



# 2018 Minerals Yearbook

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## BISMUTH [ADVANCE RELEASE]

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# BISMUTH

By Sheryl A. Singerling and Robert M. Callaghan

Domestic survey data and tables were prepared by Raymond I. Eldridge III, statistical assistant.

In 2018, reported consumption of bismuth in the United States was 570 metric tons (t), 18% less than the revised quantity for 2017 (tables 1, 2). The estimated value of bismuth consumed domestically decreased to \$5.83 million in 2018, 23% less than the revised value for 2017 owing to the 18% decrease in consumption and a 6% decrease in the average U.S. dealer price. In 2018, all primary bismuth consumed in the United States was imported, principally from China, which accounted for 60% of total imported bismuth. Other leading suppliers to the United States were, in descending order by quantity, the Republic of Korea (12%), Mexico (8%), and Belgium (6%) (table 4). In 2018, world refinery production of bismuth was estimated to be 19,200 t, 4% more than the revised quantity for 2017 (table 5). China was the world's leading producer of refined bismuth as a byproduct of fluorspar, lead, tin, and tungsten ore processing, accounting for 73% of the estimated world total, followed by Laos with 16%.

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 recycle bismuth alloy scrap; however, data were unavailable to make estimates of secondary production for 2018.

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.

## Legislation and Government Programs

In May, the U.S. Department of the Interior, in coordination with other executive branch agencies, published a list of 35 critical minerals, including bismuth. The list was developed to serve as an initial focus, pursuant to Executive Order 13817, "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals" (U.S. Department of the Interior, 2018).

Under sections 301(b) and 304(a) of the Trade Act of 1974, as amended, the Office of the U.S. Trade Representative (USTR) determined that acts, policies, and practices of China related to technology transfer, intellectual property, and innovation were discriminatory or unreasonable, and those actions burdened or restricted United States commerce (83 FR 14906). An initial list of 818 tariff lines became subject to an additional import duty of 25% in July 2018. In August, the USTR imposed an additional 25% import duty on a second list of 279 tariff lines. A third list of 5,745 full and partial tariff lines, including nonfuel mineral ores and concentrates and forms, became subject to an additional 10% import duty in late September. Bismuth-containing materials subject to the section 301 actions included the following Harmonized Tariff Schedule of the United States codes: 2836.99.20, 3815.90.10, 3824.99.31, and

8106.00.00. These classifications were described, respectively, as bismuth carbonate; reaction initiators, reaction accelerators and catalytic preparations, nesoi (not elsewhere specified or included), consisting wholly of bismuth, of tungsten or of vanadium; mixtures of bismuth; and bismuth (including waste and scrap) and articles thereof, nesoi (Office of the U.S. Trade Representative, 2018).

## Consumption

The U.S. Geological Survey surveyed domestic bismuth consumers on an annual basis. Of the 28 companies that were surveyed for bismuth consumption in 2018, 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 on information from other sources. In 2018, reported consumption was 570 t, a decrease of 18% as compared with that in 2017 (table 1).

The leading use of bismuth metal in the United States was in chemicals, accounting for 55% 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 degrees Celsius [ $^{\circ}\text{C}$ ]), 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.

In 2018, BiSN Ltd., in conjunction with Aker BP ASA and Altus Intervention AS, announced the first successful deployment of the largest bismuth plug for petroleum wells after the well's productive life. The plug was a 3,500-kilogram bismuth alloy that acted as a permanent seal in place of cement (Dunkley, 2018).

## Prices

The annual average free market price for 99.99%-pure bismuth was \$4.64 per pound in 2018, a 6% decrease from the 2017 annual average price of \$4.93 per pound (table 1). The average daily price in 2018 began at \$5.25 per pound and fluctuated between \$5.20 per pound and \$5.30 per pound throughout the first quarter. In the second through fourth quarters, the price generally decreased from \$5.30 per pound to \$3.60 per pound, where it ended the year. The price had an overall decrease of 32% from January to December 2018, largely as a result of oversupply of bismuth and trade tensions between the United States and China, which lowered market demand (Radford, 2018). 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. When prices were low, apparent consumption was greater. The decrease in apparent consumption in 2008 was largely a result of the global economic slowdown at that time.

