



2016 Minerals Yearbook

MOLYBDENUM [ADVANCE RELEASE]

MOLYBDENUM

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In the United States, total mine production of molybdenum concentrate decreased for the second year in a row. In 2016, production decreased by 24% to 36,200 metric tons (t) compared with 47,400 t in 2015, which had decreased by 31% from 68,200 t in 2014, resulting in a 47% decrease in production from 2014 to 2016 (table 1). World mine production of molybdenum concentrate was estimated at 278,000 t of contained molybdenum in 2016 compared with the revised 288,000 t in 2015 (table 10). The U.S. share of world production was 13% in 2016, down from 16% and 22% in 2015 and 2014, respectively. Reported U.S. consumption of primary molybdenum products, not including molybdenum concentrates, decreased by 5% in 2016 compared with that of 2015 (table 3).

Molybdenum is contained in various minerals, but only molybdenite (MoS_2) is suitable for the industrial production of marketable molybdenum products. Although molybdenum is marketed largely as ferromolybdenum (FeMo) or as roasted concentrates [molybdic oxide (MoO_3 , called MoX)], published production data refer to mine production, which is the recoverable molybdenum content of raw concentrates. Depending upon the minerals contained in the ore body, mines can be grouped into primary mines, where the recovery of MoS_2 is the sole objective, or byproduct mines, where the recovery of copper-bearing ores is the primary objective and MoS_2 provides additional economic value.

Molybdenum is a refractory metallic element used principally as an alloying agent in cast iron, steel, and superalloys to enhance hardenability, strength, toughness, and wear- and corrosion-resistance. To achieve desired metallurgical properties, molybdenum, primarily in the form of MoX or FeMo, is commonly used in combination with or added to chromium, manganese, nickel, niobium (columbium), tungsten, or other alloy metals. The versatility of molybdenum in enhancing a variety of alloy properties has ensured it a significant role in contemporary industrial technology, which increasingly requires materials that can sustain high stress, expanded temperature ranges, and highly corrosive environments. Significant uses of molybdenum are as a refractory metal and in numerous chemical applications, including catalysts, lubricants, and pigments. Molybdenum has become increasingly important in green technology, particularly in the manufacture of biofuels, catalysts, ethanol, solar panels, and wind turbines.

U.S. molybdenum reserves were estimated to have been about 2.7 million metric tons (Mt) in 2016, about 18% of world molybdenum reserves. About 90% of U.S. reserves occur in large, low-grade porphyry molybdenum deposits mined or anticipated to be mined primarily for molybdenum and in low-grade porphyry copper deposits as an associated metal sulfide. These deposits are in Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, and Utah.

Production

Domestic primary and byproduct molybdenum mine production data were derived from three separate voluntary surveys by the U.S. Geological Survey: the annual “Molybdenum Ore and Concentrate” and monthly “Molybdenum Concentrate” and “Molybdenum Concentrates and Molybdenum Products” surveys. Surveys were sent to all nine U.S. operations (two primary molybdenum mines and seven byproduct mines) that currently produce molybdenum concentrates and products from ore, and all responded, representing 100% of U.S. concentrate production reported in table 1.

Molybdenum concentrate production at primary molybdenum mines continued at two U.S. operations, accounting for 33% of total U.S. molybdenum concentrate production. Molybdenum concentrate production at byproduct mines continued at seven U.S. operations, accounting for 67% of total U.S. molybdenum concentrate production.

As of December 31, 2016, U.S.-rated capacity for mines and mills was estimated to be 85,900 metric tons per year (t/yr) of contained molybdenum. Rated capacity is defined as the maximum quantity of product that can be produced in a period of time on a normally sustainable long-term operating rate, based on the physical equipment of the plant and given acceptable routine operating procedures involving energy, labor, maintenance, and materials. Capacity included plants that were temporarily closed but could be brought into production within a short period of time with minimal capital expenditure.

Primary molybdenum production continued at the Climax Mine and the Henderson Mine in Colorado. Freeport-McMoRan Copper & Gold Inc. (FCX) operated the Henderson underground mine and the Climax open pit mine. Both mines produced high-purity, chemical-grade molybdenum concentrates, which were further processed into value-added molybdenum chemical products. The Climax Mine restarted commercial operations in May 2012 and included a 25,000-metric-ton-per-day (t/d) mill facility. Climax had the capacity to produce approximately 13,600 t/yr of molybdenum. Molybdenum production from Climax totaled 7,260 t in 2016, a 30% decrease from the 10,400 t produced in 2015 (Freeport-McMoRan Copper & Gold Inc., 2017b, p. 15–16).

In response to market conditions, the Henderson Mine operated at reduced rates during 2016. The Henderson Mine produced 4,540 t of molybdenum in 2016, a 60% decrease compared with the 11,340 t produced in 2015. The Henderson operation consisted of a large underground mining complex that fed a 32,000-t/d concentrator. Henderson had the capacity to produce 18,100 t/yr of molybdenum concentrate. The majority of the molybdenum concentrate produced at Henderson was shipped to FCX’s Fort Madison, IA, processing facility (Freeport-McMoRan Copper & Gold Inc., 2017b, p. 15).

The Thompson Creek Mine in Idaho was placed on care-and-maintenance status in 2014 and did not produce any molybdenum in 2016. The Ashdown Mine in Nevada and the Questa Mine in New Mexico remained closed.

