



# 2017 Minerals Yearbook

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**BISMUTH [ADVANCE RELEASE]**

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# BISMUTH

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In 2017, reported consumption of bismuth in the United States was 756 metric tons (t), 6% more than that in 2016 (tables 1, 2). The estimated value of bismuth consumed domestically increased to \$8.22 million in 2017, 16% more than the estimated value in 2016 owing to the increase in consumption and a 9% increase in the average U.S. dealer price. In 2017, all primary bismuth consumed in the United States was imported, principally from China, which accounted for 78% of total imported bismuth. Other leading suppliers to the United States were, in descending order by quantity, Mexico (6%), Belgium (5%), and the Republic of Korea (4%) (table 4). In 2017, world refinery production of bismuth was estimated to be 16,900 t, essentially unchanged from the revised quantity for 2016 but 10% lower than in 2015 (table 5). China was the world's leading producer of refined bismuth as a byproduct of lead, fluorspar, tin, and tungsten-ore processing, accounting for 80% of the estimated world total, followed by Laos with 12%.

Bismuth was last produced domestically as a byproduct of lead refining at a Nebraska refinery that closed in 1997. The last stocks of bismuth in the National Defense Stockpile were sold that same year. Some domestic firms continued to remelt bismuth alloy scrap; however, data were unavailable to make estimates of secondary production for 2017.

Bismuth is one of the rarest elements on Earth, constituting less than an estimated 0.001% of the Earth's continental crust and ranking 65th in abundance among the elements. It occurs in association with lead and, consequently, is most often recovered as a byproduct of lead refining.

## Consumption

The U.S. Geological Survey surveyed domestic bismuth consumers on an annual basis. Of the 27 companies that were surveyed for bismuth consumption in 2017, 14 companies reported their consumption. The amount of bismuth consumed by the companies that did not respond to the survey was estimated on the basis of prior reports or information from other sources. In 2017, reported consumption was 756 t, an increase of 6% as compared with that in 2016 (table 1).

The leading use of bismuth metal in the United States was in chemicals, accounting for 66% of consumption (table 2). Within chemicals, the leading use of bismuth was for pharmaceuticals, including bismuth salicylate (the active ingredient in over-the-counter stomach remedies) and other bismuth medicinal compounds used to treat burns, intestinal disorders, and stomach ulcers in humans and animals. Other applications of bismuth included superconductors and pearlescent pigments for cosmetics and paints.

Bismuth metal also was used as a major constituent of various alloys and as a metallurgical additive (table 2). One class of bismuth-base alloys, fusible alloys (characterized as having a low melting point, as low as 20 °C), consists of combinations of

bismuth with other metals, such as antimony, cadmium, gallium, indium, lead, and tin. Applications for those alloys included fuel tank safety plugs, holders for optical lenses, and other articles for machining or grinding, solders, and fire sprinkler triggering mechanisms. As a metallurgical additive, bismuth was added in small amounts to aluminum and copper alloys to improve machinability and to malleable iron to prevent formation of graphite flakes.

Bismuth is substituted for lead in certain steel products to provide greater machinability and in lead-free glasses, pigments, shot for waterfowl hunting, and solder. Although bismuth has been used successfully to replace lead in various applications, tin and tungsten may also substitute for lead in some applications.

## Prices

The annual average free market price for 99.99%-pure bismuth was \$4.93 per pound in 2017, a 9% increase from the 2016 annual average price of \$4.53 per pound (table 1). The average daily price began 2017 at \$4.70 per pound and fluctuated between \$4.60 per pound and \$4.75 per pound throughout the first quarter. In the second quarter, the price steadily increased from \$4.70 per pound to \$4.95 per pound until it dropped in June to \$4.85 per pound, where it remained until late August. In the latter half of the third quarter, the price increased steadily from \$4.93 per pound to \$5.20 per pound and again increased to \$5.25 per pound in late November, where it ended the year. The price had an overall increase of 12% from January to December 2017 largely as a result of the restricted supply of bismuth from China. Many smelters in China were shut down for environmental violations as part of the Government's anti-pollution campaign (Xu and Zou, 2018, p. 32). Figure 1 illustrates the relation between price and apparent consumption, defined as imports for consumption minus exports plus adjustments for industry stock changes, over the past 20 years (1997–2017). When prices were low, apparent consumption was greater. The decrease in apparent consumption in 2008 was largely a result of the global economic slowdown.

