



# 2012 Minerals Yearbook

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## MOLYBDENUM

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# MOLYBDENUM

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In the United States, mine production of molybdenum concentrate in 2012 decreased by 5% to 60,400 metric tons (t) from 63,700 t in 2011. Estimated world mine production of molybdenum in 2012 was about 259,000 t, a 2% decrease from 264,000 t in 2011 (table 1). The U.S. share of world production was 23% in 2012. Reported U.S. consumption of molybdenum materials, not including molybdenum concentrates, decreased by 4% in 2012 compared with that of 2011 (table 3).

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 molybdic oxide ( $\text{MoO}_3$ , called MoX) or ferromolybdenum ( $\text{FeMo}$ ), is frequently 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. There is significant use of molybdenum as a refractory metal and in numerous chemical applications, including catalysts, lubricants, and pigments.

U.S. molybdenum reserves were estimated to be about 2.7 million metric tons (Mt), about 31% of the 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 as an associated metal sulfide in low-grade porphyry copper deposits. These deposits are in Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, and Utah. Other molybdenum sources do not contribute significantly to U.S. reserves.

## Production

Domestic molybdenum mine production data were derived from three separate voluntary surveys by the U.S. Geological Survey. These surveys are “Molybdenum Ore and Concentrate” (annual), “Molybdenum Concentrate” (monthly), and “Molybdenum Products and Molybdenum Concentrates” (monthly). Surveys were sent to all 13 U.S. operations that currently produce molybdenum concentrates and products from ore, and all responded, representing 100% of the U.S. production listed in table 1.

As of December 31, 2012, U.S. rated capacity for mines and mills was estimated to be about 99,500 metric tons per year (t/yr) of contained metal. Rated capacity was defined as the maximum quantity of product that could be produced in a period of time at 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 operating plants temporarily closed, which could be brought into production within a short period of time with minimal capital expenditure.

Primary molybdenum production continued at the Ashdown Mine in Nevada, the Henderson Mine in Colorado, the Questa Mine in New Mexico, and the Thompson Creek Mine in Idaho. In May, the Climax Mine in Colorado began commercial molybdenum production. Freeport-McMoRan Copper & Gold Inc. (FCX) announced that its Henderson Mine produced 15,400 t of molybdenum in 2012, a 10% decrease compared with 17,200 t produced in 2011 (Freeport-McMoRan Copper & Gold Inc., 2013a, p. 26). The Henderson underground mine produces high-purity, chemical-grade molybdenum concentrates, which typically are further processed into value-added molybdenum chemical products. The Henderson operation consists of a large underground mining complex that feeds a 32,000-metric-ton-per-day (t/d) concentrator. Henderson has the capacity to produce 18,140 t/yr of molybdenum (Freeport-McMoRan Copper & Gold Inc., 2012, p. 14). The majority of the molybdenum concentrate produced at Henderson is shipped to FCX’s Fort Madison, IA, processing facility.

FCX announced that Climax produced 3,175 t of molybdenum in 2012 and was targeted to produce 13,600 t of molybdenum in 2013. The company announced that it intended to operate its Climax and Henderson Mines in a flexible manner to meet market requirements (Freeport-McMoRan Copper & Gold Inc., 2013a, p. 17).

In early 2012, Win-Eldrich Mines Ltd. decided to phase out the molybdenum mining operations at its Ashdown Mine in northern Nevada, and return to mining only gold.

Thompson Creek Metals Co. Inc. (TCMC) owns the Thompson Creek open pit molybdenum mine and mill near Challis, ID, a metallurgical roasting facility in Langeloth, PA, and a 75% joint-venture interest in the Endako open pit mine, mill, and roasting facility in northern British Columbia, Canada. The molybdenum concentrate produced at the Thompson Creek Mine is transported to the Langeloth facility, which produces ferromolybdenum products, molybdenum trioxide, and other specialty products. The Langeloth facility also processes nonmolybdenum catalysts for various customers, primarily in the food industry. TCMC has two high-grade underground molybdenum deposits, the Davidson deposit near Smithers, British Columbia, Canada, and the Mount Emmons deposit near Crested Butte, CO (Thompson Creek Metals Co. Inc., 2012, p. 25).

TCMC announced that its Thompson Creek Mine produced 7,370 t of molybdenum in 2012, a 24% decrease from the 9,690 t of molybdenum produced in 2011. During the first half of 2011, because of the planned mine pit sequencing, the Thompson Creek Mine was mining high-grade ore primarily in the bottom of the pit. Beginning in the third quarter of 2011, the

Thompson Creek Mine transitioned from the bottom to the top of the pit. As a result, production was primarily lower, owing to the significantly lower ore grade. Additionally, production in the second and third quarter of 2012 was negatively affected by a pit wall slough in May 2012 (Thompson Creek Metals Co. Inc., 2013, p. 54).

Molybdenum was produced as a byproduct of copper production at the Bagdad, Mineral Park, Morenci, and Sierrita Mines in Arizona; the Continental Pit Mine in Montana; the Robinson Mine in Nevada; the Chino Mine in New Mexico; and the Bingham Canyon Mine in Utah (table 2). The Mission and Pinto Valley Mines in Arizona did not produce molybdenum in 2012. In the case of byproduct molybdenum recovery at a copper mine, all mining costs associated with producing molybdenum concentrate are allocated to the primary metal (copper). In 2012, byproduct molybdenite recovery accounted for approximately 53% of the U.S. molybdenum supply.