Thompson Creek Metals Co. Inc. (TCMC) continued to operate its metallurgical roasting facility in Langeloth, PA. The facility had the capacity to roast 16,300 t/yr of raw molybdenum concentrate and the capacity to process more than 4,000 t/yr of MoX into FeMo. The Langeloth facility also processed nonmolybdenum catalysts for various customers, primarily in the food industry (Langeloth Metallurgical Co., LLC, undated).

Byproduct mines included the Bagdad, Morenci, Pinto Valley, and Sierrita Mines in Arizona; the Continental Pit Mine in Montana; the Robinson Mine in Nevada; and the Bingham Canyon Mine in Utah (table 2). In the case of byproduct molybdenum recovery at a copper mine, all mining costs associated with molybdenum concentrate production are allocated to the primary metal (copper). In 2016, byproduct molybdenite recovery accounted for approximately 67% of the U.S. molybdenum concentrate production.

The Bagdad operation of FCX included a 75,000-t/d concentrator that produced copper and molybdenum concentrates, as well as a pressure-leach plant that processed molybdenum concentrate. Bagdad produced approximately 3,630 t of molybdenum concentrate in 2016 compared with 4,080 t in 2015 (Freeport-McMoRan Copper & Gold Inc., 2017b, p. 10).

The Morenci operation of FCX consisted of two concentrators capable of milling 115,000 t/d of ore to produce copper and molybdenum concentrates. FCX owns an 85% undivided interest in Morenci, with the remaining 15% owned by Sumitomo Metal Mining Arizona, Inc. Morenci's production, including the joint-venture partner's share, totaled 6,800 t of molybdenum concentrate, more than double the 3,180 t produced in 2015. The large increase in molybdenum production was due to the completion of the Morenci mill expansion project, which achieved full rates in the second quarter of 2015 and expanded the mill capacity from 50,000 t/d of ore to approximately 115,000 t/d of ore (Freeport-McMoRan Copper & Gold Inc., 2017a, p. 11).

The Sierrita operation of FCX included a 102,000-t/d concentrator that produced copper and molybdenum concentrates. It also had molybdenum facilities consisting of a leaching circuit, two molybdenum roasters, and a packaging facility. The molybdenum facilities processed concentrate from Sierrita, other FCX mines, and third-party sources. Molybdenum concentrate production at Sierrita in 2016 was 6,350 t, a 33% decrease compared with 9,530 t of molybdenum concentrate produced in 2015 (Freeport-McMoRan Copper & Gold Inc., 2017b, p. 12).

Rio Tinto plc (London, United Kingdom) reported that 2016 molybdenum concentrate production at its Bingham Canyon Mine (operated by its subsidiary Rio Tinto Kennecott) was 2,800 t compared with 7,600 t produced in 2015. Rio Tinto attributed the large decrease in molybdenum production to a significant decrease in the molybdenum content of the ore at the Bingham Canyon Mine (Rio Tinto plc, 2017, p. 224).

Consumption

Statistics on consumption of molybdenum in end-use applications by U.S. metal consumers were developed from the voluntary "Consolidated Consumers Survey." For this survey, molybdenum consumers were canvassed on a monthly or annual basis. Reported consumption and stocks data in tables 1 and 3 include estimates to account for nonrespondents.

In 2016, U.S.-reported consumption of molybdenum contained in concentrate for roasting decreased compared with that of 2015. Reported consumption of molybdenum contained in concentrate was withheld to avoid disclosing company proprietary data (table 1). Domestic mine production of molybdenum concentrate was roasted, exported for conversion, or purified to lubricant-grade MoS₂. MoX was the leading form of molybdenum used by industry, particularly in making stainless steel. Superalloy industry consumption of molybdenum products decreased in 2016 compared with that of 2015 (tables 1, 3).

Metallurgical applications dominated reported molybdenum use in 2016, accounting for approximately 88% of 2016 total reported consumption. In 2016, FeMo accounted for 20% of the molybdenum-bearing materials used to make steel (not including tool steel, which was withheld) (table 3). Nonmetallurgical applications included catalysts, chemicals, lubricants, and pigments. Catalytic applications, principally those related to petroleum refining, constituted the largest use for molybdenum outside the steel industry and were the most important chemical end use for molybdenum.

Stocks

At yearend 2016, consumer industry stocks increased compared with yearend 2015 stocks. Inventories of molybdenum in concentrate at mines and plants decreased (table 1). Consumer stocks of molybdenum in FeMo, MoX, metal powders, and other products also increased compared with stocks of 2015 (table 3).

Prices

In 2016, the average monthly price for domestic MoX, as published by CRU Group, ranged from \$5.300 to \$7.967 per pound, compared with \$4.625 to \$9.422 per pound in 2015. In 2016, the average monthly price for domestic FeMo ranged from \$6.547 to \$8.969 per pound of contained molybdenum, compared with \$6.050 to \$10.775 per pound reported in 2015 (fig. 1). FeMo has historically commanded a small price premium over MoX as a result of the additional conversion costs incurred during production.

In the first half of 2016, both FeMo and MoX prices increased owing to stronger than anticipated molybdenum demand from Chinese steel producers. However, FeMo and MoX prices decreased in July and continued to decrease until December when FeMo increased. Prices have not been this low since early 2003, when the average annual MoX price was \$5.34 per pound.

Foreign Trade

Molybdenum enters into international trade largely in raw and roasted concentrates and FeMo. Exports of molybdenum ore and

concentrates (both unroasted and roasted) totaled approximately 27,700 t (contained weight) with 56% of this total going to the Netherlands (table 5). The Netherlands featured prominently in international trade of molybdenum concentrates and molybdenum-containing products, both as a transiting and warehouse location and as the location for one of Climax Molybdenum Co.'s processing facilities in Rotterdam.