## Foreign Trade

The United States imported 2,820 t of bismuth metal, alloys, and waste and scrap in 2017, a 29% increase from 2,190 t in 2016 (table 4). The imported bismuth was principally sourced from China (78%), followed by Mexico (6%), Belgium (5%), and the Republic of Korea (4%). The United States exported 392 t of bismuth metal, alloys, and waste and scrap in 2017, a 9% decrease from 431 t in 2016 (table 3). The bismuth was principally exported to Vietnam (40%), followed by Hong Kong (15%), Canada (9%), and Brazil (5%).

## World Review

Bismuth was produced principally as a byproduct of the smelting of lead concentrates; however, it was also a byproduct of fluor spar, tin, and tungsten ore processing in China; copper smelter smoke in Zambia; and zinc production in Japan. A world production total for mined bismuth ore was not available owing to its being a byproduct. World production data are only available once the bismuth is refined. World refinery production of bismuth was estimated to be 16,900 t, essentially unchanged from the revised quantity for 2016. China was the world's leading producer of refined bismuth, accounting for 80% of the estimated world total, followed by Laos (12%), Japan (3%), Mexico (3%), and Kazakhstan (2%) (tables 1, 5).

**Argentina.**—Centenera Mining Corp. (Canada) began exploration work at its El Quemado pegmatite project in 2017. The project site included the former El Quemado Mine, a small-scale operation that produced tantalum-niobium oxide concentrates and bismuth concentrates. An average grade of 61.5% bismuth was reported from two shipments of bismuth concentrate. Although historical resource estimates have been reported for bismuth, recent exploration focused on lithium (Centenera Mining Corp., 2016, p. 1; 2017, p. 1).

**Canada.**—In August 2017, Fortune Minerals Ltd. announced that it was updating its 2014 feasibility study on the NICO cobalt-gold-bismuth-copper project in the Northwest Territories. The study was done to determine the current economics for the project owing to the recent demand for cobalt with the rapidly expanding use of lithium-ion batteries and the market supply risks of cobalt sourced from Congo (Kinshasa), the world's leading cobalt producer. Proven and probable reserves of bismuth at the NICO deposit were previously reported to be 109.1 million pounds (46,300 t) with a mine life of 21 years, assuming an average annual production rate of 1,750 metric tons per year (t/yr) of bismuth. Major mine permits and environmental assessment approvals had already been obtained (Fortune Minerals Ltd., 2017).

**China.**—Beginning in March, Zhuzhou Smelter Group Co., Ltd., a producer of bismuth metal and a subsidiary of China Minmetals Corp., began a relocation project to move its lead-zinc smelter from Zhuzhou to Hengyang, where it will be incorporated into Minmetals' existing facilities. The relocation was expected to continue through the end of 2018 (Lead & Zinc Monthly, 2017b, p. 17; Ma, 2017, p. 10). In October, Xiyu Nonferrous Metals Co., Ltd. commissioned an upgrade for its recycling and gas treatment operation in Geermu, Qinghai Province. The upgrade would allow for the processing of 250,000 t/yr of lead, which would produce 700 t/yr of refined bismuth (Lead & Zinc Monthly, 2017a, p. 14). In 2017, a Government campaign against environmental violations caused many smelters in China to shut down, some permanently, which reduced production and was thought to have affected prices (Xu and Zou, 2018, p. 32).

**Vietnam.**—Masan Resources Corp.'s Nui Phao Mine produced bismuth for its third full year and reported a 22% increase in production of bismuth compared with that in 2016. Masan sends all its concentrate to 5N Plus Inc.'s (Canada) refinery facility in Laos owing to an offtake agreement (5N Plus Inc., 2013; Masan Resources Corp., 2018, p. 70).

## Outlook

Globally, most end uses of bismuth, especially its use as a metallurgical additive, are in the industrial sectors of the economy. An increase in global demand depends on economic growth in emerging nations and bismuth being used as a replacement for lead. Emerging uses in data transmission, medical treatment, and solar cells could potentially increase the demand for bismuth though these applications are still in the research and development stage. Though global mine and refinery production are expected to increase from Canada's NICO project, China's recent closure of smelters for environmental violations could significantly decrease global primary refinery production. However, recycling could meet some of the demand for bismuth if the price increases substantially.

