



# 2016 Minerals Yearbook

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## BISMUTH [ADVANCE RELEASE]

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# BISMUTH

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In 2016, reported bismuth consumption in the United States was 733 metric tons (t), 11% more than that in 2015 (tables 1, 2). Owing to a 30% decrease in the average U.S. dealer price, the estimated value of bismuth consumed domestically decreased to \$7.32 million in 2016, 22% less than \$9.38 million in 2015.

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. Secondary production was estimated to be less than 5% of domestic supply during 2016.

In 2016, all primary bismuth consumed in the United States was imported, principally from China, which accounted for 82% of total imported bismuth. Other suppliers to the United States were, in descending order by quantity, Mexico, Belgium, the United Kingdom, Chile, and the Republic of Korea.

## Consumption

The U.S. Geological Survey surveyed domestic bismuth consumers on a quarterly and annual basis. Of the 35 companies that were surveyed for bismuth consumption, 13 companies reported their consumption and another 6 no longer used bismuth. The amount of bismuth consumed by nonrespondents to the survey was estimated based on prior reports or on information from other sources.

The leading use of bismuth metal in the United States was in chemicals, accounting for 70% 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 was also 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. Bismuth was also 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

In 2016, the average Platts Metals Week New York dealer price for bismuth was \$4.53 per pound, a 30% decrease from the average price in 2015, the lowest since 2006. The price decline began in 2014 from \$11.14 per pound and was attributed to a continued buildup of reported inventories in Fanya-Metal-Exchange (FME)-approved warehouses that rose from 18,600 t at yearend 2014 to 19,228 t in mid-July, reportedly owing to producer liquidation of inventories (Sparks and Willing, 2015).

## Foreign Trade

U.S. exports of bismuth alloys, metal, and waste and scrap were 421 t, a 19% decrease from that in 2015 (tables 1, 3). U.S. imports of bismuth metal were 2,190 t, a 12% increase compared with that in 2015. The leading supplier of United States imports was China (82%), followed by Mexico (7%), Belgium (6%), the United Kingdom (2%), and Chile and the Republic of Korea (1% each) (tables 1, 4).

## World Review

Bismuth was produced principally as a byproduct of the smelting of lead ores. In China, however, it was also a byproduct of fluorspar, tin, and tungsten ore processing.

World refinery production of bismuth was estimated to be 17,100 t, a 12% decrease from that revised in 2015. China was the world's leading producer of refined bismuth, accounting for 82% of the estimated world total, followed by Laos (12%) (tables 1, 5).

**Argentina.**—Centenera Mining Corp. (Canada) signed a letter of intent to acquire the El Quemado pegmatite project in Argentina. The project site included the former El Quemado Mine, a small-scale operation that produced tantalum-niobium oxide concentrates and bismuth concentrates. Historical records from two shipments indicated an average bismuth concentrate grade of 61.5% bismuth. Although historical resource estimates have been reported, no modern exploration or formal resource evaluation has taken place (Centenera Mining Corp., 2016).

**Australia.**—Alt Resources Ltd. (Australia) announced the discovery of a silver-gold-bismuth deposit at the Paupong project in New South Wales, Australia. The new zone, called the Lone Ranger prospect, is located 2 kilometers east of the Kidman prospect and 2.5 kilometers south of the Windy Hill prospect. Rock chips from the Lone Ranger prospect indicated similar grades of bismuth, gold, and silver as the Kidman prospect (Alt Resources Ltd., 2016, p. 1).

**Canada.**—In August 2015, Fortune Minerals Ltd. (Ontario) completed a restructuring agreement with Lascaux Resource Capital Fund LP and others to settle its secured debt obligations. As part of the settlement, Fortune Revenue Silver Mines, Inc. (Colorado) was spun off into a separate company, Ouray Silver

Mines Inc., and all shares in the new company were transferred to Lascaux. The NICO gold-cobalt-bismuth-copper project in the Northwest Territories contains proven and probable reserves of 31,100 t and 16,000 t of bismuth, respectively, with an estimated mine life of 20 years and a proposed mine and mill throughput of 4,650 metric tons per day of ore (Fortune Minerals Ltd., undated; Micon International Ltd., 2014, p. 9). In January 2016, the company reported production of the premium battery-grade cobalt-sulfate sample from the NICO project to support offtake discussions (Fortune Minerals Ltd., 2016).

**China.**—Government authorities in Kunming, Yunnan Province, have reportedly determined that illegal activities took place on the FME. The owner of the FME was arrested on February 5, 2016. Metal stocks held by the exchange have been heavily monitored by the Government since November 2015, and since then, the exchange has ceased operations and producers have not been able to move metal out of FME warehouses. On March 31, 2016, the Public Security Bureau declared they were deepening their investigation into the FME. The FME reported stocks of 19,228 t of bismuth in its warehouses in November, but that amount has not been verified by either the Government or a third party (Stanway, 2016; Xu, 2016).

**Vietnam.**—Masan Resources Corp.'s Nui Phao Mine produced bismuth for its second full year. Masan reported increased production (in tungsten equivalents) for bismuth, copper, and tungsten (Masan Resources Corp., 2016, p. 68).

## 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. With Vietnam's new production in the Nui Phao Mine and Canada's increased production expected in the NICO project, global mine and refinery production are expected to increase.