## Foreign Trade

The United States imported 2,510 t of bismuth metal, alloys, and waste and scrap in 2018, an 11% decrease from 2,820 t in 2017 (tables 1, 4). The imported bismuth was principally sourced from China (60%), followed by the Republic of Korea (12%), Mexico (8%), and Belgium (6%). The United States exported 653 t of bismuth metal, alloys, and waste and scrap in 2018, a 67% increase from 392 t in 2017 (tables 1, 3). The bismuth was principally exported to Vietnam (39%), followed by Canada (20%), Thailand (10%), and Hong Kong (6%).

## World Review

Bismuth was produced principally as a byproduct of the smelting of lead concentrates; however, it was also a byproduct of fluorospar, tin, and tungsten ore processing in China; tungsten-polymetallic ore processing in Vietnam; copper smelter flue dust processing 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 19,200 t, 4% more than the revised quantity for 2017. China was the world's leading producer of refined bismuth, accounting for 73% of the estimated world total, followed by Laos (16%), the Republic of Korea (5%), Japan (3%), and others (3%) (table 5).

**Canada.**—In June 2018, Fortune Minerals Ltd. announced it had been approached by several companies interested in purchasing concentrates directly from its NICO cobalt-gold-bismuth-copper project in the Northwest Territories, which would remove the need to develop a hydrometallurgical refinery in Saskatchewan. Consequently, Fortune Minerals commissioned a technical report update to assess how this change would affect the project (Fortune Minerals Ltd., 2018).

**China.**—Beginning in April, China's Hunan Yongxing Zhongde Environmental Protection Technology Co., Ltd. increased bismuth metal production from 200 metric tons per month (t/mo) to 300 t/mo in anticipation of a decreased supply of bismuth in China owing to environmental inspections that

shut down some operations. Other producers still operating included Yongxing Yonghe Precious Metals Co., Ltd., Yongxing Rongpeng Metals Co., Ltd., Chenzhou Xiongfeng Environmental Protection Science and Technology Co., Ltd., and Jinwang Bismuth Industry Co., Ltd. (Argus Metals International, 2018c).

In May, China's state-owned Zhuzhou Smelter Group Co., Ltd. announced that it was planning to build a lead smelter with a capacity of 100,000 metric tons per year (t/yr) in Hengyang, Hunan Province, within 2 years. The project would include capacity for the recycling of minor and precious metals. Zhuzhou's existing 100,000-t/yr lead smelter recycled bismuth from lead scrap at a rate of 360 t/yr (Argus Metals International, 2018b). However, as part of an ongoing relocation of Zhuzhou's smelting complex to Hengyang for environmental reasons, that facility closed at the end of 2018 (Hunter and Luk, 2019).

In June, China's Hunan-based Fujia Nonferrous Metal CEFR Technologies delayed restarting bismuth production owing to a management issue. Production, previously at 150 t/mo of bismuth metal, was stopped for environmental inspections and initially was expected to resume in mid-May. As of June, it was not known when production would resume (Argus Metals International, 2018a).

From June 30 to July 1, the trial for the four companies and 21 individuals accused of illegal activities in the Fanya Metal Exchange took place in Kunming, Yunnan Province. Neither a verdict nor a decision on the disbursement of the stocks of minor metals was announced. About 20,000 t of bismuth was reported to be held by the Government of China in 2018. In December, a new minor metals exchange was created by Guixi Dasanyuan Metal Co. in Jiangxi Province. This was to allow for bismuth, selenium, and tellurium to be traded (Fu, 2018; Manthey, 2018).

**Vietnam.**—Byproduct bismuth cement production at Masan Resources Corp.'s (Ho Chi Minh City, Vietnam) Nui Phao tungsten mine complex increased by 13% to 3,099 t in 2018. This increase was made possible by a 16% increase in feed grades; however, the results were lessened by a 7.7% decrease in bismuth recovery efficiency from that in 2017 because of grinding issues that developed and were mitigated late in 2018 (Masan Resources Corp., 2019, p. 78, 81). Bismuth cement, an intermediate in the production of bismuth metal, was produced by additional leaching and refining of the mine's byproduct bismuth concentrate. 5N Plus Inc. (Montreal, Quebec, Canada) had signed an exclusive long-term offtake agreement with Masan Resources for the bismuth cement when the mine began production; 5N Plus processed the bismuth concentrate at its plant in Laos (5N Plus Inc., 2013).