In 2016, molybdenum-containing exports (excluding molybdenum ore and concentrates) collectively totaled approximately 3,980 t (gross weight) valued at \$105 million (tables 4, 6). Imports for consumption of all molybdenum-containing products collectively totaled approximately 40,100 t (gross weight) valued at \$389 million (table 9).

In 2016, U.S. imports of molybdenum ore and concentrates (both unroasted and roasted) totaled approximately 14,900 t (contained weight), a 16% increase from the 12,900 t imported in 2015 (table 9).

World Review

World molybdenum reserves and production capacity were concentrated in a few countries. In 2016, world mine output was estimated to have been 278,000 t (molybdenum contained in concentrate), of which, in descending order of production, China, Chile, the United States, Peru, Mexico, and Armenia provided about 95% (table 10).

According to the International Molybdenum Association (IMO), global molybdenum consumption in 2016 increased to 232,500 t compared with 231,400 t in 2015. The leading consumer of molybdenum in 2016 continued to be China, where consumption increased to 84,400 t in 2016 from 80,600 t in 2015. Europe was the second leading consumer at 59,600 t in 2016 compared with 61,300 t in 2015 (International Molybdenum Association, 2017).

Argentina.—Minera Alumbrera Ltd. began molybdenum production at the Alumbrera copper-gold-molybdenum mine in northern Argentina in 2008 when it commissioned a molybdenum recovery circuit. The Alumbrera Mine is a joint venture among Glencore plc (50%), Goldcorp Inc. (37.5%), and Yamana Gold Inc. (12.5%). According to the company, all molybdenum produced at the mine was exported to Chile (Minera Alumbrera Ltd., 2016, p. 71–73).

Armenia.—The Zangezur Copper-Molybdenum Combine continued to produce molybdenum at its Kajaran Mine. According to Cronimet Mining AG, the Kajaran Mine is the leading copper and molybdenum mine in Armenia. Zangezur Copper-Molybdenum shareholders are Cronimet Mining (60%), Pure Iron Plant OJSC (15%), Armenian Molybdenum Production Ltd. (12.5%), and Zangezur Mining Ltd. (12.5%) (Cronimet Mining AG, undated).

In 2016, Vallex Group (Yerevan) completed the construction of its copper and molybdenum ore processing plant near the Kashen deposit and started processing its first ore. The deposit contained an estimated 56 Mt of ore with 0.49% copper content and 0.006% molybdenum content. Vallex has been working on the Kashen Mine since 2012 and has invested approximately \$120 million to bring it to the first phase of production (Metal-Pages, 2016b). Vallex also owns the Teghut copper and molybdenum mine and concentrator plant located

in the Tumanyan region in northern Armenia. According to the company, the Teghut Mine has been producing approximately 380 t/yr of molybdenum concentrate (Vallex Group, undated).

Canada.—Teck Resources Ltd. announced that its Highland Valley Mine in south-central British Columbia produced 3,490 t of molybdenum concentrate in 2016, a 75% increase from the 2,000 t of molybdenum concentrate produced in 2015. The company attributed the large increase to higher grades of ore. The company expected molybdenum production to be approximately 4,100 to 4,300 t/yr in 2017, before declining to approximately 3,200 t/yr from 2018 to 2020 (Teck Resources Ltd., 2017, p. 19).

At its Gibraltar Mine in south-central British Columbia, Taseko Mines Ltd. produced 430 t of molybdenum in 2016, a slight decrease from the 437 t of molybdenum produced in 2015. The molybdenum circuit at Gibraltar restarted in September 2016 after being idle since the third quarter of 2015 (Taseko Mines Ltd., 2017, p. 2).

Chile.—In 2015, Amerigo Resources Ltd. produced only 44 t of molybdenum at its Minera Valle Central processing facility in central Chile because molybdenum was only produced in the first quarter of 2015. Molybdenum production restarted in August 2016, with an annual production of 230 t of molybdenum. To optimize costs, operation of the molybdenum-processing facility was outsourced to a subcontractor who refurbished it with a \$1.0 million investment, which was to be paid by Minera Valle Central S.A. (MVC) over the course of 3 years. MVC continued to sell its molybdenum concentrates to Molibdenos y Metales S.A. through a contract that expires in 2019 (Amerigo Resources Ltd., 2017, p. 11, 22).

Antofagasta plc (London, United Kingdom) announced that 2016 byproduct molybdenum production at its Los Pelambres Mine was 7,100 t, a 30% decrease compared with 10,100 t of molybdenum produced in 2015. Antofagasta also announced that it was constructing a new molybdenum plant at Centinela. The new plant was expected to produce approximately 2,400 t/yr of molybdenum concentrate, and construction was expected to commence in 2017 (Antofagasta plc, 2016, p. 20, 40, 45, 49).

Corporación Nacional del Cobre de Chile (CODELCO), the state-controlled copper and molybdenum producer, announced that it produced 30,600 t of molybdenum in 2016 compared with 27,700 t in 2015. CODELCO attributed the 10% increase in molybdenum production to higher output from the Chuquicamata open pit mine (Corporación Nacional del Cobre de Chile, 2017, p. 2).

