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2006 Minerals Yearbook

BISMUTH

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BISMUTH

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Bismuth consumption in the United States was estimated to be 2,050 metric tons (t), a decrease of 13% compared with that of 2005 (tables 1, 2). As a result of an ongoing U.S. Geological Survey (USGS) analysis and evaluation of the bismuth market that began in 2003, end-use patterns for 2003 through 2006 contain different assumptions than in previous years. The estimated domestic consumption breakdown for bismuth for 2006 was about 45% for metallurgical additives for castings and galvanizing; 29% for bismuth alloys, fusible alloys, solder, and ammunition; 25% for chemical and pharmaceutical uses; and 1% for research and other uses (table 2).

Bismuth was last produced domestically, as a byproduct of lead refining, at a Nebraska refinery that closed in 1997. The last stocks of bismuth held in the National Defense Stockpile were sold that same year. In 2006, all primary bismuth consumed in the United States was imported. Only a small amount of bismuth was obtained by recycling old scrap. The leading foreign producers of refined bismuth in 2006 were China, Mexico, Belgium, and Peru, in descending order. Belgium had no mine production, and its sole bismuth producer refined metal from anode slimes, concentrates, and smelter residues and flue dust, all of foreign origin.

In recent years, new uses for bismuth have been developed as a nontoxic substitute for lead. These include the use of bismuth in shot for water fowl hunting, lubricating greases, pigments, and solders.

The average annual dealer price for bismuth in 2006 increased to $5.04 per pound, 29% more than that of 2005. A moderate rise in world mine production combined with reportedly strong world demand caused the market price to rise.

The estimated value of bismuth consumed domestically was about $23 million in 2006. That represents an increase of 15% compared with the value in 2005.

Legislation and Government Programs

Production

Domestic production of primary refined bismuth ceased in 1997. Some domestic firms continued to recover secondary bismuth from fusible alloy scrap in 2006, but secondary production data were not available. Secondary production was estimated to be less than 5% of domestic supply during the year.

Consumption

The USGS surveys domestic bismuth consumption annually. The amount used by nonrespondents is estimated based on reports from prior years or on information from other sources. Accordingly, estimated bismuth consumption was about 2,050 t in 2006, a 13% decline from that of 2005 (table 1).

Consumption of bismuth in chemical uses (chemicals, cosmetics, and pharmaceuticals) in 2006 increased by 2% compared with use in 2005. The leading use, metallurgical additives, experienced a 20% decrease in consumption in 2006 compared with that in 2005. The alloys category of use registered a 14% decline in tonnage compared with that of 2005.

Although it has the crystal structure of a semimetal, bismuth is often considered a metal. This crystal structure, along with several other salient properties, makes it an ideal substitute for lead in extreme-pressure additives. These unique properties include expansion on solidification, the widest range between melting and boiling points among all metals, and the lowest thermal and heat conductivity. Bismuth is the most diamagnetic of all metals, the least toxic, and has the lowest absorption for neutrons; bismuth is also characterized as “soft” like lead.

Bismuth pharmaceuticals include the well-known bismuth salicylate (the active ingredient in the over-the-counter stomach remedies) and other bismuth medicinal compounds used to treat burns, intestinal disorders, and stomach ulcers in humans and animals. Bismuth nitrate is the initial material used for the production of most bismuth compounds. Other applications of bismuth chemicals and compounds include uses in superconductors and pearlescent pigments for cosmetics and paints.

Bismuth metal is used primarily as a major constituent of various alloys and as a metallurgical additive (table 2). One class of bismuth alloys consists of fusible (low-melting-point, as low as 20° C) alloys—combinations of bismuth with other metals, such as antimony, cadmium, gallium, indium, lead, and tin. Applications for those alloys include fuel tank safety plugs, holders for optical lens grinding, and other articles for machining or grinding, solders, and fire sprinkler triggering mechanisms.

