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Features and Interviews

Bismuth: A Help In Many Ways

Written by Tom Vulcan
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Have you even wondered what the "Bis" is in Pepto-Bismol? Yes, you're right; it's bismuth!

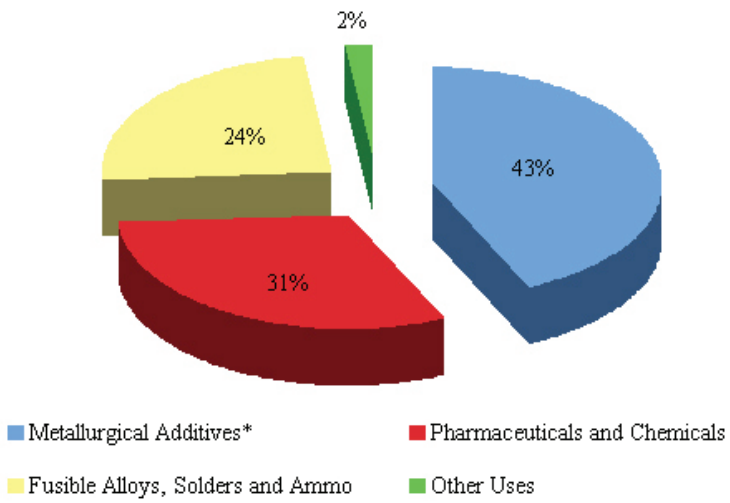
And not just in Pepto-Bismol: bismuth, in a number of different chemical compounds, is to be found in a variety of both cosmetics and pharmaceuticals.

For example, internally, both bismuth subnitrate and subcarbonate are used to help with adverse stomach and intestinal conditions. And medicines containing bismuth have been used successfully to treat both duodenal and peptic ulcers. Externally, bibrocathol - another compound containing bismuth - is used to treat eye infections; for example, blepharitis, which causes inflammation of the eyelids.

In cosmetics, bismuth oxychloride (or Bismuth White) is commonly used in lipsticks and eye shadows, not only to give the makeup its sheen, or pearly look, but also to help it actually adhere to the skin. Bismuth oxide is also used as a yellow pigment in cosmetics (and paints).

Of all the bismuth consumed in the U.S. last year, according to the United States Geographical Survey (USGS), some 31% was used in pharmaceuticals and various other chemicals.

U.S. Bismuth Consumption - 2008



** For castings and galvanizing*

Source: *USGS*

Why Bismuth?

There are a number of reasons, most associated with some of bismuth's extraordinary characteristics.

In its pure form, bismuth is a heavy, brittle, white metal with a hint of pink. For much of its early history, it was mistaken for either of, or both, tin and lead, until 1753, when Claude François Geoffroy, a French chemist, demonstrated it was a separate element.

However, in sharp contrast to lead, bismuth is, in fact, the least toxic of all the heavy metals. Hence its current use in cosmetics (where once lead was sometimes used) and its increasing use as a substitute for lead - in, for example, shot - and its use in pharmaceuticals.

With the exception of mercury, bismuth has the lowest thermal conductivity of all metals. Because of this, when mixed with, for example, tellurium (forming, in this instance, bismuth telluride (Bi_2Te_3)), the resulting compound is a semiconductor. And, as such, bismuth telluride is excellent for making thermoelectric coolers.