The Bagdad operation of FCX includes a 75,000-t/d concentrator that produces copper and molybdenum concentrates, as well as a pressure-leach plant that processes molybdenum concentrate (Freeport-McMoRan Copper & Gold Inc., 2012, p. 9).

The Sierrita operation of FCX includes a 102,000-t/d concentrator that produces copper and molybdenum concentrates. It also has molybdenum facilities consisting of a leaching circuit, two molybdenum roasters, and a packaging facility. The molybdenum facilities process concentrate from Sierrita, from other FCX mines, and from third-party sources. Molybdenum production at Sierrita in 2012 was 9,530 t, an 8% decrease compared with 10,400 t of molybdenum produced in 2011 (Freeport-McMoRan Copper & Gold Inc., 2013b, p. 10).

FCX's Chino Mine is an open pit copper-mining complex located in southwestern New Mexico's Grant County. The Chino operation consists of a 39,000-t/d concentrator that produces copper and molybdenum concentrates. During 2011, FCX restarted mining and milling activities at the Chino Mine, which were suspended in late 2008. Chino produced approximately 900 t of molybdenum in 2012 (Freeport-McMoRan Copper & Gold Inc., 2013b, p. 12).

Rio Tinto plc (London, United Kingdom) reported that molybdenum concentrate production at its Bingham Canyon Mine (operated by Kennecott Utah Copper Corp.) was 9,400 t in 2012, compared with 13,600 t in 2011 (Rio Tinto plc, 2013, p. 49). In June, Rio Tinto announced it would invest \$660 million during the next 7 years to extend the life of the Bingham Canyon Mine from 2018 to 2029. The investment would enable production of approximately 13,800 t/yr of molybdenum (Rio Tinto plc, 2013, p. 24).

Rio Tinto announced that its Molybdenum Autoclave Process (MAP) plant at Bingham Canyon was expected to come onstream by the middle of 2014. MAP would allow lower-grade molybdenum concentrate to be processed more efficiently than through conventional roasters, allow improved molybdenum recovery and operating flexibility, and enable production of metallurgical and higher chemical grade molybdenum products. MAP would produce chemical grade MoX, ammonium dimolybdate, autoclaved molybdenum concentrate, and catalyst grade ammonium perrhenate (Kennecott Utah Copper Corp.,

2010). Chemical grade molybdenum is primarily used in catalysts for oil refineries to remove sulfur from oil. The capital cost for the MAP plant was estimated to be \$600 million. As of January 1, 2013, Rio Tinto announced that \$200 million remained to be spent on the plant (Ryan's Notes, 2013).

General Moly Inc. (Lakewood, CO) began preliminary construction activities at the Mt. Hope molybdenum project in Eureka County, NV. Ames Construction Inc. cleared areas for the administrative office, mill site, and water pipeline corridor in preparation for developing a well field and water distribution system to support heavy construction activities, scheduled to start in the spring of 2013. According to the company, Mt. Hope contains 590,000 t of molybdenum in proven and probable reserves and has an expected mine life of more than 40 years (General Moly Inc., 2013).

Mercator Minerals Ltd. announced that it expected to produce between 5,000 and 5,400 t/yr of molybdenum in 2013 at its Mineral Park Mine, an increase from the 4,700 t of molybdenum produced in 2012. The Mineral Park Mine is located in northwestern Arizona, 120 kilometers (km) from Las Vegas, NV (Mercator Minerals Ltd., 2013).

Grupo Mexico S.A.B. de C.V. (GMexico) announced that refurbishment work was in progress for the reopening of the molybdenum plant at its Mission Mine. Once completed, it was expected to have a production capacity of 544 t/yr of molybdenum and to start operations in the second quarter of 2013 (Grupo Mexico S.A.B. de C.V., 2013, p. 9).

## Consumption

In 2012, U.S. reported consumption of molybdenum contained in concentrate for roasting decreased compared with that of 2011. Domestic mine production of molybdenum concentrate was roasted, exported for conversion, or purified to lubricant-grade molybdenum disulfide (MoS<sub>2</sub>). Technical-grade MoX consumption, not including superalloy use, was slightly less in 2012 from that of 2011. MoX was the leading form of molybdenum used by industry, particularly in making stainless steel. Superalloy industry consumption decreased by 19% in 2012 from that of 2011. Overall, total molybdenum use in steel in 2012 decreased from that of 2011 (table 3).

Metallurgical applications dominated molybdenum use in 2012, accounting for about 88% of 2012 grand total reported consumption. In 2012, FeMo accounted for 39% of the molybdenum-bearing materials used to make steel (not including tool steel) (table 3). Nonmetallurgical applications included catalysts, chemicals, lubricants, and pigments. The dominant nonmetallurgical use was in catalysts, principally catalysts related to petroleum refining.

Molybdenum was playing a more important role in green technology than ever before, with use focused on biofuels, catalysts, ethanol, solar panels, and wind power.

## Stocks

At yearend 2012, producer plus consumer industry stocks decreased compared with yearend 2011 stocks. Inventories of molybdenum in concentrate at mines and plants decreased (table 1). Stocks of molybdenum in FeMo, molybdates, MoX,

metal powders, and other products decreased compared with stocks of 2011 (table 3).