The Sierra Gorda project, in the Antofagasta Region in northern Chile, was a joint venture among KGHM International Ltd., Sumitomo Metal Mining Co., Ltd., and Sumitomo Corp. under the company Sierra Gorda SCM. The Sierra Gorda Mine produced 10,000 t of molybdenum concentrate in 2016, a 52% increase compared with the 6,600 t of molybdenum concentrate produced in 2015. The increase was mainly attributed to the mine and processing plant remaining in the rampup phase during the first half of 2015 (KGHM Polska Miedź S.A., 2017, p. 106, 147).

China.—Chinese molybdenum production took place predominantly in Hebei, Henan, and Shaanxi Provinces and Nei Mongol Autonomous Region. China has a large number of small-scale mining operations that were very susceptible to changes

in prices and also were able to increase or decrease production quickly during price fluctuations. In 2016, the decrease in Chinese production was attributed to a new round of environmental inspections that was launched by the Chinese Government. The environmental inspections have forced some producers to shut down permanently or upgrade their facilities to comply with stricter environmental standards (Metal-Pages, 2016a).

Jinduicheng Molybdenum Co. Ltd. announced that it reduced production in 2016. Inner Mongolia Zhongxi Mining Co. Ltd. announced that their 2016 production levels remained unchanged (Tungsten & Molybdenum Monthly, 2017, p. 5).

Mexico.—Grupo Mexico S.A.B. de C.V. (Grupo Mexico) reported that its La Caridad Mine, in northeastern Sonora, produced 9,900 t of molybdenum concentrate in 2016 compared with 10,040 t of molybdenum concentrate in 2015 (Grupo Mexico S.A.B. de C.V., 2017, p. 20). Grupo Mexico also reported that it completed the \$3.5 billion investment program at Buenavista del Cobre on time and \$100 million below budget. The new copper-molybdenum concentrator has a production capacity of 188,000 t/yr of copper and 2,600 t/yr of molybdenum concentrate. In 2016, it produced 1,600 t of molybdenum concentrate. The Buenavista Mine is located 40 kilometers (km) south of the border between the United States (Arizona) and Mexico (Grupo Mexico S.A.B. de C.V., 2017, p. 20, 26).

Peru.—The Cerro Verde Mine (FCX has a 53.56% ownership interest) is an open pit copper and molybdenum mining complex, 16 km southwest of Arequipa. According to FCX, the Cerro Verde expansion project commenced operations in September 2015 and achieved capacity operating rates during the first quarter of 2016. Production in 2016 was approximately 9,500 t of molybdenum concentrate compared with 3,200 t of molybdenum concentrate in 2015 (Freeport-McMoRan Copper & Gold Inc., 2017b, p. 14).

Grupo Mexico also announced that it continued to work on the Toquepala expansion project in southern Peru. The Toquepala expansion project was expected to increase annual molybdenum production by 3,100 t. The project was expected to be complete in the second quarter of 2018 (Grupo Mexico S.A.B. de C.V., 2017, p. 26).

Chinalco Mining Corporation International announced that, as of June 2016, the molybdenum hydrometallurgical project at the Toromocho copper-molybdenum operation had not started production. The Toromocho project is located in central Peru in the core of the Morochocha mining district. The molybdenum operation had a production capacity of 25.1 t/d of molybdenum over the life of the mill and would be Peru's first molybdenum-processing facility (Chinalco Mining Corporation International, 2016, p. 8, 10, 11).

Outlook

The principal uses for molybdenum are expected to continue to be in catalysts and chemicals and as an additive in steel manufacturing, most importantly alloy and stainless steel. Molybdenum plays a vital role in the energy industry, and it may become an increasingly important factor in environmental protection technology, where it is used in high-strength steels for automobiles to reduce weight and improve fuel economy and

safety. Molybdenum-based catalysts have a number of important applications in the petroleum and plastics industries. A major use is in the hydrodesulfurization of petroleum, petrochemicals, and coal-derived liquids. Catalysts are estimated to account for more than 70% of chemical uses of molybdenum (Roskill Information Services Ltd., 2017, p. A195). Molybdenum not only allows for economical fuel refining, it also contributes to a safer environment through lower sulfur emissions. Analysts expect global demand for catalysts to continue to increase as there are no practical alternatives to molybdenum in many of its catalytic applications. The need for companies to reduce carbon dioxide emissions from coal-fired power stations will require plants to run at higher temperatures, resulting in greater demand for higher grade molybdenum-bearing steels. Increase in molybdenum use is expected to continue in stainless steels and full alloy steels, mainly in the consumer product and transportation industries (Roskill Information Services Ltd., 2017, p. 1–2).

According to the IMO, global molybdenum consumption in 2016 increased to 232,500 t compared with 231,400 t in 2015 (International Molybdenum Association, 2017). In the first half of 2016, the price of molybdenum was characterized by a stable growth trend, which was the effect of higher than expected growth in molybdenum consumption, mainly in China. This took place mainly in the construction and automotive sectors.

New and expanded molybdenum byproduct capacity at copper operations in the early 2010s led to oversupply by 2015, despite the efforts of many primary molybdenum producers to cut production. A number of mine closures in 2014 and 2015, including the North American-based Thompson Creek Mine, Endako Mine (TCMC), and Mineral Park Mine (Mercator), reduced global molybdenum supply by more than 10,000 t; however, this loss of molybdenum was offset by increased production at the Sierra Gorda Mine in Chile as well as the Yichun Luming Mine in China. Existing molybdenum producers were expected to form the majority of additional supply through 2020, particularly from mines located in the United States and China (Roskill Information Services Ltd., 2017, p. 8).