## 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. Although global mine

and refinery production are expected to increase as a result of Canada's NICO project and because of increased recovery of bismuth concentrates at Vietnam's Nui Phao Mine, China's recent closure of smelters for environmental violations could significantly decrease global primary refinery production. However, releases of bismuth metal formerly held by the Fanya Metal Exchange and currently held by the Chinese Government could potentially flood the market.

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## GENERAL SOURCES OF INFORMATION

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

		2014	2015	2016	2017	2018
United States:						
Consumption, reported, bismuth metal	metric tons	625 <sup>r</sup>	566 <sup>r</sup>	651 <sup>r</sup>	694 <sup>r</sup>	570
Exports <sup>2</sup>	do.	567	519	431	392	653
Imports for consumption <sup>2</sup>	do.	2,270	1,950	2,190	2,820	2,510
Price, average, domestic dealer <sup>3</sup>	dollars per pound	11.14	6.43	4.53	4.93	4.64
Stocks, December 31, consumer, bismuth metal	metric tons	431 <sup>r</sup>	457 <sup>r</sup>	513 <sup>r</sup>	489 <sup>r</sup>	346
World refinery production	do.	19,000 <sup>r</sup>	19,400 <sup>r</sup>	19,700 <sup>r</sup>	18,500 <sup>r</sup>	19,200

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

<sup>1</sup>Table includes data available through May 21, 2020. 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>Prices in 2014–15 are based on the New York dealer price for 99.99%-purity metal in minimum lots of 1 ton; source: Platts Metals Week. Prices in 2016–18 are based on 99.99%-purity metal at warehouse (Rotterdam) in minimum lots of 1 ton; source: American Metal Market (Fastmarkets AMM).

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

(Kilograms)

Use	2017	2018
Chemicals <sup>2</sup>	439,000 <sup>r</sup>	314,000
Bismuth alloys	98,600	96,200
Metallurgical additives	W	W
Other	W	W
Total	694,000 <sup>r</sup>	570,000

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

<sup>1</sup>Table includes data available through May 21, 2020. 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	2017		2018	
	Quantity (kilograms)	Value (thousands)	Quantity (kilograms)	Value (thousands)
Argentina	2,240	\$23	60	\$7
Australia	68	4	--	--
Belgium	17,600	224	--	--
Bolivia	442	5	20	4
Brazil	19,700	229	2,910	64
Canada	34,000	432	128,000	1,860
Chile	1,560	14	1,560	15
China	13,800	338	31,000	394
Colombia	30	6	104	10
Costa Rica	524	23	2,000	18
Dominican Republic	--	--	887	14
Egypt	45	3	93	4
France	324	15	10,500	180
French Guiana	1,720	16	--	--
Germany	4,200	153	14,500	172
Greece	--	--	5,430	120
Honduras	--	--	110	8
Hong Kong	60,400	589	39,100	377
India	11,800	151	15,300	178
Indonesia	80	9	--	--
Israel	475	27	1,740	63
Italy	172	15	1,020	27
Japan	2,100	59	5,950	53
Korea, Republic of	2,130	51	--	--
Laos	18,400	168	--	--
Malaysia	--	--	713	6
Mexico	13,000	304	33,200	493
Netherlands	785	7	--	--
Pakistan	960	31	--	--
Peru	--	--	23	4
Philippines	--	--	347	3
Poland	--	--	45	5
Russia	72	5	34	3
Singapore	5,770	80	28,500	275
South Africa	--	--	1,850	94
Switzerland	427	6	--	--
Taiwan	683	14	1,870	29
Thailand	11,500	129	62,400	553
United Kingdom	8,440	98	10,200	96
Uruguay	25	5	--	--
Vietnam	158,000	1,440	254,000	2,320
Total	392,000	4,680	653,000	7,450

-- Zero.

<sup>1</sup>Table includes data available through May 21, 2020. 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 of the United States code 8106.00.0000.