## Prices

In 2012, the annual average price for domestic FeMo, as published in Ryan's Notes, ranged from \$14.582 to \$14.851 per pound of molybdenum content, compared with \$17.489 to \$17.828 per pound reported in 2011. The Ryan's Notes published annual average price for domestic MoX ranged from \$12.630 to \$12.854 per pound in 2012, compared with \$15.367 to \$15.598 per pound in 2011.

## Foreign Trade

In 2012, molybdenum-containing material exports (excluding molybdenum ore and concentrates) collectively were about 6,400 t (gross weight) valued at \$202 million (table 6). Imports for consumption of all molybdenum-containing products collectively were about 32,900 t (gross weight) valued at \$570 million (table 9).

## World Review

World molybdenum reserves and production capacity were concentrated in a few countries. In 2012, world mine output was estimated to have been 259,000 t (molybdenum contained in concentrate), of which, in descending order of production, China, the United States, Chile, Peru, Mexico, and Canada provided about 91% (table 10).

In North America, most Canadian reserves of molybdenum were contained in porphyry molybdenum and porphyry copper-molybdenum deposits in British Columbia. Other Canadian reserves were associated with minor porphyry copper-molybdenum deposits in New Brunswick and Quebec. The La Caridad porphyry copper-molybdenum deposit in Mexico was a leading producer. Molybdenum reserves in Central America and South America were associated mainly with large porphyry copper deposits. Of several such deposits in Chile, the Chuquicamata and El Teniente deposits were among the largest in the world and accounted for 85% of molybdenum reserves in Chile. Peru also had substantial reserves. Reserves of molybdenum in China and the Commonwealth of Independent States (CIS) were thought to be substantial, but definitive information about the current sources of supply or prospects for future development in these two areas was lacking.

According to the International Molybdenum Association (IMO), global molybdenum consumption was 236,300 t in 2012, compared with a record high of 236,800 t in 2011. The leading consumer of molybdenum in 2012 was China, where consumption increased from 80,600 t in 2011 to 83,100 t in 2012. Europe had the second largest share with 63,400 t in 2012, a decrease compared with 67,500 t in 2011 (International Molybdenum Association, 2013).

In 2011, IMO, assisted by the Steel & Metals Market Research Co. (Austria), completed a detailed analysis of molybdenum end uses. According to the study, in 2009, global molybdenum consumption in all applications was 212,000 t, which included new and recycled molybdenum. Most recycled molybdenum is introduced via scrap in steelmaking. The

study's analysis was based on more than 250 interviews with key molybdenum end users. For all applications, approximately 15% of molybdenum input material originated from scrap. Molybdenum was consumed in the following end uses—engineering steels (34%), stainless steels (26%), chemical products (13%), tool and high-speed steels (10%), cast iron (7%), superalloys (5%), and molybdenum metal (5%) (International Molybdenum Association, 2011, p. 2).

**Canada.**—TCMC announced that its 75%-owned Endako Mine produced 2,810 t of molybdenum in 2012 compared with 3,160 t of molybdenum in 2011. The Endako operation is an open pit molybdenum mine, concentrator, and roaster 190 km west of Prince George, British Columbia, with an estimated mine life of approximately 16 years. In March, the mill expansion project was completed. The project included construction of a new mill to replace the previous mill constructed in the 1960s. The new mill was designed to process 55,000 t/d of ore compared with 31,000 t/d at the old mill. The old mill at the site was shut down and was in care-and-maintenance mode (Thompson Creek Metals Co. Inc., 2013, p. 15–16).

Taseko Mines Ltd. produced 598 t of molybdenum in 2012, a slight increase from the 590 t of molybdenum produced in 2011 at its Gibraltar Mine in south-central British Columbia. The new concentrator and molybdenum recovery facility underwent wet commissioning in December 2012. The facility was on schedule to reach startup production levels during the first quarter of 2013 (Taseko Mines Ltd., 2013, p. 4–5).

**Chile.**—Corporación Nacional del Cobre de Chile (Codelco), the state-controlled copper and molybdenum producer, planned to build a molybdenum processing plant in northern Chile. The company was expected to spend \$400 million and begin construction in 2015 (Ryan's Notes, 2012b). Codelco produced approximately 20,000 t of molybdenum in 2012 (Metal-Pages, 2013b).

The Sierra Gorda project is a joint venture between KGHM International Ltd., Sumitomo Metal Mining Co., Ltd., and Sumitomo Corp. in the Antofagasta region in northern Chile. Preliminary construction and prestripping commenced at the project in preparation for production in 2014. Estimated production from current reserves was approximately 11,300 t/yr of molybdenum (KGHM International Ltd., undated).

Amerigo Resources Ltd. produced a record 479 t of molybdenum in 2012, compared with 314 t in 2011, at its Minera Valle Central plant. The company expected to produce approximately 450 t of molybdenum in 2013 (Amerigo Resources Ltd., 2013). The plant extracts copper from tailings discharged from CODELCO's El Teniente concentrators. The tailings are then returned to El Teniente's tailings disposal system.

Antofagasta plc announced that 2012 molybdenum production at its Los Pelambres Mine was 12,200 t, a 23% increase compared with 9,900 t of molybdenum produced in 2011. The increase was mainly owing to better ore grades. Los Pelambres is in Chile's Coquimbo Region, 240 km northeast of Santiago (Metal-Pages, 2013a).