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TABLE 1
SALIENT MOLYBDENUM STATISTICS¹

(Metric tons of contained molybdenum)

	2012	2013	2014	2015	2016
United States:					
Concentrate:					
Production	60,400	61,000	68,200	47,400	36,200
Shipments	60,200	68,100	71,900	50,500	38,600
Reported consumption ²	W	W	W	W	W
Imports for consumption	12,000	13,100	15,800	12,900 ^r	14,900
Exports	43,500 ^r	48,600 ^r	60,500 ^r	36,800 ^r	27,700
Stocks, December 31:					
Concentrate, mine and plant	W	W	W	W	W
Product producers ³	W	W	W	W	W
Consumers	1,770	1,820	2,010	1,880	1,940
Total	1,770	1,820	2,010	1,880	1,940
Primary products:					
Production	W	W	W	W	W
Shipments	W	W	W	W	W
Reported consumption	19,400	18,600	19,500	17,600	16,700
Imports for consumption	7,830	7,190	9,500	4,540	7,910
World, mine production	272,000 ^r	281,000 ^r	306,000 ^r	288,000 ^r	278,000 ^e

^rRevised. W Withheld to avoid disclosing company proprietary data.

¹Table includes data available through October 3, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

²Molybdenum concentrates roasted to make molybdenum oxide.

³Includes ammonium, calcium, and sodium molybdate; briquets; ferromolybdenum; molybdenum hexacarbonyl; molybdenum metal; molybdenum pentachloride; molybdic acid; pellets; phosphomolybdic disulfide; and technical and purified molybdic oxide.

TABLE 2
MOLYBDENUM-PRODUCING MINES IN THE UNITED STATES IN 2016

State and mine	County	Operator	Source of molybdenum
Arizona:			
Bagdad	Yavapai	Freeport-McMoRan Copper & Gold Inc.	Copper-molybdenum ore, concentrated.
Morenci	Greenlee	do.	Do.
Pinto Valley	Gila	Capstone Mining Corp.	Do.
Sierrita	Pima	Freeport-McMoRan Copper & Gold Inc.	Do.
Colorado:			
Climax	Lake	do.	Molybdenum ore, concentrated.
Henderson	Clear Creek	do.	Do.
Montana, Continental Pit	Silver Bow	Montana Resources	Copper-molybdenum ore, concentrated.
Nevada, Robinson	White Pine	Robinson Nevada Mining Co. ¹	Do.
Utah, Bingham Canyon	Salt Lake	Rio Tinto Kennecott	Do.

Do., do. Ditto.

¹Wholly owned subsidiary of KGHM International Ltd.

TABLE 3
U.S. REPORTED CONSUMPTION, BY END USES, AND CONSUMER STOCKS OF MOLYBDENUM MATERIALS¹

(Kilograms of contained molybdenum)

End use	Molybdic oxides	Ferromolybdenum ²	Ammonium and sodium molybdate	Molybdenum scrap	Other	Total
2015:						
Steel:						
Carbon	W	W	--	--	--	W
High-strength low-alloy	W	106,000	--	--	--	106,000
Stainless and heat-resisting	2,170,000	682,000	--	(3)	W	2,850,000
Full alloy	3,240,000	2,170,000	--	--	W	5,410,000
Tool	W	W	--	(3)	--	W
Total	5,410,000 [†]	2,960,000	--	--	W	8,370,000 [†]
Cast irons (gray, malleable, ductile iron)	W	330,000	--	--	W	330,000
Superalloys	485,000	W	--	(3)	1,080,000	1,570,000
Alloys (other than steels, cast irons, superalloys):						
Welding materials (structural and hard-facing)	--	W	--	--	W	W
Other alloys	1,410	100,000	--	--	W	102,000
Mill products made from metal powder ⁴	--	--	--	--	W	W
Cemented carbides and related products ⁵	--	--	--	--	77	77
Chemical and ceramic uses:						
Pigments	W	--	(3)	--	--	W
Catalysts	W	--	(3)	--	W	W
Other	--	--	--	--	W	W
Miscellaneous and unspecified uses:						
Lubricants	--	--	--	--	152,000	152,000
Other	2,290,000 [†]	364,000	10,500	(3)	4,370,000	7,030,000 [†]
Grand total	8,190,000	3,750,000	10,500	(3) [†]	5,600,000	17,600,000
Stocks, December 31	600,000	357,000	5,970	(6)	(6)	1,880,000
2016:						
Steel:						
Carbon	W	W	--	--	--	W
High-strength low-alloy	W	103,000	--	--	--	103,000
Stainless and heat-resisting	2,190,000	674,000	--	(3)	W	2,870,000
Full alloy	3,260,000	1,890,000	--	--	W	5,150,000
Tool	W	W	--	(3)	--	W
Total	5,450,000	2,670,000	--	--	W	8,110,000
Cast irons (gray, malleable, ductile iron)	W	329,000	--	--	W	329,000
Superalloys	201,000	W	--	(3)	1,050,000	1,250,000
Alloys (other than steels, cast irons, superalloys):						
Welding materials (structural and hard-facing)	--	W	--	--	W	W
Other alloys	2,650	90,000	--	--	W	92,700
Mill products made from metal powder ⁴	--	--	--	--	W	W
Cemented carbides and related products ⁵	--	--	--	--	77	77
Chemical and ceramic uses:						
Pigments	W	--	(3)	--	--	W
Catalysts	W	--	(3)	--	W	W
Other	--	--	--	--	W	W
Miscellaneous and unspecified uses:						
Lubricants	--	--	--	--	152,000	152,000
Other	2,330,000	328,000	5,110	(3)	4,100,000	6,760,000
Grand total	7,980,000	3,410,000	5,110	(3)	5,300,000	16,700,000
Stocks, December 31	661,000	360,000	7,080	(6)	(6)	1,940,000

[†]Revised. W Withheld to avoid disclosing company proprietary data; included in "Miscellaneous and unspecified uses: Other." -- Zero.