In addition to lead-free solder noted above, bismuth has been a substitute for the lead added to certain steel products to provide greater machinability. A major domestic steel producer began to use a bismuth-containing substitute for the leaded alloy about 1982. Although bismuth has been successfully used in replacing lead in various applications, it has been challenged as a lead substitute by tin and tungsten (Cusack, 1999). Bismuth is also added in small amounts to aluminum (along with lead) and copper alloys to improve machinability. It is also added to malleable iron graphite flakes. These uses constitute the traditional metallurgical additives category.

Price

In 2006, the average Platts Metals Week New York dealer price for bismuth rose to $5.04 per pound, an increase of 29% from the average price of $3.91 per pound in 2005. The average annual price has experienced a steady and substantial rise starting in 2003.

The weekly price started 2006 at $4.50 to $4.80 per pound and ended the first quarter at $4.45 to $4.70 per pound; the second quarter saw prices drift lower to end the quarter at $4.20 to $4.50 per pound; in the third quarter prices rose to end the quarter at $4.60 to $4.80 per pound; and prices in the fourth quarter experienced a sharp price rise to end the year at $7.30 to $7.80 per pound.

Trade

U.S. exports of bismuth metal, alloys and waste and scrap soared by 120% from those of 2005. Notable increases were recorded by exports to the Dominican Republic, Japan, Singapore, and Vietnam. Substantial decreases were noted for Belgium and Mexico (table 3).

Total U.S. imports of metallic bismuth decreased by 9% by weight compared with the prior year's figures (table 4). Bismuth imports were seven times greater, by weight, than bismuth exports. The leading import source for the United States was Belgium, which supplied 38% of imports. Considerable increases in imports were observed for Hong Kong, Peru, and the United Kingdom. Notable decreases in imports were seen for Belgium and China.

World Review

In much of the world, bismuth is produced as a byproduct of smelting lead ores. In China, it is also a byproduct of fluorspar, tin, and tungsten ore processing. In Bolivia, the Tasna Mine, the only mine that produces bismuth from bismuth ore, has been on standby since the mid-1990s, awaiting a sufficient and substantial rise in the metal price. There are several other deposit types that may be developed in the near future that would have bismuth as a coproduct.

World refinery production of bismuth remained the same, at 12,000 t, as it was in 2005. China was the world's leading producer of refined bismuth with 71% of the world total, followed by Mexico with 10%, and Belgium with 7%.

Canada.—Fortune Minerals Ltd. in Toronto, Ontario, announced positive results from its full, bankable feasibility study assessing the company's 90%-owned NICO gold-cobalt-bismuth project in the Northwest Territories. As a comprehensive analysis of a project's economics, a bankable feasibility study would be used by financial institutions to assess the credit worthiness of the project for financing. Fortune plans to proceed with an environmental assessment and permitting for the mine. The NICO study was led by Micon International Ltd. (Toronto, Ontario) and Met-Chem Canada Inc. (Montreal, Quebec) with a number of additional engineering companies that were retained to work on specific parts of the project. The study was based on the assessment of a combined open pit and underground mine processing 4,000 metric tons per day (1.46 million metric tons per year) in a plant constructed at the site to produce gold dore, cobalt cathode, and high-grade bismuth concentrate. The NICO property consists of more than 5,140 hectares of contiguous mining leases, located 160 kilometers northwest of the city of Yellowknife, Northwest Territories. Fortune plans to start production at the NICO deposit in 2010 (Fortune Minerals Ltd., 2007).

China.—The country's leading bismuth producer, Hunan Shizhuyuan Nonferrous Metals Co., announced that it would double its bismuth concentrate capacity once the new concentrator was brought online in October. Construction of the 24,000-metric-ton-per-year concentrator at the firm's Chenzhou Works in Hunan Province started in late 2005. Work on the project has cut the company's current bismuth output by an average of 10% to 20% per month owing to its impact on the existing concentrator (Metal Bulletin, 2006).

China remained the world's leading bismuth producer from mine sources. Reportedly, the two leading European bismuth refiners have secured much of the mined output of bismuth from China. Those two refiners are Mining and Chemical Products Group Ltd. (MCP) (Wellingborough, United Kingdom) and Sidech S.A. (Tilly, Belgium). As a result, relatively little bismuth is available through other sources, tending to cause upward pressure on prices.

