



# 2019 Minerals Yearbook

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## ARSENIC [ADVANCE RELEASE]

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# ARSENIC

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In 2019, the United States produced no arsenic and relied mainly on China and Morocco for arsenic trioxide and China and Japan for arsenic metal (table 2). No arsenic trioxide or commercial-grade arsenic metal had been produced domestically since 1985 following the closure of the ASARCO Inc. copper smelter in Tacoma, WA, but shipments from the remaining stockpile continued until 1994. Arsenic trioxide was used primarily to produce the arsenic acid used in the formulation of chromated copper arsenate (CCA), a pesticide and preservative used to treat wood products for nonresidential applications such as guard rails, pilings, posts, railroad ties, and utility poles. Arsenic compounds (arsenic acids, trioxide, and sulfides) also were used in fertilizers, fireworks, glassmaking, and pesticides. Arsenic metal was used in nonferrous alloys. High-purity arsenic metal was used for semiconductors in a wide variety of applications for the defense, electronics, energy, and telecommunications sectors. In 2019, estimated world production of arsenic was 32,300 metric tons (t), slightly less than estimated production in 2018 (table 3). Production data for arsenic metal were not available.

## Legislation and Government Programs

Executive Order (EO) 13817, “A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals,” was issued on December 20, 2017. Pursuant to the EO, the Secretary of the Interior, in coordination with the Secretary of Defense, and in coordination with other executive branch agencies, was tasked with developing and submitting to the Federal Register a list of minerals defined as critical minerals. On May 18, 2018, arsenic was 1 of the 35 minerals or mineral material groups identified as critical. On June 4, 2019, the Trump administration released “A Federal Strategy to Ensure a Reliable Supply of Critical Minerals.” The strategy directed the U.S. Department of the Interior to assist in locating domestic sources of critical minerals, provide information for the study and production of the minerals, and expedite permitting for mineral projects (Trump, 2017; U.S. Department of the Interior, 2018, 2019).

## Consumption

In 2019, domestic apparent consumption of arsenic, based on the estimated arsenic content of imports, was 7,480 t, an increase of 16% from the 6,470 t consumed in 2018 (table 1). The value of arsenic compounds and metal imported in 2019 was \$7.21 million, a 6% increase from that in the previous year (table 2). Known domestic consumers of arsenic trioxide that produced CCA were Arch Wood Protection, Inc. (Atlanta, GA), a subsidiary of Lonza Group A.G. (Switzerland); Koppers Inc. (Pittsburgh, PA); and Viance, LLC (Charlotte, NC).

Arsenic metal was used to harden ammunition, in solders, and in other applications. The addition of arsenic metal strengthens

grids and posts in lead-acid storage batteries. Arsenic was one of several metals used as an antifriction additive in babbitt metals (alloys used for bearings). High-purity (99.9999%) arsenic metal was used to produce gallium-arsenide (GaAs), indium-arsenide, and indium-gallium-arsenide semiconductors that were widely used in biomedical, communications, computer, electronics, light-emitting diodes (LEDs), and photovoltaic applications. Arsenic was also used for germanium-arsenide-selenide or GaAs specialty optical materials. GaAs devices generate less signal noise than other semiconductor materials; as a result, GaAs semiconductors were useful in weak-signal amplification applications such as wireless communications. The value of worldwide GaAs device revenues was reportedly \$8.9 billion in 2019, a 3.7% decrease from that in 2018 (Higham, 2020a). The decrease, the first since 2004, was attributed to the decline in smartphone shipments. About one-half of the production of GaAs wafers was from China. More information on GaAs use can be found in the Gallium chapter of the 2019 U.S. Geological Survey Minerals Yearbook, volume I, Metals and Minerals.

## Prices

According to U.S. Census Bureau unrounded data, the unit value of arsenic trioxide originating from Morocco averaged 78 cents per kilogram in 2019, a 4% increase from the previous year. The unit value of arsenic trioxide originating from China averaged 46 cents per kilogram, a 5% increase from that in 2018. The unit value of arsenic metal imported from China averaged \$1.92 per kilogram, an increase of 34% from that in 2018 (table 1).

## Foreign Trade

In 2019, domestic imports of arsenic compounds were estimated to contain 7,090 t of arsenic, an increase of 28% compared with the 5,540 t imported in 2018 (table 1). Arsenic trioxide, which accounted for 98% of the gross weight of compound imports in 2019, contains about 76% arsenic by weight. In 2019, China was the source of 61% of the arsenic trioxide imported into the United States; Morocco was the source of 35% (table 2).

In 2019, the United States imported 391 t of arsenic metal, a 58% decrease compared with the 929 t of arsenic metal imported in 2018. The leading sources of arsenic metal in 2019 were China and Japan, accounting for 87% and 11%, respectively, of United States arsenic metal imports (table 2).

According to U.S. Census Bureau data, exports of arsenic metal (under the Harmonized Tariff Schedule of the United States code 2804.80.0000) from the United States in 2019 decreased to 56 t from 107 t in 2018, a 48% decrease. Export destinations included China (77%), Mexico (5%), and Japan, the Republic of Korea, Peru, and Singapore (4% each). Because the

United States did not produce arsenic metal and the other Harmonized Tariff Schedule of the United States code for arsenic has not been used, much of the material reported as exports of metal was thought to be arsenic-containing compounds and waste, as well as nonferrous alloys containing relatively minor quantities of arsenic. Therefore, it is likely that actual exports of arsenic metal were significantly less than reported.