¹Table includes data available through October 3, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes calcium molybdate.

³Withheld to avoid disclosing company proprietary data; included in "Miscellaneous and unspecified uses: Other" under "Other."

⁴Includes ingot, wire, rod, and sheet.

⁵Includes construction, mining, oil and gas, and metal working machinery.

⁶Withheld to avoid disclosing company proprietary data; included in "Total."

TABLE 4
U.S. EXPORTS OF MOLYBDENUM PRODUCTS, BY PRODUCT AND COUNTRY OR LOCALITY¹

(Metric tons, gross weight, and thousand dollars)

Product and country or locality	HTS ² code	2015		2016	
		Quantity	Value	Quantity	Value
Oxides and hydroxides: ³	2825.70.0000				
Brazil		197	2,570	48	677
Canada		26	280	104	1,090
Germany		4	84	7	147
Japan		418	6,160	67	1,250
Korea, Republic of		26	462	17	332
Kuwait		245	5,280	18	388
Mexico		116	1,490	80	783
Netherlands		154	1,540	326	4,450
Poland		--	--	4	79
Turkey		72	1,050	180	2,300
Other (9 countries)		40 ^r	542 ^r	3	83
Total		1,300	19,400	853	11,600
Molybdates, all: ⁴	2841.70.0000				
Canada		369	3,630	254	3,000
Germany		8 ^r	171 ^r	115	1,720
Japan		83	1,310	72	1,120
Mexico		462	6,680	538	7,030
Netherlands		756	6,340	311	2,400
Other (29 countries)		339 ^r	4,130 ^r	151	1,920
Total		2,020	22,300	1,440	17,200
Ferromolybdenum: ^{4,5}	7202.70.0000				
Argentina		--	--	(6)	4
Canada		688 ^r	13,300 ^r	588	12,200
Colombia		1	29	2	41
Denmark		1	37	1	37
Mexico		120 ^r	1,700	60	1,060
Vietnam		(6)	6	--	--
Total		810 ^r	15,000 ^r	650	13,300
Molybdenum, other: ^{3,7}	Various ⁸				
Canada		80	3,100	69	3,040
China		101	7,830	101	6,390
Germany		92	4,640	140	9,280
India		26	1,350	27	1,260
Israel		87	6,850	38	3,030
Japan		104	5,380	81	2,970
Korea, Republic of		139	15,900	129	12,800
Malaysia		27	1,840	24	1,540
Taiwan		117	8,320	84	5,100
United Kingdom		110	5,660	220	8,890
Other (40 countries)		295 ^r	16,800 ^r	119	8,360
Total		1,180	77,700 ^r	1,030	62,700

^rRevised. -- Zero.

¹Table includes data available through October 3, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

²Harmonized Tariff Schedule of the United States (HTS).

³Presentation of annual data is based on the quantities (gross weight) of the ten leading countries in 2016.

⁴Presentation of annual data is based on the quantities (gross weight) of the five leading countries in 2016.

⁵Ferromolybdenum contains about 60% to 65% molybdenum.

⁶Less than ½ unit.

⁷Includes powder, unwrought, waste and scrap, wire, wrought, and other.

⁸Includes HTS codes 8102.10.0000, 8102.94.0000, 8102.95.0000, 8102.96.0000, 8102.97.0000, and 8102.99.0000.

Source: U.S. Census Bureau.

TABLE 5
U.S. EXPORTS OF MOLYBDENUM ORE AND CONCENTRATES
(INCLUDING ROASTED AND UNROASTED CONCENTRATES), BY COUNTRY OR LOCALITY^{1,2}

(Metric tons, contained weight, and thousand dollars)

Country or locality	2015		2016	
	Quantity	Value	Quantity	Value
Belgium	3,910	61,200	1,820	23,500
Canada	1,690	32,000	1,290	16,900
China	477	6,830	3,500	44,400
Japan	2,900	45,400	2,100	28,800
Korea, Republic of	1,350	20,100	152	1,690
Mexico	2,530	55,800	118	1,660
Netherlands	18,100	275,000	15,400	184,000
Thailand	2	42	132	1,550
United Kingdom	5,110	78,600	2,720	35,100
Vietnam	274	5,110	168	1,760
Other (15 countries)	498 ^r	7,140 ^r	278	3,990
Total	36,800	587,000	27,700	343,000

^rRevised.

¹Table includes data available through October 3, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

²Presentation of annual data is based on the quantities (contained weight) of the 10 leading countries in 2016.

Source: U.S. Census Bureau.