**China.**—In line with the 12th Five-Year Plan, the Ministry of Land and Resources reclassified molybdenum as a national resource in March 2012 (Roskill Information Services Ltd.,

2012, p. 93). In July, the Chinese Government announced its final version of “industry access rules” for all molybdenum projects in its plan to facilitate the restructuring of the industry, to protect the environment, and to provide standardized rules for investing in any molybdenum project. The rules specified that any open pit mine processing less than 25,000 t/d of ore would not be approved, and that existing mines with a production capacity of less than 15,000 t/d would gradually be shut down. Any new molybdenum oxide plants and expansions with a capacity less than 20,000 t/d would not be permitted. The Government also stated that it would not approve any new projects that involved only FeMo production. Any new project or expansions for ammonium molybdate capacity less than 5,000 t/yr also would not be permitted, and existing producers with capacity under 3,000 t/yr would be closed (Ryan’s Notes, 2012a).

Zhongxi Mining Co. Ltd. started up a molybdenum plant in Inner Mongolia in September. The plant has the capacity to produce 12,000 t/yr of molybdenum concentrate and 6,000 t/yr of molybdenum metal (Ryan’s Notes, 2012c).

**Kazakhstan.**—Kazakhmys plc announced that main construction had commenced at its Bozshakol project in northern Kazakhstan. Bozshakol was expected to have an average output of 75,000 t/yr of copper concentrate during a mine life of 40 years. Bozshakol has indicated and inferred resources of 57,000 t of contained molybdenum at 0.004% Mo. The capital cost for the project was approximately \$1.9 billion, funded from a \$2.7 billion financing facility provided by the China Development Bank and Samruk-Kazyna, the National Welfare Fund in Kazakhstan. Production was expected to begin in 2015 (Kazakhmys plc, 2012).

**Mexico.**—GMexico reported that its Caridad Mine produced a record 10,968 t of molybdenum in 2012 (Grupo Mexico S.A.B. de C.V., 2013, p. 2). Construction continued on the molybdenum processing plant at GMexico’s Buenavista del Cobre Mine in Cananea, Sonora. The plant was expected to produce 2,000 t/yr of molybdenum and cost approximately \$38 million (Grupo Mexico S.A.B. de C.V., 2013, p. 8).

**Peru.**—The Cerro Verde Mine of FCX is an open pit copper and molybdenum mining complex 16 km southwest of Arequipa. In 2012, the operation consisted of an open pit copper mine, a 120,000-t/d concentrator, and leaching facilities. Cerro Verde was engaged in a large-scale expansion project, which would expand its concentrator facilities from 120,000 t/d of ore to 360,000 t/d of ore and would have the capacity to produce 6,800 t/yr of molybdenum beginning in 2016. Construction was expected to commence in 2013. In 2012, molybdenum production at Cerro Verde was approximately 3,630 t of molybdenum compared with 4,540 t of molybdenum produced in 2011 (Freeport-McMoRan Copper & Gold Inc., 2013a, p. 37–38).

## Outlook

The principal uses for molybdenum were expected to continue to be in chemicals and catalysts 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 essential 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 hydrodesulfurisation of petroleum, petrochemicals, and coal-derived liquids. Production of ultra-low-sulfur diesel fuels was expected to more than double the amount of molybdenum used in oil refineries. Molybdenum not only allows for economical fuel refining, it also contributes to a safer environment through lower sulfur emissions. With no practical alternatives to molybdenum in many of its catalytic applications, analysts expect global demand for catalysts to increase by more than 5% annually until 2016, resulting in a market for new molybdenum of approximately 20,000 t/yr (Roskill Information Services Ltd., 2012, p. 305). 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.

Primary molybdenum mines were the first to respond to the recovery in demand in 2010, but in 2011 and 2012, byproduct molybdenum mines outpaced production growth from primary mines. In 2013, mine capacity was expected to be sufficient to meet demand. Approximately 60 new projects and expansions could potentially produce molybdenum, yielding an additional 240,000 t/yr of molybdenum (Roskill Information Services Ltd., 2012, p. 321). In the past, insufficient roasting capacity has resulted in a bottleneck, but additional roasting capacity has been installed and further expansions are under construction in Chile, China, and the United States.

During the past decade, molybdenum consumption has shown a strong annual average growth rate, primarily fueled by rapid increases in China’s industrial growth. Molybdenum consumption continues to be heavily dependent on the steel industry. As emerging economies, such as China and India, continue on the path to industrialization, they are expected to need increasing amounts of molybdenum, and this trend is expected to contribute to global demand growth in the coming years (Virga and Horn, 2009). Roskill Information Services Ltd. (2012, p. 300) reported that global consumption for molybdenum was expected to increase at an average of 4.6% through 2016. The principal areas of molybdenum growth were expected to continue to be in the use of stainless and other steels containing molybdenum in aero engine components, chemical and petrochemical processing plants, power and desalination plants, motor vehicle components, nuclear power plants, and in wind power generation components.