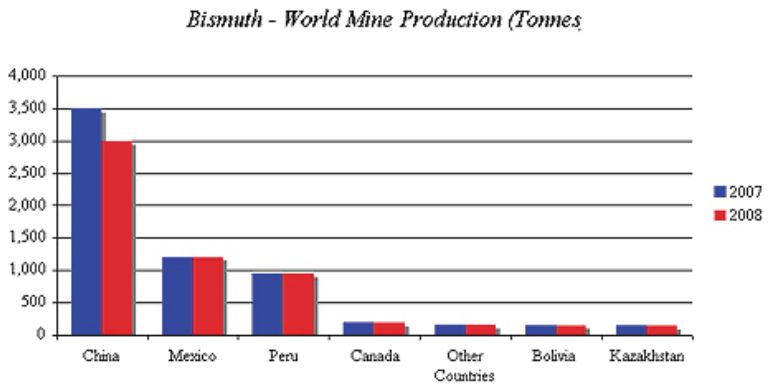
In addition to having the highest electrical resistance of any metallic element, bismuth also has the highest Hall effect of any metal (i.e., greatest increase in electrical resistance when placed in a magnetic field). Before cheaper, rare earth, magnets came along, bismuth - together with manganese and iron - was used in a variety of powerful permanent magnets; in particular, "Bismanol" developed by the U.S. Naval Surface Warfare Center.

With its low melting point, only some 520.7°F (271.5°C), alloys of bismuth and other metals such as cadmium, iron, tin and lead are used extensively in electrical fuses, fire detection and automatic sprinkler systems. Such an alloy containing bismuth (49.5%), cadmium (11.1%), lead (27.3%) and tin (13.1%) has a melting point of only 70°C. Others have lower melting points, down even to 20°C.

Finally, since bismuth, like antimony, expands when it solidifies, alloys of the metal are excellent for making sharp castings of objects that can be damaged at high temperatures, solders (for use in, for example, plumbing) and holding devices for grinding optical lenses.

Whence Bismuth?

Bismuth - World Mine Production (Tonnes)



Source: USGS

Little, if any, bismuth is currently derived from bismuth ore. A Bolivian mine that once so produced the metal has been mothballed since the mid-90s. And, in 2008, only some small mines in China produced the metal from bismuth ore.

For the most part, bismuth is a by-product of processing either lead or tungsten ores. But it can also be extracted from copper-, gold-, silver- and tin-bearing ores.

As with so many other metals, China is the world's major source of bismuth, where it is produced, for the most part, as a by-product of processing tungsten ore, but also of tin and fluorspar. Bismuth production in China is spread across some 13 different provinces and autonomous regions, with Hunan Guangdong and Jiangxi provinces accounting for some 85% of domestic reserves. In terms of production, at least in 2007, Hunan accounted for some 57% of total output, followed by Jiangxi with 28% and the various other areas accounting for the remainder.

Of China's main bismuth producers, Hunan Shizhuyan Nonferrous Metals Co is owned by the publicly quoted Hunan Nonferrous Group (**Bloomberg Ticker - 2626:HK**), and the Kunming Bismuth Industry Co is owned by Yunnan Copper, in which Chinalco has a 49% stake: Chinalco, or Chalco, is the Aluminum Corporation of China (**Bloomberg Ticker - ACH:US**). Yunnan Tin (**Bloomberg Ticker - 000960:CH**), another quoted company, is also a producer of bismuth. For none of these companies, however, is the production of bismuth anything but a sideline to their main mining and processing activities.

In Mexico (after China, the world's second-largest source of the metal), while Peñoles (the country's main bismuth producer) is actually part of the privately held Grupo BAL, its shares are quoted on the Mexican stock exchange and in New York (**Bloomberg Tickers - PE&OLES*:MM** and **IPOAF:US**). Once again, though, for Peñoles, even if it may be the world's largest producer of metallic bismuth (out of its Met-Mex facility), the metal is only one of a number it produces.

In Peru there are two major producers. Doe Run Peru (a privately held company) produces bismuth at its La Oroya "metallurgical complex." The Antamina mine, located in the Peruvian Andes some 149 miles (240 km) northeast of Lima, apart from being one of the world's top 10 copper mines, and one of the top five zinc mines, also produces bismuth as a by-product. Antamina is jointly owned by BHP Billiton (33.75%), Xstrata (33.75%), Teck Cominco (22.50%) and Mitsubishi Corporation (10.00%).