Vietnam.—Tiberon Minerals Ltd. in Toronto, Ontario, Canada, announced completion of the Nui Phao (northern Vietnam) project update which was prepared by Ausenco Ltd. (Brisbane, Queensland, Australia) and Nui Phao Mining Joint Venture Co. Ltd. Based on the project update, total capital costs to complete the project were expected to be $303 million, and production from the Nui Phao Mine was anticipated to begin in early 2009. The mining plan anticipated annual production of 2,040 t of bismuth, along with substantial tonnages of tungsten trioxide, acid-grade fluorspar, copper, gold, and silver during a 16-year mine life (Tiberon Minerals Ltd., 2006).

Outlook

Worldwide bismuth demand appeared to be increasing at about 3% to 5% per year. Demand for bismuth in the steel sector, although relatively minor compared with that in other use sectors, appeared to be increasing. World consumption in the chemical industry seemed to be rising, especially in Japan, as bismuth there was starting to replace lead in pigments.

Commercial and research organizations in Europe, Japan, and North America agreed to a framework to eliminate lead from solders in manufacturing. This agreement would tend to increase the demand for bismuth during the next several years. Many Japanese manufacturers are using lead-free solders in some or all of their soldering applications, and studies on how best to develop lead-free solders were being performed independently by the European Union, Japan, the Republic of Korea, and the United States. Although world lead consumption was expected to be reduced by only 0.8% by these moves, world bismuth consumption may increase by about 25% with a move to lead-free solders.

A significant near-term increase in supplies of lead byproduct bismuth was unlikely because world production of lead from mine sources was expected to be relatively stable, and an increasing portion of lead demand was expected to be met by recycling. A global shortage of bismuth, however, was not anticipated. In China, where bismuth is a byproduct of fluorspar, lead, tin, and tungsten processing, new technologies applied to this resource have increased world bismuth reserves. Therefore, despite possible large increases in world demand, Chinese supplies can be expected to help keep the bismuth market stable.

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TABLE 1
SALIENT BISMUTH STATISTICS[1]

		2002	2003	2004	2005	2006
United States:						
Consumption	metric tons	2,320	2,120	2,420	2,340	2,050
Exports[2]	do.	131	108	109	142	311
Imports for consumption	do.	1,930	2,320	1,980	2,530	2,300
Price, average, domestic dealer	dollars per pound	3.14	2.87	3.35	3.91	5.04
Stocks, December 31, consumer	metric tons	111	279	134	136	155
World production:[e]						
Mine metal content[3]	do.	4,600 [r]	5,100	5,600	5,400 [r]	5,700
Refinery[4]	do.	6,700	8,700	15,000 [r]	12,000	12,000

[e]Estimated. [r]Revised.

[1]Data are rounded to no more than three significant digits.

[2]Comprises bismuth metal and the bismuth content of alloys and waste and scrap.

[3]Excludes the United States.

[4]Excludes Canada.

TABLE 2
BISMUTH METAL CONSUMED IN THE
UNITED STATES, BY USE[1]

(Metric tons)

Use	2005	2006
Chemicals[2]	498	510
Bismuth alloys	685	591
Metallurgical additives	1,150	923
Other	14	24
Total	2,340	2,050

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes industrial and laboratory chemicals, cosmetics, and pharmaceuticals.

TABLE 3
U.S. EXPORTS OF BISMUTH METAL, ALLOYS, AND WASTE AND SCRAP,
BY COUNTRY[1]

