

# Bismuth

**Bismuth is a** reddish white, brittle metal which, unusually, is less dense as a solid than as a liquid. Its name derives from the old German "wismut", meaning white metal.

In 1753, the French chemist Claude Francois Geoffroy showed bismuth was not a variety of lead or tin, but a separate element, and industrial production of the metal began in Saxony around 1830.

Today, China, Mexico and Peru are the main sources of bismuth. The US Geological Survey (USGS) estimates that total world resources are 680,000 tonnes and that economic reserves are over 300,000 tonnes.

World mine production in 2005 was estimated to be 5,200 tonnes by the USGS, of which 2,500 tonnes came from China, 1,100 tonnes from Mexico and 1,000 tonnes from Peru.

## EXTRACTION

Bismuth is rarely found free in nature and is obtained commercially as a by-product of the mining and production of several other metals, including lead, tungsten, copper, silver, gold and zinc. The most common bismuth minerals are bismuthinite and bismite, which are found in minute quantities within other metals' ores.

The Tasna mine in Bolivia is one of the rare mines that has produced bismuth from a bismuth ore, but it has been on standby status since the mid-1990s, awaiting a significant rise in the metal price.

According to Umicore, about 90-95% of bismuth production is as a by-product of lead refining. When lead is refined by electrolysis, impure bismuth metal is recovered from the anode slimes.

The impure metal is refined by either a thermal or conventional route – consisting of a series of operations similar to those used in lead refining – and the final product can be almost 100% pure. The metal is converted into ingots, powder, pieces, shot, and pellets.

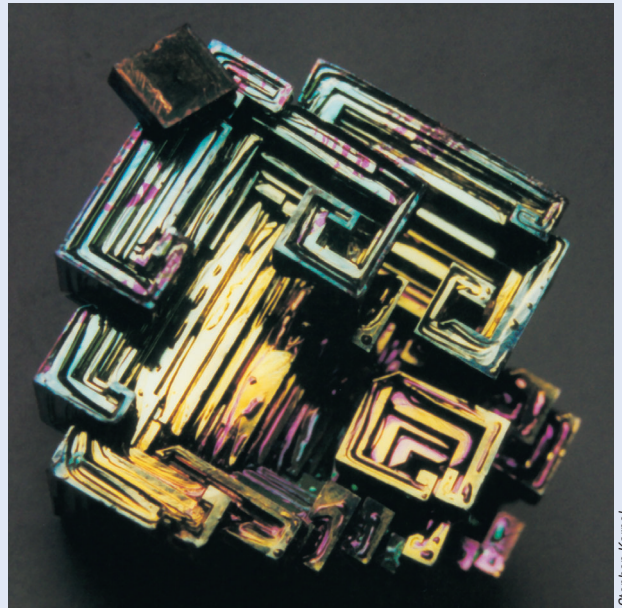
## USES

Bismuth's low toxicity has helped boost its applications. Market demand is around 10,000 tpy and it is increasing at a steady pace of around 10% each year, says a European bismuth refiner.

The metal's demand is spread across a wide range of uses, within each of which it is used in small quantities.

In free-cutting steels, for example, bismuth is added as an alloying element (0.1-0.4%) to improve machinability. Low levels of the metal (0.2-0.6%) are also used to improve the machinability of aluminium alloys. In much smaller amounts (20-50 ppm) it improves the strength of malleable cast irons.

Bismuth is used in low melting-point alloys for safety fuses. Alloys containing 50% bismuth neither expand nor contract on solidifying. The metal is also a component of low



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**Bismuth is a reddish white, brittle metal with many uses**

melting point solders, used in temperature-sensitive electronic assemblies.

Low toxicity makes bismuth a potential substitute for lead in many applications. In some countries, bismuth-tin alloy is already used instead of lead for shot.

Pharmaceutical products account for 10-15% of bismuth consumption, estimates Umicore. The active ingredient in Pepto-bismol is bismuth subsalicylate, which is used as an antidiarrheal and to treat other gastro-intestinal diseases.

Other uses for bismuth include catalysts, cosmetics, pigments in paints, thermoelectric materials, radiation detectors, lubricating agents in special greases and a range of chemical uses. Researchers are investigating possibilities for bismuth in lead-free solders, bismuth-containing metal-polymer bullets and liquid lead-bismuth coolants for use in nuclear reactors.