TABLE 6
U.S. EXPORTS OF MOLYBDENUM PRODUCTS¹

Item	HTS ² code	2015			2016		
		Quantity (metric tons)		Value (thousands)	Quantity (metric tons)		Value (thousands)
		Gross weight	Contained weight		Gross weight	Contained weight	
Molybdenum ore and concentrates:							
Roasted	2613.10.0000	NA	18,100 ^r	\$282,000 ^r	NA	11,800	\$158,000
Unroasted	2613.90.0000	NA	18,700	305,000	NA	15,900	185,000
Molybdenum chemicals:							
Oxides and hydroxides	2825.70.0000	1,300 ^r	NA	19,400 ^r	853	NA	11,600
Molybdates, all	2841.70.0000	2,020 ^r	NA	22,300 ^r	1,440	NA	17,200
Ferromolybdenum	7202.70.0000	810 ^r	565 ^r	15,000 ^r	650	455	13,300
Molybdenum powders	8102.10.0000	191	NA	7,470 ^r	143	NA	5,660
Molybdenum unwrought, bars and rods	8102.94.0000	36	NA	1,320 ^r	68	NA	2,520
Molybdenum waste and scrap	8102.97.0000	206	NA	4,350	200	NA	2,960
Molybdenum wire	8102.96.0000	23 ^r	NA	2,690 ^r	27	NA	2,980
Molybdenum, other	Various ³	723 ^r	NA	61,900 ^r	595	NA	48,600
Total		XX	XX	722,000 ^r	XX	XX	448,000

^rRevised. NA Not available. XX Not applicable.

¹Table includes data available through October 3, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

²Harmonized Tariff Schedule of the United States (HTS).

³Includes HTS codes 8102.95.0000 and 8102.99.0000.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF MOLYBDENUM PRODUCTS, BY PRODUCT AND COUNTRY OR LOCALITY¹

(Metric tons, gross weight, and thousand dollars)

Product and country or locality	HTS ² code	2015		2016	
		Quantity	Value	Quantity	Value
Oxides and hydroxides:	2825.70.0000				
Chile		605	7,700	2,130	27,400
China		134	2,110	726	9,630
Germany		2	49	5	97
Korea, Republic of		3	32	404	4,030
Singapore		--	--	19	279
Other (3 countries)		12 ^r	229 ^r	--	--
Total		756	10,100	3,280	41,400
Molybdates, all: ³	Various ⁴				
Chile		547	5,570	1,200	13,400
China		459	5,890 ^r	1,440	17,000
India		11	116	121	1,020
Poland		--	--	68	513
United Kingdom		9	150	19	388
Other (9 countries)		10 ^r	306 ^r	16	290
Total		1,040	12,000	2,870	32,700
Molybdenum orange:	3206.20.0020				
Canada		416	1,700	534	1,830
China		44	215	4	27
Colombia		118	579	103	388
India		19	37	95	172
Mexico		12	48	2	9
Total		609	2,580	737	2,420
Ferromolybdenum: ^{3,5}	7202.70.0000				
Canada		562	8,130	434	6,990
Chile		883	13,300	1,700	28,600
China		--	--	67	1,250
Korea, Republic of		740	11,100	505	9,090
United Kingdom		120	2,270	37	697
Other (3 countries)		74 ^r	1,540 ^r	7	209
Total		2,380	36,300	2,750	46,900
Other: ⁶	Various ⁷				
Austria		252 ^r	12,200 ^r	414	13,400
Canada		257	5,670	264	4,440
China		894 ^r	26,500 ^r	909	20,400
Germany		161	5,610 ^r	201	7,160
Japan		36	963 ^r	37	1,640
Korea, Republic of		11	146	18	240
Netherlands		(8)	105	22	210
Russia		13	1,360	4	300
Taiwan		8	438	9	312
United Kingdom		43	1,080	62	1,320
Other (19 countries)		29 ^r	1,660 ^r	10	1,370
Total		1,700 ^r	55,800 ^r	1,950	50,800

¹Revised. -- Zero.

¹Table includes data available through October 3, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

²Harmonized Tariff Schedule of the United States (HTS).

³Presentation of annual data is based on the quantities (gross weight) of the five leading countries in 2016.

⁴Includes HTS codes 2841.70.1000 and 2841.70.5000.

⁵Ferromolybdenum contains about 60% to 65% molybdenum.

⁶Presentation of annual data is based on the quantities (gross weight) of the ten leading countries in 2016.

⁷Includes HTS codes 8102.10.0000, 8102.94.0000, 8102.95.3000, 8102.95.6000, 8102.96.0000, 8102.97.0000, and 8102.99.0000.

⁸Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS OF MOLYBDENUM ORE AND CONCENTRATES (INCLUDING
ROASTED AND UNROASTED CONCENTRATES), BY COUNTRY OR LOCALITY¹

(Metric tons, gross weight, and thousand dollars)

Country or locality	2015		2016	
	Quantity	Value	Quantity	Value
Canada	2,840	22,600	2,150	16,200
Chile	9,910	69,700	11,600	81,700
China	1	21 ^r	200	1,190
Korea, Republic of	20	225	--	--
Mexico	3,370	49,200	852	10,100
Netherlands	7 ^r	84 ^r	--	--
Peru	8,610	64,100	13,700	106,000
Total	24,800 ^r	206,000	28,500	215,000

^rRevised. -- Zero.