	2005		2006	
Country	Quantity (kilograms, metal content)	Value (thousands)	Quantity (kilograms, metal content)	Value (thousands)
Argentina	240	$57	9,400	$89
Australia	--	--	20	3
Belgium	17,000	69	--	--
Brazil	4,260	112	20	5
Canada	70,100	870	72,100	910
Chile	1,560	34	916	17
China	35	6	--	--
Columbia	39	7	--	--
Dominican Republic	5,420	219	42,200	423
France	10,100	2,300	14,400	131
Germany	--	--	210	14
Hong Kong	234	43	5,740	56
Israel	50	12	2,000	18
India	2,000	23	164	8
Ireland	618	8	324	6
Japan	2,100	84	15,000	340
Korea, Republic of	293	15	309	20
Malaysia	11	3	--	--
Mexico	17,400	843	9,400	184
Morocco	--	--	717	7
Saudi Arabia	--	--	50	12
Singapore	160	5	29,300	290
South Africa	98	6	--	--
Spain	1,000	10	115	3
Taiwan	49	8	2,030	18
Thailand	--	--	2,690	24
United Kingdom	8,840	26	6,050	67
Vietnam	--	--	97,800	898
Total	142,000	4,760	311,000	3,540

-- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 4
U.S. IMPORTS FOR CONSUMPTION OF METALLIC BISMUTH, BY COUNTRY[1]

Country	2005 Quantity (kilograms)	2005 Value (thousands)	2006 Quantity (kilograms)	2006 Value (thousands)
Bahamas, The	2,620	$25	1,080	$14
Belgium	1,050,000	8,360	876,000	8,070
Canada	7,370	72	9,100	106
China	667,000	5,490	356,000	3,920
Germany	18,500	199	295	18
Hong Kong	--	--	74,600	747
Italy	106	25	380	49
Mexico	480,000	3,750	552,000	5,630
Netherlands	4	2	1,080	26
Peru	--	--	17,600	229
Spain	700	10	1,920	28
Switzerland	1	4	--	--
United Kingdom	304,000	2,550	406,000	3,100
Total	2,530,000	20,500	2,300,000	21,900

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 5
BISMUTH: ESTIMATED WORLD MINE AND REFINERY PRODUCTION, BY COUNTRY[1, 2]

(Metric tons)

Country	Mine 2002	Mine 2003	Mine 2004	Mine 2005	Mine 2006	Refinery 2002	Refinery 2003	Refinery 2004	Refinery 2005	Refinery 2006
Belgium	--	--	--	--	--	1,000	1,000	800	800	800
Bolivia	20 [3]	72 [3]	62 [3]	44 [r, 3]	70	88 [3]	51 [r, 3]	32 [r, 3]	-- [r, 3]	3
Bulgaria	40	40	40	40	40	40	40	35	35	35
Canada[4]	189	145	185 [r]	185 [r]	190 [p]	250	250	250	250	250
China	2,000	2,500	3,000	3,000	3,000	3,000	5,000	11,700 [r]	8,500	8,500
Italy	--	--	--	--	--	5	5	5	5	5
Japan[5]	-- [r]	-- [r]	-- [r]	-- [r]	--	474	513	522	463 [r, 3]	510
Kazakhstan	161	150	150	140	140	130	130	130	120	115
Mexico	1,126 [3]	1,064 [3]	1,064 [3]	970 [3]	1,180	1,126 [3]	1,064 [3]	1,064 [3]	970 [3]	1,180
Peru	1,000	1,000	1,000	952 [r, 3]	950 [p]	568 [3]	600	600	600	600
Romania	40	40	40	40	40	35	35	35	35	30
Russia	50	50	50	50	55	10	10	10	10	11
Serbia and Montenegro[6]	2	1	--	--	--	--	--	--	--	--
Total[7]	4,600 [r]	5,100	5,600	5,400 [r]	5,700	6,700	8,700	15,000 [r]	12,000	12,000

[p]Preliminary. [r]Revised. -- Zero.

[1]Estimated data are rounded to no more than three significant digits.

[2]Table includes data available through April 4, 2007. Bismuth is produced primarily as a byproduct of other metals, mainly lead and tungsten.

[3]Reported figure.

[4]Figures listed under mine output are the metal content of concentrates produced, according to Natural Resources Canada, 2004-05.

[5]Mine output figures have been estimated to be 5% of reported metal output figures.

[6]In June 2006, Montenegro and Serbia formally declared independence from each other and dissolved their union. Mineral production data for 2006, however, still reflect the unified country.

[7]World totals are rounded to no more than two significant digits.