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

(Metric tons of contained molybdenum)

	2008	2009	2010	2011	2012
United States:					
Concentrate:					
Production	55,900	47,800	59,400	63,700	60,400
Shipments	57,800	63,700	59,400	62,800	60,200
Reported consumption <sup>2</sup>	44,500	W	W	W	W
Imports for consumption	10,200	7,520	12,900	14,600	12,000
Stocks, December 31:					
Concentrate, mine and plant	1,690	2,550	2,200	3,520 <sup>f</sup>	W
Product producers <sup>3</sup>	3,680	3,660	W	W	W
Consumers	1,620	1,540	1,630	1,810	1,780
Total	6,990	7,750	3,820	5,330 <sup>f</sup>	1,780
Primary products:					
Production	72,900	59,900	68,600	W	W
Shipments	51,300	43,300	51,100	W	W
Reported consumption	21,100	17,700	19,200	19,100 <sup>f</sup>	19,700
Imports for consumption	4,290	3,870	6,780	6,450	7,830
World, mine production	221,000 <sup>f</sup>	223,000 <sup>f</sup>	247,000 <sup>f</sup>	264,000 <sup>f</sup>	259,000 <sup>e</sup>

<sup>e</sup>Estimated. <sup>f</sup>Revised. W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Molybdenum concentrates roasted to make molybdenum oxide.

<sup>3</sup>Includes 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 2012

State and mine	County	Operator	Source of molybdenum
Arizona:			
Bagdad	Yavapai	Freeport-McMoRan Copper & Gold Inc.	Copper-molybdenum ore, concentrated.
Mineral Park	Mohave	Mercator Minerals Ltd.	Do.
Morenci	Greenlee	Freeport-McMoRan Copper & Gold Inc.	Do.
Sierrita	Pima	do.	Do.
Colorado:			
Climax	Lake	do.	Molybdenum ore, concentrated.
Henderson	Clear Creek	do	Do.
Idaho, Thompson Creek	Custer	Thompson Creek Metals Co. Inc.	Do.
Montana, Continental Pit	Silver Bow	Montana Resources	Copper-molybdenum ore, concentrated.
Nevada:			
Ashdown	Humboldt	Win-Eldrich Mines Ltd.	Molybdenum ore, concentrated.
Robinson	White Pine	KGHM International Ltd. <sup>1</sup>	Copper-molybdenum ore, concentrated.
New Mexico:			
Chino	Grant	Freeport-McMoRan Copper & Gold Inc.	Do.
Questa	Taos	Chevron Mining	Molybdenum ore, concentrated.
Utah, Bingham Canyon	Salt Lake	Kennecott Utah Copper Corp. <sup>2</sup>	Copper-molybdenum ore, concentrated.
Do., do. Ditto.			

<sup>1</sup>The Robinson Mine was formerly owned by Quadra FNX Mining Ltd., which was purchased by KGHM Polska Miedz S.A. on March 5, 2012, and renamed KGHM International Ltd.

<sup>2</sup>Wholly owned subsidiary of Rio Tinto plc.

TABLE 3  
U.S. REPORTED CONSUMPTION, BY END USES, AND CONSUMER STOCKS OF MOLYBDENUM MATERIALS<sup>1</sup>

(Kilograms of contained molybdenum)

End use	Molybdic oxides	Ferromolybdenum <sup>2</sup>	Ammonium and sodium molybdate	Molybdenum scrap	Other	Total
<b>2011:</b>						
<b>Steel:</b>						
Carbon	445,000	310,000	--	--	W	755,000
High-strength low-alloy	737,000	123,000 <sup>r</sup>	--	--	--	860,000 <sup>r</sup>
Stainless and heat-resisting	2,050,000 <sup>r</sup>	714,000 <sup>r</sup>	--	(3)	131,000 <sup>r</sup>	2,890,000 <sup>r</sup>
Full alloy	3,580,000	3,760,000 <sup>r</sup>	--	--	W	7,340,000 <sup>r</sup>
Tool	607,000	W	--	(3)	--	607,000
Total	7,410,000 <sup>r</sup>	4,910,000 <sup>r</sup>	--	--	131,000 <sup>r</sup>	12,500,000
Cast irons (gray, malleable, ductile iron)	W	342,000	--	--	W	342,000 <sup>r</sup>
Superalloys	(4)	(4)	--	(4)	1,350,000 <sup>r</sup>	1,350,000 <sup>r</sup>
<b>Alloys (other than steels, cast irons, superalloys):</b>						
Welding materials (structural and hard-facing)	--	41,500	--	--	W	41,500
Other alloys	1,300	112,000 <sup>r</sup>	--	--	W	113,000 <sup>r</sup>
Mill products made from metal powder <sup>5</sup>	W	--	--	--	W	W
Cemented carbides and related products <sup>6</sup>	--	--	--	--	77	77
<b>Chemical and ceramic uses:</b>						
Pigments	W	--	10,600	--	--	10,600
Catalysts	941,000	--	(3)	--	W	941,000
Other	--	--	--	--	W	W
<b>Miscellaneous and unspecified uses:</b>						
Lubricants	--	--	--	--	219,000	219,000
Other	43,400	92,800	(3)	--	3,520,000 <sup>r</sup>	3,660,000 <sup>r</sup>
Grand total	8,400,000 <sup>r</sup>	5,500,000 <sup>r</sup>	10,600	--	5,220,000 <sup>r</sup>	19,100,000 <sup>r</sup>
Stocks, December 31	552,000 <sup>r</sup>	342,000 <sup>r</sup>	3,500	(7)	(7)	1,810,000 <sup>r</sup>
<b>2012:</b>						
<b>Steel:</b>						
Carbon	450,000	283,000	--	--	W	732,000
High-strength low-alloy	652,000	123,000	--	--	--	775,000
Stainless and heat-resisting	1,970,000	684,000	--	(3)	131,000	2,780,000
Full alloy	3,240,000	3,350,000	--	--	W	6,600,000
Tool	607,000	W	--	(3)	--	607,000
Total	6,920,000	4,440,000	--	--	131,000	11,500,000
Cast irons (gray, malleable, ductile iron)	W	345,000	--	--	W	345,000
Superalloys	(4)	(4)	--	(4)	1,610,000	1,610,000
<b>Alloys (other than steels, cast irons, superalloys):</b>						
Welding materials (structural and hard-facing)	--	41,500	--	--	W	41,500
Other alloys	2,130	92,500	--	--	W	94,600
Mill products made from metal powder <sup>5</sup>	W	--	--	--	W	W
Cemented carbides and related products <sup>6</sup>	--	--	--	--	77	77
<b>Chemical and ceramic uses:</b>						
Pigments	W	--	4,890	--	--	4,890
Catalysts	941,000	--	(3)	--	W	941,000
Other	--	--	--	--	W	W
<b>Miscellaneous and unspecified uses:</b>						
Lubricants	--	--	--	--	208,000	208,000
Other	44,600	84,100	(3)	--	3,520,000	3,650,000
Grand total	7,910,000	5,000,000	4,890	--	5,480,000	18,400,000
Stocks, December 31	540,000	331,000	4,200	(7)	(7)	1,780,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included in "Other" of the "Miscellaneous and unspecified uses" category. -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes calcium molybdate.