A potential new use for bismuth is for solar generation of hydrogen fuel. Bismuth vanadate has been identified as a key component in a process to split water molecules into hydrogen and oxygen by using sunlight. By using bismuth vanadate with nitrogen, the amount of energy needed to split the water molecules has been decreased by 0.2 electron volts, or by 8% (Kim and others, 2015).

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

		2012	2013	2014	2015	2016
United States:						
Consumption, reported	metric tons	647	774	727	662	733
Exports <sup>2</sup>	do.	767 <sup>r</sup>	857 <sup>r</sup>	567	519	421
Imports for consumption of metallic bismuth	do.	1,700	1,710	2,270	1,950	2,190
Price, average, domestic dealer <sup>3</sup>	dollars per pound	10.10	8.71	11.14	6.43	4.53
Stocks, December 31, consumer	metric tons	134	50	329	464	643
World, refinery production	do.	16,700 <sup>r</sup>	17,000 <sup>r</sup>	19,800 <sup>r</sup>	19,500 <sup>r</sup>	17,100 <sup>p</sup>

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

<sup>1</sup>Table includes data available through March 15, 2018. Data are rounded to no more than three significant digits; except prices.

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

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

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

(Kilograms)

Use	2015	2016
Chemicals <sup>2</sup>	416,000	516,000
Bismuth alloys	83,600	79,900
Metallurgical additives	W	W
Other	W	W
Total	662,000	733,000

W Withheld to avoid disclosing company proprietary data; included in "Total."

<sup>1</sup>Table includes data available through March 18, 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</sup>

Country or locality	2015		2016	
	Quantity (kilograms, metal content)	Value (thousands)	Quantity (kilograms, metal content)	Value (thousands)
Belgium	3,530	\$70	6,500	\$373
Brazil	4,860	55	8,500	109
Canada	145,000	1,340	18,000	174
Chile	3,530	97	866	7
China	63,000	569	37,400	449
Costa Rica	1,850	17	1,790	16
Dominican Republic	1,240	18	336	11
Ecuador	3,020	39	528	6
France	6,380	64	15,600	242
French Guiana	--	--	1,690	15
Guyana	1,690	15	--	--
Hong Kong	47,100	439	22,000	203
India	4,770	43	1,720	42
Israel	1,720	16	3,160	29
Japan	2,540	23	4,020	63
Korea, Republic of	554	14	581	22
Laos	--	--	11,300	103
Malaysia	6,320	57	178	8
Mexico	49,900	678 <sup>r</sup>	17,600	370
Netherlands	2,530	55	42,000	369
Singapore	5,060	64	6,030	77
Switzerland	1,250	49	--	--
Taiwan	2,070	19	952	13
Thailand	11,400	113	32,200	299
United Kingdom	3,450	36	1,240	14
Vietnam	143,000	1,300	184,000	1,680
Other	3,060 <sup>r</sup>	168 <sup>r</sup>	2,410	126
Total	519,000	5,350	421,000	4,820

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

<sup>1</sup>Table includes data available through March 18, 2018. 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 OR LOCALITY<sup>1</sup>

Country or locality	2015		2016	
	Quantity (kilograms)	Value (thousands)	Quantity (kilograms)	Value (thousands)
Belgium	155,000	\$2,750	130,000	\$1,330
Canada	6,710	160	6,210	194
Chile	--	--	20,000	202
China	1,680,000	29,700	1,800,000	17,400
Germany	1,860	106	863	53
Korea, Republic of	28,000	288	18,000	178
Malaysia	1,470	147	--	--
Mexico	16,400	167	161,000	1,450
Netherlands	1,570	159	433	91
United Kingdom	57,600	1,960	49,500	755
Other	656	42	229	12
Total	1,950,000	35,500	2,190,000	21,600

-- Zero.

<sup>1</sup>Table includes data available through March 18, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

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>	2012	2013	2014	2015	2016
Bulgaria <sup>e</sup>	5 <sup>r</sup>	5 <sup>r</sup>	5 <sup>r</sup>	4 <sup>r</sup>	--
Canada	145	100	100 <sup>e</sup>	25 <sup>r,e</sup>	25 <sup>e</sup>
China	15,078 <sup>r</sup>	15,447 <sup>r</sup>	15,871 <sup>r</sup>	16,013 <sup>r</sup>	14,000 <sup>e</sup>
Japan <sup>3</sup>	470 <sup>e</sup>	480 <sup>e</sup>	588 <sup>r</sup>	632 <sup>r</sup>	428
Kazakhstan <sup>e</sup>	150	150	140 <sup>r</sup>	150	140
Laos <sup>e</sup>	--	--	2,000	2,000	2,000
Mexico	798 <sup>r</sup>	825 <sup>r</sup>	864 <sup>r</sup>	603 <sup>r</sup>	539
Russia <sup>e</sup>	4 <sup>r</sup>	4 <sup>r</sup>	4 <sup>r</sup>	4 <sup>r</sup>	4
Zambia <sup>4</sup>	--	--	180	40	--
Total	16,700 <sup>r</sup>	17,000 <sup>r</sup>	19,800 <sup>r</sup>	19,500 <sup>r</sup>	17,100 <sup>p</sup>

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

<sup>1</sup>Table includes data available through May 1, 2017. All data are reported unless otherwise noted. Totals and estimated data are rounded to three significant digits; may not add to totals shown.

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

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

<sup>4</sup>Bismuth recovered from copper smelter smoke.