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	2017		2018	
	Quantity (kilograms)	Value (thousands)	Quantity (kilograms)	Value (thousands)
Austria	122	\$5	--	--
Belgium	141,000	1,650	143,000	\$1,370
Bolivia	60,100	630	20,100	194
Canada	10,100	277	8,640	152
China	2,210,000	22,100	1,510,000	15,900
Denmark	--	--	4	8
France	--	--	108	4
Germany	10,800	278	8,100	210
Hong Kong	47,600	516	120,000	1,350
India	239	4	3,070	46
Indonesia	161	6	146	3
Italy	--	--	419	15
Japan	--	--	5	3
Korea, Republic of	125,000	1,270	313,000	2,720
Laos	61	6	42,900	481
Mexico	176,000	1,750	205,000	1,970
Netherlands	453	6	1,060	9
Russia	1	3	--	--
Spain	--	--	37	5
Taiwan	90	4	1,210	38
Thailand	--	--	136,000	1,380
United Kingdom	35,800	538	101	15
Total	2,820,000	29,100	2,510,000	25,800

-- Zero.

<sup>1</sup>Table includes data available through May 21, 2020. 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>1,2</sup>

(Metric tons)

Country or locality <sup>3</sup>	2014	2015	2016	2017	2018
Bolivia	24	--	8	-- <sup>e</sup>	-- <sup>e</sup>
Bulgaria <sup>c</sup>	50	42	47	50	50
Canada <sup>e</sup>	25	25	25	25	25
China	15,871	16,013	15,643 <sup>r</sup>	13,500 <sup>e</sup>	14,000 <sup>e</sup>
Japan <sup>4</sup>	588	632	428	525	571
Kazakhstan <sup>e</sup>	230	220	270	270	290
Korea, Republic of	500	500	700	900	900 <sup>e</sup>
Laos	670 <sup>r,e</sup>	1,300 <sup>r,e</sup>	2,013 <sup>r</sup>	2,743 <sup>r</sup>	3,009
Mexico	864	603	539	513	333
Zambia <sup>5</sup>	180	40	--	--	-- <sup>e</sup>
Total	19,000 <sup>r</sup>	19,400 <sup>r</sup>	19,700 <sup>r</sup>	18,500 <sup>r</sup>	19,200

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

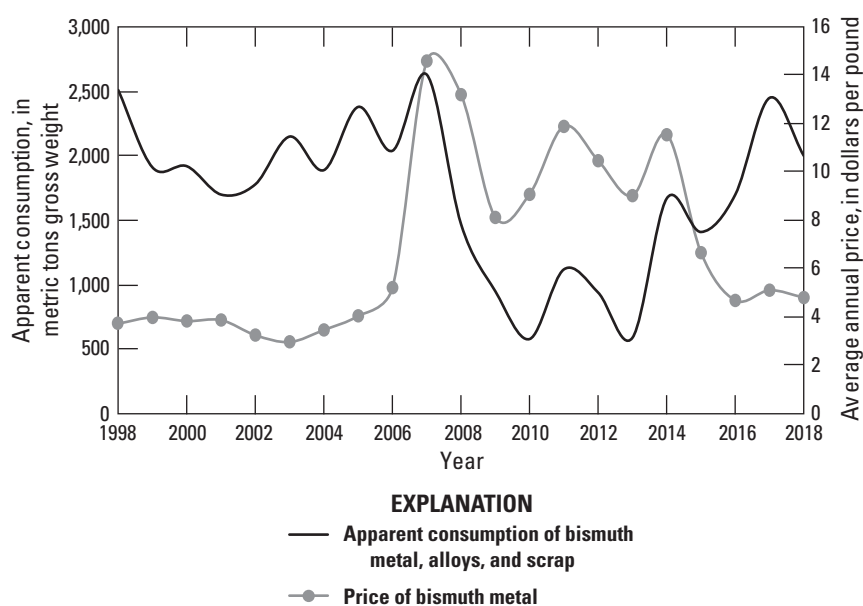
<sup>1</sup>Table includes data available through June 24, 2019. All data are reported unless otherwise noted. Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Bismuth is produced as a byproduct of mining and processing other metals, mainly lead and tungsten. Not all mines that produce ores containing recoverable bismuth report their production. Therefore, some bismuth production may only be accounted for at the refinery level.

<sup>3</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>4</sup>Refined bismuth was produced as a byproduct of zinc.

<sup>5</sup>Bismuth recovered from flue dust at the Chambishi copper smelter.



**Figure 1.** Bismuth metal apparent consumption and price for the past 20 years (1998–2018). 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.