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## GENERAL SOURCES OF INFORMATION

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TABLE 1  
 SALIENT BISMUTH STATISTICS<sup>1</sup>

		2013	2014	2015	2016	2017
United States:						
Consumption, reported, bismuth metal	metric tons	737 <sup>r</sup>	655 <sup>r</sup>	621 <sup>r</sup>	710 <sup>r</sup>	756
Exports <sup>2</sup>	do.	857	567	519	431 <sup>r</sup>	392
Imports for consumption <sup>2</sup>	do.	1,710	2,270	1,950	2,190	2,820
Price, average, domestic dealer <sup>3</sup>	dollars per pound	8.71	11.14	6.43	4.53	4.93
Stocks, December 31, consumer, bismuth metal	metric tons	400 <sup>r</sup>	430 <sup>r</sup>	456 <sup>r</sup>	512 <sup>r</sup>	487
World refinery production	do.	17,100 <sup>r</sup>	17,800 <sup>r</sup>	18,700 <sup>r</sup>	16,900 <sup>r</sup>	16,900

<sup>r</sup>Revised. do. Ditto.

<sup>1</sup>Table includes data available through September 26, 2018. Data are rounded to no more than three significant digits, except prices.

<sup>2</sup>Consists of bismuth metal, alloys, and waste and scrap.

<sup>3</sup>Source: American Metal Market.

TABLE 2  
 ESTIMATED BISMUTH CONSUMED  
 IN THE UNITED STATES, BY USE<sup>1</sup>

(Kilograms)

Use	2016	2017
Chemicals <sup>2</sup>	453,000 <sup>r</sup>	500,000
Bismuth alloys	98,700 <sup>r</sup>	98,600
Metallurgical additives	W	W
Other	W	W
Total	710,000 <sup>r</sup>	756,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included in "Total."

<sup>1</sup>Table includes data available through September 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes industrial and laboratory chemicals, cosmetics, and pharmaceuticals.

TABLE 3  
U.S. EXPORTS OF BISMUTH METAL, ALLOYS, AND WASTE AND SCRAP,  
BY COUNTRY OR LOCALITY<sup>1,2</sup>

Country or locality	2016		2017	
	Quantity (kilograms)	Value (thousands)	Quantity (kilograms)	Value (thousands)
Argentina	141	\$20	2,240	\$23
Belgium	6,500	373	17,600	224
Bolivia	440	6	442	5
Brazil	8,500	109	19,700	229
Canada	18,000	174	34,000	432
Chile	866	7	1,560	14
China	37,400	449	13,800	338
Costa Rica	1,790	16	524	23
France	15,600	242	324	15
French Guiana	1,690	15	1,720	16
Germany	323	21	4,200	153
Hong Kong	22,000	203	60,400	589
India	1,720	42	11,800	151
Israel	3,160	29	475	27
Italy	549	12	172	15
Japan	4,020	63	2,100	59
Korea, Republic of	581	22	2,130	51
Laos	11,300	103	18,400	168
Mexico	17,600	370	13,000	304
Netherlands	42,000	369	785	7
Pakistan	--	--	960	31
Singapore	6,030	77	5,770	80
Switzerland	--	--	427	6
Taiwan	952	13	683	14
Thailand	32,200	299	11,500	129
United Kingdom	1,240	14	8,440	98
Vietnam	194,000 <sup>r</sup>	1,780 <sup>r</sup>	158,000	1,440
Other <sup>3</sup>	2,000 <sup>r</sup>	91 <sup>r</sup>	320	31
Total	431,000 <sup>r</sup>	4,910 <sup>r</sup>	392,000	4,680

<sup>r</sup>Revised. -- Zero.

<sup>1</sup>Table includes data available through September 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes data for the Harmonized Tariff Schedule B code 8106.00.0000.

<sup>3</sup>Includes countries and (or) localities to which the United States exported less than 100 kilograms in 2017.

Source: U.S. Census Bureau.

TABLE 4  
U.S. IMPORTS FOR CONSUMPTION OF BISMUTH METAL, ALLOYS, AND WASTE AND SCRAP  
BY COUNTRY OR LOCALITY<sup>1,2</sup>

Country or locality	2016		2017	
	Quantity (kilograms)	Value (thousands)	Quantity (kilograms)	Value (thousands)
Austria	--	--	122	\$5
Belgium	130,000	\$1,330	141,000	1,650
Bolivia	--	--	60,100	630
Canada	6,210	194	10,100	277
Chile	20,000	202	--	--
China	1,800,000	17,400	2,210,000	22,100
Germany	863	53	10,800	278
Hong Kong	--	--	47,600	516
India	--	--	239	4
Indonesia	--	--	161	6
Korea, Republic of	18,000	178	125,000	1,270
Laos	25	3	61	6
Mexico	161,000	1,450	176,000	1,750
Netherlands	433	91	453	6
Peru	104	6	--	--
Russia	--	--	1	3
Taiwan	100	4	90	4
United Kingdom	49,500	755	35,800	538
Total	2,190,000	21,600	2,820,000	29,100

-- Zero.