TABLE 3—Continued  
U.S. REPORTED CONSUMPTION, BY END USES, AND CONSUMER STOCKS OF MOLYBDENUM MATERIALS<sup>1</sup>

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<sup>3</sup>Withheld to avoid disclosing company proprietary data; included in "Miscellaneous and unspecified uses: Other" of the "Other" category.

<sup>4</sup>Withheld to avoid disclosing company proprietary data.

<sup>5</sup>Includes ingot, wire, rod, and sheet.

<sup>6</sup>Includes construction, mining, oil and gas, and metal working machinery.

<sup>7</sup>Withheld to avoid disclosing company proprietary data; included in "Total."

TABLE 4  
U.S. EXPORTS OF MOLYBDENUM PRODUCTS, BY PRODUCT AND COUNTRY<sup>1</sup>

Product and country	HTS <sup>2</sup> code	2011		2012	
		Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Oxides and hydroxides, gross weight: <sup>3</sup>	2825.70.0000				
Austria		34	\$1,420	54	\$1,420
Brazil		8	246	24	533
Canada		2,330	29,800	153	2,270
Japan		892	22,200	752	16,900
Kuwait		12	84	18	383
Mexico		106	2,740	102	2,010
Netherlands		1,140	28,500	130	3,110
Peru		--	--	18	374
Russia		164	3,750	179	4,220
Turkey		80	2,040	120	2,320
Other (13 countries)		69 <sup>r</sup>	1,700 <sup>r</sup>	38	1,320
Total		4,840	92,400	1,590	34,900
Molybdates, all, gross weight: <sup>4</sup>	2841.70.0000				
Canada		244	3,470	341	4,930
Japan		236	5,390	110	2,000
Mexico		104	1,530	200	2,420
Netherlands		1,090	19,000	493	7,220
United Kingdom		15	456	162	1,830
Other (31 countries)		314 <sup>r</sup>	5,790 <sup>r</sup>	219	3,940
Total		2,010	35,600	1,530	22,300
Ferromolybdenum, contained weight: <sup>4,5</sup>	7202.70.0000				
Argentina		--	--	26	795
Canada		871	30,200	677	23,200
Mexico		48	1,720	188	5,620
Netherlands		293	10,500	77	2,580
Saudi Arabia		--	--	26	814
Other (5 countries)		117 <sup>r</sup>	4,670 <sup>r</sup>	2	76
Total		1,330	47,100	996	33,100
Molybdenum, other, gross weight: <sup>3,6</sup>	Various <sup>7</sup>				
Austria		323	18,800	202	8,160
Canada		69	3,660	70	3,880
China		25	2,610	39	2,750
Germany		215	16,300	69	4,070
Israel		84	6,570	69	5,370
Japan		206	12,400	179	11,300
Korea, Republic of		744	32,200	429	34,900
Mexico		87	6,080	92	6,250
Taiwan		77	4,790	121	8,010
United Kingdom		887	21,800	337	10,600
Other (47 countries)		249 <sup>r</sup>	18,700 <sup>r</sup>	240	16,200
Total		2,970	144,000	1,850	112,000

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

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Harmonized Tariff Schedule (HTS) of the United States.

<sup>3</sup>Presentation of annual data is based on the quantities (gross weight) of the 10 leading countries in 2012.

<sup>4</sup>Presentation of annual data is based on the quantities (gross weight) of the five leading countries in 2012.

<sup>5</sup>Ferromolybdenum contains about 60% to 65% molybdenum.

<sup>6</sup>Includes powder, unwrought, waste and scrap, wire, wrought, and other.