A little closer to home, a number of Canadian mines also produce bismuth. The major producers are Teck Cominco (**Bloomberg Ticker - TCK:US**) from its lead smelter located in Trail, British Columbia, and Xstrata (**Bloomberg Ticker - XTA:LN**) from the Brunswick mine it acquired when it bought Falconbridge.

In Canada, there are also a number of smaller, publicly quoted, resource companies involved with bismuth. Fortune Minerals Limited (**Bloomberg Ticker - FT:CN**) is working toward production at its NICO cobalt-gold-bismuth deposit near Yellowknife in the country's Northwest Territories. Cypress Development Corporation (**Bloomberg Ticker - CYP:CN**), based in Vancouver, has a number of different projects it is pursuing in both Canada and the U.S. As long ago as 2006, it discovered "strongly elevated values" in bismuth at its Verde property in Nevada, but the company has yet to develop the site, rather concentrating on its Gunman Zinc Project in the same state. And, en passant, back in 2005, the Kaminak Gold Corporation (**Bloomberg Ticker - KAM:CN**) discovered the metal in the Gela Lake Gold-Copper-Bismuth Zone in Nunavut in the far north of Canada.

Elsewhere around the world, the privately held Canadian company, Tiberon Minerals, which owns a 77.5% interest in the Nui Phao mining project located north of Hanoi in Vietnam, continues to develop the open pit mine there that will, eventually, produce (in addition to bismuth) fluorspar and tungsten.

The Prospects For Bismuth

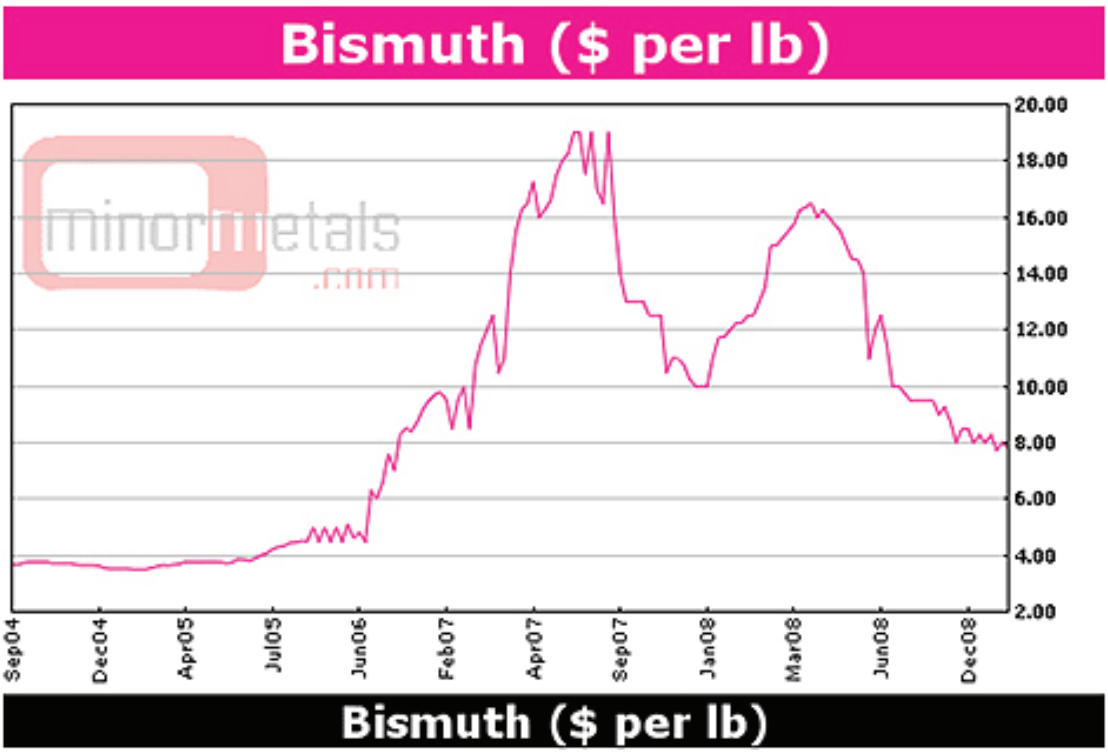
While substitutes for bismuth in medicines do exist - for example alumina and magnesia - it probably will not be any time soon that we are rushing out to buy Pepto-Alol for that stomach ache.