<sup>1</sup>Table includes data available through September 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes data for the Harmonized Tariff Schedule B code 8106.00.0000.

Source: U.S. Census Bureau.

TABLE 5  
BISMUTH: WORLD REFINERY PRODUCTION BY COUNTRY OR LOCALITY<sup>1</sup>

(Metric tons)

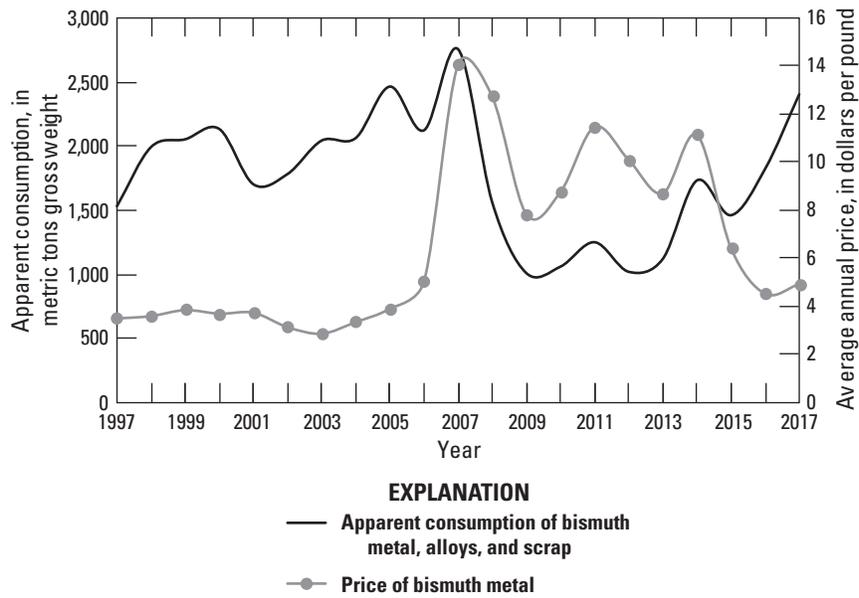
Country or locality <sup>2</sup>	2013	2014	2015	2016	2017
Bolivia	-- <sup>e</sup>	24	--	8	-- <sup>e</sup>
Bulgaria <sup>e</sup>	51 <sup>r</sup>	50 <sup>r</sup>	42 <sup>r</sup>	47 <sup>r</sup>	50
Canada <sup>e</sup>	100	25 <sup>r</sup>	25	25	25
China	15,447	15,871	16,013	14,000 <sup>e</sup>	13,500 <sup>e</sup>
Japan <sup>3</sup>	497 <sup>r</sup>	588	632	428	525
Kazakhstan <sup>e</sup>	160 <sup>r</sup>	230 <sup>r</sup>	220 <sup>r</sup>	270 <sup>r</sup>	270
Laos <sup>e</sup>	--	-- <sup>r</sup>	1,100 <sup>r</sup>	1,600 <sup>r</sup>	2,000
Mexico	825	864	603	539	513
Zambia	--	180	40	--	-- <sup>e</sup>
Total	17,100 <sup>r</sup>	17,800 <sup>r</sup>	18,700 <sup>r</sup>	16,900 <sup>r</sup>	16,900

<sup>e</sup>Estimated. <sup>r</sup>Revised. -- Zero.

<sup>1</sup>Table includes data available through May 15, 2018. All data are reported unless otherwise noted. Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>In addition to the countries and (or) localities listed, Belgium, Romania, and Russia may have produced refined bismuth, but available information was inadequate to make reliable estimates of output.

<sup>3</sup>Refined bismuth was produced as a byproduct of zinc production.



**Figure 1.** Bismuth metal apparent consumption and price for the past 20 years (1997–2017). The decrease in apparent consumption in 2008 was caused by the global economic slowdown that affected many industries that consume bismuth. For the timespan shown, consumption was greater when prices were low.