<sup>7</sup>Includes 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 OTHER CONCENTRATES), BY COUNTRY<sup>1,2</sup>

Country	2011		2012	
	Quantity (metric tons of contained Mo)	Value (thousands)	Quantity (metric tons of contained Mo)	Value (thousands)
Belgium	6,620	\$220,000	6,190	\$169,000
Canada	1,400	52,000	2,220	54,900
China	2,580	90,000	2,130	62,300
India	901	30,800	660	18,200
Japan	4,150	135,000	3,780	104,000
Korea, Republic of	1,460	48,200	420	12,300
Mexico	7,270	108,000	7,590	136,000
Netherlands	11,500	375,000	13,000	353,000
South Africa	--	--	382	6,670
United Kingdom	6,210	216,000	6,450	184,000
Other (23 countries)	4,990 <sup>r</sup>	171,000 <sup>r</sup>	695	19,100
Total	47,100	1,450,000	43,500	1,120,000

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

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Presentation of annual data is based on the quantities (gross weight) of the 10 leading countries in 2012.

Source: U.S. Census Bureau.

TABLE 6  
U.S. EXPORTS OF MOLYBDENUM PRODUCTS<sup>1</sup>

Item	HTS <sup>2</sup> code	2011			2012		
		Gross weight (metric tons)	Contained Mo (metric tons)	Value (thousands)	Gross weight (metric tons)	Contained Mo (metric tons)	Value (thousands)
Molybdenum ore and concentrates, roasted	2613.10.0000	NA	21,300	\$725,000	NA	21,000	\$580,000
Molybdenum ore and concentrates, other	2613.90.0000	NA	25,800	721,000	NA	22,500	539,000
Molybdenum chemicals:							
Oxides and hydroxides	2825.70.0000	4,840	NA	92,400	1,590	NA	34,900
Molybdates, all	2841.70.0000	2,010	NA	35,600	1,530	NA	22,300
Ferromolybdenum	7202.70.0000	1,950	1,330	47,100	1,440	996	33,100
Molybdenum powders	8102.10.0000	625	NA	28,000	533	NA	22,700
Molybdenum unwrought, bars and rods	8102.94.0000	667	NA	24,100	291	NA	10,100
Molybdenum waste and scrap	8102.97.0000	810	NA	15,700	223	NA	4,150
Molybdenum wire	8102.96.0000	130	NA	11,500	120	NA	10,200
Molybdenum, other	Various <sup>3</sup>	733	NA	64,700	680	NA	64,400
Total		XX	XX	1,760,000	XX	XX	1,320,000

NA Not available. XX Not applicable.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Harmonized Tariff Schedule (HTS) of the United States.

<sup>3</sup>Includes HTS codes 8102.95.0000 and 8102.99.0000.

Source: U.S. Census Bureau.

TABLE 7  
U.S. IMPORTS OF MOLYBDENUM PRODUCTS, BY PRODUCT AND COUNTRY<sup>1</sup>

Product and country	HTS <sup>2</sup> code	2011		2012	
		Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Oxides and hydroxides, gross weight: <sup>3</sup>	2825.70.0000				
Chile		146	\$3,800	303	\$6,080
China		1	15	178	3,570
Germany		--	--	20	322
Japan		--	--	12	253
Mexico		--	--	18	345
Other (2 countries)		(4) <sup>r</sup>	8 <sup>r</sup>	1	12
Total		147	3,820	532	10,600
Molybdates, all, contained weight: <sup>3</sup>	Various <sup>5</sup>				
Belgium		1	173	8	467
Chile		420	15,800	282	9,260
China		117	4,560	184	5,770
India		(4)	14	1	77
Japan		7	854	2	66
Other (4 countries)		(4) <sup>r</sup>	1,120 <sup>r</sup>	(4)	17
Total		545	22,500	477	15,700
Molybdenum orange, gross weight: <sup>3</sup>	3206.20.0020				
Canada		237	2,230	225	2,180
China		4	27	4	28
Colombia		65	386	108	618
Germany		3	29	18	83
Mexico		19	112	--	--
Other (4 countries)		(4)	11	--	--
Total		328	2,790	355	2,910
Ferromolybdenum, contained weight: <sup>3,6</sup>	7202.70.0000				
Canada		227	9,580	387	13,000
Chile		2,600	97,200	3,680	117,000
Japan		12	792	16	1,140
Korea, Republic of		--	--	55	1,850
United Kingdom		285	8,140	145	3,600
Other (7 countries)		88 <sup>r</sup>	3,310 <sup>r</sup>	36	1,240
Total		3,210	119,000	4,320	138,000
Other, gross weight: <sup>7</sup>	Various <sup>8</sup>				
Austria		327	27,700	297	16,900
Canada		348	12,600	622	17,600
Chile		--	--	20	351
China		1,400	64,500	1,340	53,000
Germany		202	9,330	150	8,060
Hong Kong		38	1,670	40	1,540
Japan		41	1,680	40	1,590
Mexico		12	73	45	129
Thailand		20	388	40	794
United Kingdom		49	2,200	21	924
Other (22 countries)		83 <sup>r</sup>	8,140 <sup>r</sup>	37	3,340
Total		2,520	128,000	2,650	104,000

<sup>1</sup>Revised. -- Zero.

<sup>2</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>3</sup>Harmonized Tariff Schedule of the United States.

<sup>4</sup>Presentation of annual data based on the quantities (gross weight) of the five leading countries in 2012.

<sup>5</sup>Less than ½ unit.

<sup>6</sup>Includes HTS codes 2841.70.1000 and 2841.70.5000.

<sup>7</sup>Ferromolybdenum contains about 60% to 65% molybdenum.