¹Table includes data available through October 3, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 9
U.S. IMPORTS FOR CONSUMPTION OF MOLYBDENUM PRODUCTS¹

Item	HTS ² code	2015			2016		
		Quantity (metric tons)		Value	Quantity (metric tons)		Value
		Gross weight	Contained weight	(thousands)	Gross weight	Contained weight	(thousands)
Molybdenum ore and concentrates:							
Roasted	2613.10.0000	6,790 ^r	4,060 ^r	\$76,500	6,750	4,010	\$59,300
Unroasted	2613.90.0000	18,000	8,830	129,000	21,800	10,900	156,000
Molybdenum chemicals:							
Oxides and hydroxides	2825.70.0000	756	NA	10,100	3,280	NA	41,400
Molybdates, all	Various ³	1,040	578	12,000	2,870	1,580	32,700
Molybdenum orange	3206.20.0020	609	NA	2,580	737	NA	2,420
Ferromolybdenum	7202.70.0000	2,380	1,610	36,300	2,750	1,900	46,900
Molybdenum powders	8102.10.0000	232	206	7,560	160	151	4,630
Molybdenum unwrought, bars and rods	8102.94.0000	682	679	16,500	882	879	16,000
Molybdenum waste and scrap	8102.97.0000	536	516	11,500	669	636	12,200
Molybdenum wire	8102.96.0000	14	NA	1,860	18	NA	2,280
Molybdenum, other	Various ⁴	186 ^r	NA	18,400	188	NA	15,600
Total		31,200 ^r	XX	323,000	40,100	XX	389,000

^rRevised. NA Not available. XX Not applicable.

¹Table includes data available through October 3, 2017. Data are rounded to no more than three significant digits; may not add to totals shown.

²Harmonized Tariff Schedule of the United States (HTS).

³Includes HTS codes 2841.70.1000 and 2841.70.5000.

⁴Includes HTS codes 8102.95.3000, 8102.95.6000, and 8102.99.0000.

Source: U.S. Census Bureau.

TABLE 10
MOLYBDENUM: WORLD MINE PRODUCTION, BY COUNTRY OR LOCALITY¹

(Metric tons of contained molybdenum)

Country or locality ²	2012	2013	2014	2015	2016
Argentina	820	1,802	908	811	450
Armenia	6,526 ^r	6,900	7,162	6,300 ^{e,1}	6,300 ^e
Canada	8,936	7,956	9,358	2,505 ^r	2,708
Chile	35,090	38,715	48,770	52,579	55,647
China ^c	120,000 ^r	122,000 ^r	129,000 ^r	135,000 ^r	129,000
Iran	3,516	3,471	3,494	3,500	3,500
Korea, Republic of	377	428	479	--	--
Mexico	11,366	12,562	14,370	12,279 ^r	11,896
Mongolia	1,904	1,819	1,999	2,557 ^r	2,444
Peru	16,790	18,140	17,018	20,153	25,757
Russia	4,939	4,753	3,114 ^r	3,000 ^{e,1}	3,000 ^e
Turkey	600	800	900	900	900
United States	60,400	61,000	68,200	47,400	36,200
Uzbekistan	522	490	450	450	450
Total	272,000 ^r	281,000 ^r	306,000 ^r	288,000 ^r	278,000 ^e

^eEstimated. ^rRevised. -- Zero.

¹Includes data available through July 28, 2017. All data are reported unless otherwise noted. Totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²In addition to the countries and (or) localities listed, Bulgaria and Kyrgyzstan were thought to have produced molybdenum, but output was not reported quantitatively, and available general information was inadequate to make reliable estimates of output.

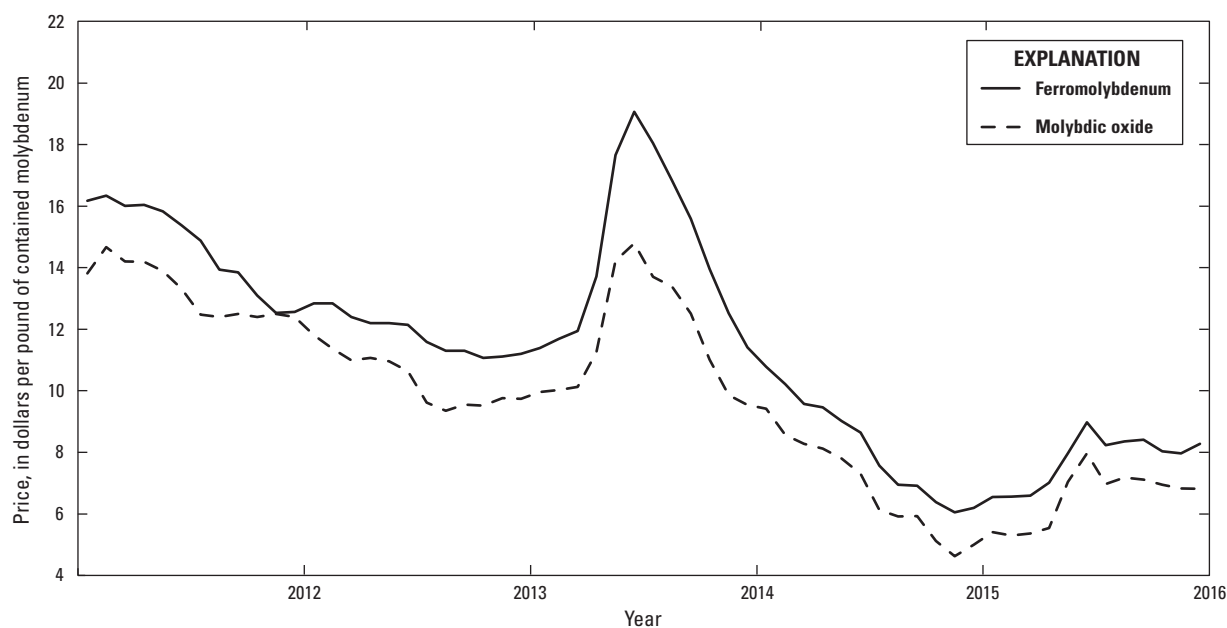


Figure 1. U.S. average monthly prices for molybdic oxide and ferromolybdenum from January 2012 through December 2016. Source: CRU Group.