Bismuth has competitors in some of its application areas. It can be replaced by lead, selenium or tellurium in free-machining alloys. Indium can replace bismuth in low-temperature solders, and a variety of alternative compounds are used in some pharmaceutical products.

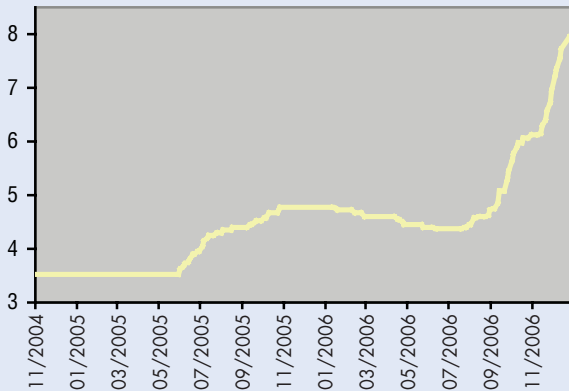
## PRICES

Bismuth prices were steady at around \$3.40-3.65/lb (*Metal Bulletin* free market, one-tonne lots in warehouse) for the first half of 2005, but started to rise in June and, after reaching a peak of \$4.65-4.90/lb in early November, steadily decreased to \$4.25-4.50/lb in early June last year, before the price began to climb rapidly. By January this year, prices breached the \$8/lb level. Some traders are forecasting that China's new export tax regime could increase prices even further.

Beijing cancelled China's 13% export tax rebate in mid-October last year. Sellers were then given a three-month grace period up to mid-December, in which they could continue to apply for the rebate.

The Chinese government is now rolling out a new export

### Bismuth price (\$/lb)



Source: Metal Bulletin bismuth free market one-tonne lots in warehouse

licence system for minor metals such as bismuth and bismuth scrap. Further changes to China's bismuth export strategy look unlikely in the short term, according to industry insiders. One market participant confirms that the Chinese have been the driving force behind the recent price rises, but claims the market may have peaked and could begin to stabilise.

### MINING DEVELOPMENTS

Sustained high bismuth prices are encouraging the opening of previously marginal mines. UK-based Mining & Chemical Products Group (MCP) is considering restarting the Aramayo

bismuth mine in Bolivia. The company operated the Aramayo mines until they were nationalised in 1952 and the mines have lain dormant since then.

In addition, new supplies of bismuth are expected from Fortune Minerals' Nico gold-cobalt-bismuth deposit in Canada's Northwest Territories and Tiberon's Nui Phao tungsten project in Vietnam. These projects are scheduled to come on stream by 2009. Nui Phao is forecast to produce just over 2,000 tpy and Nico is estimated to contain about 35,000 tonnes of bismuth reserves.

MCP will buy the entire bismuth production from the Nico project throughout the life of the mine. The minor metals company will take up to 2,000 tpy of the metal once the deposit comes on stream.

Mexico's Industrias Penoles says that it runs the world's largest producer of metallic bismuth, the Mex-Mex plant. Other companies that produce bismuth metal include Jiangxi Rare Earth & Rare Metals Tungsten Group in China and Sidech in Belgium.

### Estimated world mine production and reserves (tonnes)

	Mine production 2005*	Reserves
China	2,500	240,000
Mexico	1,100	10,000
Peru	1,000	11,000
Canada	200	5,000
Other	160	39,000
Kazakhstan	150	5,000
Bolivia	60	10,000
USA	-	9,000
<b>World Total*</b>	<b>5,200</b>	<b>330,000</b>

e: estimate \*Rounded

Source: USGS

# lundin mining

Lundin Mining is an active explorer for minerals and a fast growing producer of base metals.

The company owns four mines: Zinkgruvan and Storliden in Sweden, Neves-Corvo in Portugal and Galmoy in Ireland.

The exploration portfolio is extensive and also includes interests in international ventures and development projects.

Lundin Mining has its head office in Vancouver, Canada, and its executive management team in Stockholm, Sweden.

Lundin Mining's shares are listed on the Toronto Stock Exchange and on AMEX in New York. Its SDRs are listed on the Stockholm Stock Exchange (LargeCap Segment).

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