TABLE 7—Continued  
 U.S. IMPORTS OF MOLYBDENUM PRODUCTS, BY PRODUCT AND COUNTRY<sup>1</sup>

<sup>7</sup>Presentation of annual data based on the quantities (gross weight) of the 10 leading countries in 2012.

<sup>8</sup>Includes HTS codes 8102.10.0000, 8102.94.0000, 8102.95.3000, 8102.95.6000, 8102.96.0000, 8102.97.0000, and 8102.99.0000.

Source: U.S. Census Bureau.

TABLE 8  
 U.S. IMPORTS OF MOLYBDENUM ORE AND CONCENTRATES (INCLUDING  
 ROASTED AND OTHER CONCENTRATES), BY COUNTRY<sup>1</sup>

Country	2011		2012	
	Quantity (metric tons of contained Mo)	Value (thousands)	Quantity (metric tons of contained Mo)	Value (thousands)
Argentina	99	\$3,090	--	--
Canada	1,420	47,000	2,600	\$71,000
Chile	3,840	133,000	3,000	85,200
China	--	--	(2)	6
Kazakhstan	117	4,170	--	--
Mexico	5,290	74,300	4,440	48,600
Peru	3,880	198,000	1,950	94,000
South Africa	--	--	5	112
Sweden	--	--	(2)	8
United Kingdom	--	--	(2)	5
Total	14,700	460,000	12,000	299,000

-- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9  
U.S. IMPORTS FOR CONSUMPTION OF MOLYBDENUM PRODUCTS<sup>1</sup>

Item	HTS <sup>2</sup> code	2011			2012		
		Gross weight (metric tons)	Contained Mo (metric tons)	Value (thousands)	Gross weight (metric tons)	Contained Mo (metric tons)	Value (thousands)
Molybdenum ore and concentrates, roasted	2613.10.0000	11,700	7,080	\$136,000	10,100	6,170	\$100,000
Molybdenum ore and concentrates, other	2613.90.0000	18,700	7,570	323,000	11,900	5,810	199,000
Molybdenum chemicals:							
Oxides and hydroxides	2825.70.0000	146	NA	3,820	532	NA	10,600
Molybdates, all	Various <sup>3</sup>	1,000	588	22,500	854	476	15,700
Molybdenum orange	3206.20.0020	328	NA	2,790	355	NA	2,910
Ferromolybdenum	7202.70.0000	4,810	3,210	119,000	6,450	4,320	138,000
Molybdenum powders	8102.10.0000	281	264	13,600	408	362	16,700
Molybdenum unwrought, bars and rods	8102.94.0000	566	545	20,800	744	726	21,800
Molybdenum waste and scrap	8102.97.0000	748	700	27,400	971	925	31,400
Molybdenum wire	8102.96.0000	21	NA	3,230	20	NA	2,760
Molybdenum, other	Various <sup>4</sup>	903	NA	63,200	507	NA	31,700
Total		39,200	XX	736,000	32,900	XX	570,000

NA Not available. XX Not applicable.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Harmonized Tariff Schedule (HTS) of the United States.

<sup>3</sup>Includes HTS codes 2841.70.1000 and 2841.70.5000.

<sup>4</sup>Includes 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<sup>1,2</sup>

(Metric tons of contained molybdenum)

Country <sup>3</sup>	2008	2009	2010	2011	2012 <sup>e</sup>
Armenia	4,472	4,365	4,335	4,817 <sup>r</sup>	4,900
Canada	8,602	8,721 <sup>r</sup>	8,648 <sup>r</sup>	8,326 <sup>r</sup>	9,005 <sup>p,4</sup>
Chile	33,687	34,925	37,186	40,889	35,090 <sup>4</sup>
China <sup>e</sup>	81,000	93,500	96,600	103,000 <sup>r</sup>	104,000
Iran <sup>e</sup>	6,597 <sup>r,4</sup>	4,447 <sup>r,4</sup>	7,000 <sup>r</sup>	7,000 <sup>r</sup>	6,300
Kyrgyzstan	NA <sup>r</sup>	NA <sup>r</sup>	NA <sup>r</sup>	NA <sup>r</sup>	NA
Mexico	7,811 <sup>r</sup>	10,166 <sup>r</sup>	10,849	10,787 <sup>r</sup>	11,000
Mongolia	1,780 <sup>r</sup>	2,140 <sup>r</sup>	2,198	1,960 <sup>r</sup>	1,903 <sup>4</sup>
Peru	16,721	12,297	16,963	19,141	16,790 <sup>4</sup>
Russia <sup>e</sup>	3,600	3,800	3,800	3,900	3,900
Turkey	25	--	--	-- <sup>r</sup>	5,000
United States	55,900	47,800	59,400	63,700	60,400 <sup>4</sup>
Uzbekistan <sup>e</sup>	500	500 <sup>r</sup>	500 <sup>r</sup>	550	550
Total	221,000 <sup>r</sup>	223,000 <sup>r</sup>	247,000 <sup>r</sup>	264,000 <sup>r</sup>	259,000

<sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised. NA Not available. -- Zero.

<sup>1</sup>World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Table includes data available through January 13, 2014.

<sup>3</sup>In addition to the countries listed, the Republic of Korea and Romania are thought to produce molybdenum, but output is not reported quantitatively, and available general information is inadequate to make reliable estimates of output levels.

<sup>4</sup>Reported figure.