## World Review

In 2019, arsenic trioxide was recovered from the processing of nonferrous ores or concentrates, such as copper, gold, and lead. Reduction of arsenic trioxide to arsenic metal has accounted for all world output of commercial-grade (99%-pure) arsenic metal. Arsenic-containing residues and smelter dusts recovered from nonferrous metals plants in several countries may not have been processed to recover arsenic trioxide in 2019 but may have been stockpiled for future treatment or disposal. Production data in table 3 for most countries were estimated.

In 2019, China produced an estimated 24,000 t of arsenic trioxide and remained the world's leading producer, followed by Morocco with 5,500 t (table 3). Output from these countries accounted for an estimated 91% of total estimated world production. In China, based on historical information, arsenic was believed to have been recovered as a byproduct of smelting gold ores containing orpiment ( $\text{As}_2\text{S}_3$ ) and realgar ( $\text{AsS}$ ), the most common ore minerals of arsenic, in addition to reclaiming arsenic as a byproduct of nonferrous smelting (Peters and others, 2002, p. 182).

In Morocco, production of arsenic was from Managem S.A.'s Bou-Azzer Mine as a byproduct of primary cobalt production. In 2019, the mine produced 5,500 t of arsenic, a slight decrease from revised production in 2018. Cobalt production increased by 33% because of an increase in processing secondary cobalt (Managem S.A., 2020, p. 106–107).

## Outlook

Specific industrial applications, such as marine timber, plywood roofing, and utility poles, are expected to continue to use CCA-treated wood. High-purity arsenic metal is expected to be used increasingly in military, space, and telecommunications applications and in solar cells. The use of GaAs components in cellular handsets and GaAs-based LEDs, automotive lighting, and other applications are expected to decrease in the short term because of the impact of closures related to the coronavirus disease 2019 (COVID-19) pandemic. In the longer term, increased consumption is expected because of the expansion of teleworking and virtual businesses (Higham, 2020b).

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## GENERAL SOURCES OF INFORMATION

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

(Metric tons, arsenic content)

	2015	2016	2017	2018	2019
Imports:					
Metal <sup>2</sup>	514	793	942	929	391
Compounds <sup>3</sup>	5,920	5,320	5,980	5,540	7,090
Total	6,430	6,120	6,920	6,470	7,480
Exports, metal <sup>2</sup>	1,670	1,760	698	107	56
Apparent consumption <sup>4</sup>	6,430	6,120	6,920	6,470	7,480
Price, average: <sup>5</sup>					
Metal, China           dollars per kilogram	1.85	1.89	1.56	1.43	1.92
Trioxide, China       do.	0.45	0.46	0.45	0.44	0.46
Trioxide, Morocco   do.	0.64	0.68	0.68	0.75	0.78

do. Ditto.

<sup>1</sup>Table includes data available through May 13, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Listed as metal only, but may include alloys, compounds, and waste.

<sup>3</sup>Includes arsenic acid, arsenic sulfides, and arsenic trioxide. Arsenic content estimated from the reported gross weight of imports; arsenic trioxide contains nearly 76% arsenic by weight and accounts for nearly all imports.

<sup>4</sup>Estimated to be the same as imports.

<sup>5</sup>Landed duty-paid unit value based on U.S. imports for consumption. Source: U.S. Census Bureau.

TABLE 2  
U.S. IMPORTS FOR CONSUMPTION OF ARSENIC PRODUCTS<sup>1,2</sup>

Class and country or locality	2018		2019	
	Gross weight (metric tons)	Value (thousands)	Gross weight (metric tons)	Value (thousands)
Arsenic trioxide:				
Belgium	350	\$167	336	\$139
China	3,830	1,710	5,600	2,570
Germany	4	34	19	68
Morocco	2,900	2,170	3,180	2,490
New Zealand	108	87	--	--
United Arab Emirates	120	96	--	--
Total	7,320	4,260	9,130	5,270
Arsenic acid:				
China	--	--	41	46
Malaysia	--	--	186	247
Total	--	--	228	293
Arsenic metal:				
China	890	1,270	338	650
Germany	4	830	3	611
Japan	29	436	41	367
Taiwan	--	--	8	24
United Kingdom	6	32	(3)	2
Total	929	2,570	391	1,650

-- Zero.

<sup>1</sup>Table includes data available through May 13, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>There were no imports of arsenic sulfides in 2018 or 2019.

<sup>3</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 3  
ARSENIC: WORLD PRODUCTION, BY COUNTRY OR LOCALITY<sup>1,2</sup>

(Metric tons, gross weight)

Country or locality <sup>3</sup>	2015	2016	2017	2018	2019
Belgium <sup>e</sup>	1,000	1,000	1,000	1,000	1,000
Bolivia	33	38	20 <sup>r</sup>	238 <sup>r</sup>	120
China <sup>c</sup>	25,000	25,000	24,000	24,000	24,000
Iran <sup>c</sup>	110	110	110	110	110
Japan <sup>c</sup>	45	45	45	45	45
Morocco	7,566	7,600	6,879	5,578 <sup>r</sup>	5,500
Namibia	1,960	1,900 <sup>c</sup>	700 <sup>c</sup>	-- <sup>r</sup>	--
Russia <sup>e</sup>	1,500	1,500	1,500	1,500	1,500
Total <sup>e</sup>	37,200	37,200	34,300	32,500 <sup>r</sup>	32,300

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

<sup>1</sup>Table includes data available through May 4, 2020. 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>Includes calculated arsenic trioxide equivalent of output of elemental arsenic compounds other than arsenic trioxide; inclusion of such materials would not duplicate reported arsenic trioxide production.

<sup>3</sup>In addition to the countries and (or) localities listed, other countries or localities may have produced arsenic, but available information was inadequate to make reliable estimates of output.