Because of its low toxicity and its environmental "friendliness," bismuth is now often described as the "Green Metal." As such, it is itself a useful substitute for more-toxic metals such as lead. Following the passage in 1996 of the Safe Water Drinking Act Amendment in the U.S., all new and repaired fixtures and pipes for the country's potable water supply have had, since August 1998, to be lead free. Bismuth has helped fill the gap left by lead.

If current research around the world is successful, we will also most probably find ourselves using bismuth-based, as opposed to lead-based, solders - much safer. The metal is already being used in ammunition, in fishing weights and in both EP-greases and EP-lubricants as a substitute for lead.

Perhaps because of this steady demand base, and despite both the current economic situation and some significant movements over the past couple of years, the price of bismuth has recently been relatively stable.

Bismuth performance - $ per lb



Source: http://www.minormetals.com/

Further Prospects

A few other potential future uses for bismuth are worth noting. In addition to its use in the treatment of gastrointestinal problems, according to a project description from the chemistry department at Monash University in Australia, compounds containing bismuth have also been shown "to have a wide range of other potential biological and medical applications, for example as bactericides, fungicides, anti-parasitic agents and anti-cancer agents." As the description goes on to say, there "is still very little known about how bismuth compounds act in a biological environment..." There may, therefore, be some very interesting developments in store for bismuth on this front.

In the world of nuclear power generation, Russia has already developed the use of bismuth, in conjunction with lead, as a coolant system for the nuclear reactors in its submarines.

According to a 2004 article in Science & Technology Review, "[u]sing lead or lead-bismuth as a cooling material instead of water eliminates the large, high-pressure vessels and piping needed to contain the reactor coolant. The low pressure of the lead coolant also allows for a more compact reactor because the steam generator can be incorporated into the reactor vessel. Plus with no refueling downtime and no spent fuel rods to be managed, the reactor can produce energy continuously and with fewer personnel."

Research continues as to how this technology can be used to construct small nuclear reactors that are both economically viable (especially in this economic climate) and safe (especially in this environmental climate).

(Basically, in such a nuclear power reactor, the "bismuth dissolves sufficient uranium so that, when the solvent and solute are pumped through a moderator (graphite), criticality is reached and fission takes place. The heat generated from the fission reaction raises the temperature of the bismuth.

The heated bismuth is then pumped to conventional heat exchangers producing the steam power required for eventual conversion to electricity.")

With a number of countries eyeing nuclear power generation afresh - for example, Sweden recently reversed its nuclear phase-out policy, allowing its current reactors to be replaced - and with the recent general renewal of interest in nuclear power generation, bismuth may, perhaps, come into its element in this sector, too.

Opportunities In Bismuth

As with many of the minor metals, holding the physical metal is really not an option.

Unfortunately, too, at present there are no "pure" bismuth plays out there. Bismuth-bearing ore is now mined for its bismuth content alone only in a very few mines in China. The Tasna mine in Bolivia, owned by the country's state metal mining concern Comibol, remains inactive. And, anyway, seeking foreign investment in the country's natural resources is not high on the current government's agenda.

Therefore, setting aside the larger mining concerns - i.e., companies for whom bismuth production is purely a profitable sideline - it is probably worthwhile keeping an eye on those mining operations for

whom, although it may still be a by-product, bismuth has the potential to contribute more significantly (relative to any other metals they may be producing) to their bottom lines.

Currently, few if any are actually producing much bismuth. But, in coming years, there could be some exciting demands for the metal which may encourage them to develop their bismuth ore-bearing prospects.

Or, if you find all this a little hard to digest, there's always Pepto-Bismol!

Resources

U.S. Geological Survey (USGS)

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