important production sources of bismuth in recent decades, but no meaningful quantities have been mined or smelted in Bolivia during the past 25 years. The Bolivians have been sidelined because of the low bismuth price, in historical terms, during this period. Notwithstanding this, Bolivia holds important reserves around the La Paz-Potosi axis, centred on Oruro.

In the Western world, bismuth is occasionally found in elemental form, but more usually as an oxide or carbonate. It is essentially produced as a by-product of the processing of lead and copper ores. A crude bullion containing typically 10% bismuth is generated during the blast furnace smelting of lead ores. The bismuth is concentrated by the Betts process (electrorefining), or the Kroll-Betterton process (slag-formation using calcium and magnesium). When copper ores are smelted, most of the bismuth reports in the flue dusts and, to a lesser extent, in the matte and slag. Further concentration is achieved by chlorination, leaching and cementation. The crude bullion from all these sources is traditionally fire-refined under

caustic soda and any precious metal content is removed by the Parkes process.

China is at present the leading mine source, refiner and exporter of bismuth. Unlike the West, more than half of output is from polymetallic ores in which tungsten is the primary valuable constituent. It is also produced from lead, tin and zinc sources. After separation by gravity, magnetic or differential flotation techniques, the concentrates are smelted in reverberatory furnaces to produce a crude bismuth for refining.

The US Geological Survey (USGS) revised its estimate of reserves (bismuth content of lead and copper deposits) and reserve base (economic reserves plus marginal and sub-economic reserves) in 1999:

| World Bismuth Reserves (t) |                |                |
|----------------------------|----------------|----------------|
| Country                    | Reserves       | Reserves Base  |
| 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         |
| <b>Total</b>               | <b>112,000</b> | <b>256,000</b> |

## Production

Following the loss in 1999 of around 600 t of product, because of pollution problems, Industrias Peñoles was given permission by the Mexican environmental protection agency (PROFEPA) to resume production at full capacity from the beginning of March 2000. The company had been forced to operate at 75% of capacity since October 1999 at its

**Japanese Bismuth Trends (t)**

|             | 1996 | 1997 | 1998 | 1999 | Jan-Jun 2000 |
|-------------|------|------|------|------|--------------|
| Production  | 560  | 474  | 470  | 475  | 245          |
| Consumption | 729  | 857  | 804  | 726  | 379          |
| Imports     | 181  | 380  | 373  | 242  | 107          |
| Exports     | -    | 11   | -    | -    | -            |
| Stocks      | 84   | 70   | 109  | 100  | 73           |

Torreón, Coahuila, Northern Mexican lead and zinc smelter and refinery. Peñoles announced that it intended to produce around 1,100-1,200 t in 2000 and by the end of the year had achieved its target.

Production at Doe Run's La Oroya smelter in the Peruvian Andes was still affected by changes in the mix of lead and copper feed materials and lower concentrations of bismuth in the ores. Output for the year fell a little short of the traditional 800 t/y.

Japan maintained its output at around 500 t, continuing the pattern of recent years. The picture was also little changed in Europe where Sidech of Belgium produced significant quantities of refined metal from imported lead bullion and Mining & Chemical Products, UK, processed bismuth – containing raw materials and industrial scraps.

China continued to both produce and export more bismuth than any other single country. The industry in China is fragmented, however, with the leading producer, Shizhuyuan Non-Ferrous Metals in Hunan Province, finally reaching a production level in 2000 close to its capacity of 600 t/y (half that of Peñoles).

With Peñoles making up for lost time and the Chinese bismuth producers working flat out, total world production exceeded 6,000 t in 2000. Notwithstanding this, producer stocks fell as consumer demand showed renewed strength.

**Consumer**

We rely heavily, as ever, on US and Japanese published data. USGS data reveal consumption at a near-record level, featuring continued strong growth in the fusible alloys category:

Demand for bismuth remained buoyant in 2000 throughout the world and in all the traditional applications. Consumption was broadly based with four major applications in the field of metallurgy (fusible alloys, free-machining steel, free-machining aluminium and shotgun cartridges) and five chemical applications (pharmaceuticals, cosmetics, catalysts, pigments and electronics). Each of these accounted for around 10-15% of the total.

The trend at present around the world is for the use of lead to be reduced or even banned in certain applications, sometimes for scientific reasons and often more on political grounds. Bismuth, with its green credentials, is invariably the prime candidate for lead replacement. The markets in which it is making inroads include shotgun cartridges, lead-free solders and batch hot-dip galvanising.

**Price**

The market failed to touch the US\$4.50/lb peak of the previous year, which had been caused by the loss of 600 tonnes production at Peñoles. The price started the year at US\$4/lb and maintained a level above US\$3.50/lb during the first-half. After shipping

**US Bismuth Consumption (t)**

|                          | 1996         | 1997         | 1998         | 1999         | 2000         |
|--------------------------|--------------|--------------|--------------|--------------|--------------|
| Fusible Alloys           | 401          | 593          | 741          | 823          | 889          |
| Metallurgical Activities | 231          | 252          | 335          | 340          | 346          |
| Chemicals*               | 855          | 655          | 884          | 855          | 861          |
| Others                   | 33           | 30           | 32           | 31           | 34           |
| <b>Total</b>             | <b>1,520</b> | <b>1,530</b> | <b>1,992</b> | <b>2,049</b> | <b>2,130</b> |

Chemicals - includes pharmaceuticals, cosmetics, catalysts and electronics.

towards US\$3/lb during the September quarter there was a strong recovery to US\$4/lb during the December quarter.

The remarkable price stability of the previous five years was therefore maintained with the average price for each of these years, staying in the narrow range of US\$3.50-4/lb.

### **Outlook**

Despite signs of weakening in the global economy at the beginning of 2001, the prospects for bismuth remain sound. The market has never been so large, the applications never more broadly based and the growth prospects never so promising. It

appears that the projected growth in demand over the next few years will be matched by increased production, particularly from China.

The market does, however, remain vulnerable to disruptions of the type caused by the environmental problems at Peñoles in 1999. Industrial consumers around the world have been lulled into a false sense of security by the historically low prices of the past two decades. Their complacency is reflected in the dangerously low levels of inventories held around the world by consumers, particularly in new applications. Producers would do well to increase their inventories of refined metal to provide a buffer.