



2015 Minerals Yearbook

TUNGSTEN [ADVANCE RELEASE]

TUNGSTEN

By Kim B. Shedd

Domestic survey data and tables were prepared by Annie Hwang, statistical assistant, and the world production table was prepared by Lisa D. Miller,¹ international data coordinator.

In 2015, the tungsten market was in oversupply, owing to an economic slowdown in China and weak economic conditions elsewhere, which ultimately led to supply (mine production plus recycled scrap) exceeding consumption. World production of tungsten in concentrate increased for the sixth consecutive year to a record high of 89,400 metric tons (t). The increase was primarily because of increased production from China and Vietnam (table 15). Throughout the year, tungsten prices in Europe, China, and the United States continued to trend downward from recent highs in 2013 and 2014. By yearend, prices were at or near 10-year historic lows (Almonty Industries Inc., 2016, p. 4). As a result of these and other factors, in late 2015, the sole tungsten mine in Canada suspended operations and was placed on care-and-maintenance status, eight major producers in China announced plans to reduce their output of tungsten concentrates, and China's State Reserve Bureau planned to buy tungsten concentrates.

Domestically, one tungsten mine produced and shipped ore concentrates. Most of the U.S. supply of tungsten raw materials comprised imports and scrap; no tungsten was shipped from the National Defense Stockpile (NDS) in 2015. On the basis of total estimated tungsten content, China continued to be the leading supplier of tungsten materials and wrought products imported by the United States. U.S. reported consumption decreased by 5% from that of 2014 (tables 1, 5).

Tungsten is a whitish-gray metal with the highest melting point of all metals and one of the highest densities. When combined with carbon to make tungsten carbide, it is almost as hard as diamond. These and other properties make it useful in a wide variety of important commercial, industrial, and military applications. The leading use for tungsten is as tungsten carbide in cemented carbides, which are wear-resistant materials used by the construction, metalworking, mining, and oil and gas drilling industries. Pure or doped tungsten metal is used for contacts, electrodes, and wires in electrical, electronic, heating, lighting, and welding applications. Tungsten is also used to make alloys and composites to substitute for lead in ammunition and other products; heavy-metal alloys for armaments, heat sinks, radiation shielding, and weights and counterweights; superalloys for turbine engine parts; tool steels; and wear-resistant alloy parts and coatings. Tungsten chemicals are used to make catalysts, corrosion-resistant coatings, dyes and pigments, fire-resistant compounds, lubricants, phosphors, and semiconductors.

Most data in this report have been rounded to three significant digits. Totals and percentages were calculated from unrounded data. Unless otherwise specified, all statistics in this report are in metric tons of contained tungsten. Most tungsten prices and

many tungsten statistics from other sources are quoted in units of tungsten trioxide (WO₃). The short ton unit, which is used in the United States, is 1% of a short ton (20 pounds), and WO₃ is 79.3% tungsten by weight. A short ton unit of WO₃, therefore, equals 20 pounds of WO₃ and contains 7.19 kilograms (kg) (15.86 pounds) of tungsten. The metric ton unit, which is used in most other countries, is 1% of a metric ton (10 kg). A metric ton unit of WO₃, therefore, equals 10 kg of WO₃ and contains 7.93 kg (17.48 pounds) of tungsten.

Legislation and Government Programs

National Defense Stockpile.—The Defense Logistics Agency Strategic Materials (DLA Strategic Materials), U.S. Department of Defense, did not sell did not sell tungsten ores and concentrates or tungsten metal powder during the fiscal year 2015 (October 1, 2014, through September 30, 2015) or calendar year 2015. The quantities of tungsten materials remaining in the stockpile at the end of the calendar year are listed in tables 1 and 2. In early 2015, the DLA Strategic Materials reported the following goals for tungsten materials—tungsten metal powder, none; tungsten ores and concentrates, 5,120 t of contained tungsten. Goals are the amounts of materials to be maintained in the NDS and were based on the 2013 biennial report on stockpile requirements (U.S. Department of Defense, 2015, p. 4).

The Annual Materials Plan for fiscal year 2015, which represented the maximum quantities of tungsten materials that could be sold, is listed in table 2. The quantities of tungsten available for sale during fiscal year 2016 (October 1, 2015, through September 30, 2016) remained unchanged; sales of ores and concentrates were pending legislative authority (Defense Logistics Agency Strategic Materials, 2015).

Conflict Minerals.—The U.S. Securities and Exchange Commission (SEC) was responsible for implementing Section 1502 of the Dodd-Frank Wall Street Reform and Consumer Protection Act, which was related to the use of minerals determined to be financing conflict in Congo (Kinshasa) or an adjoining country. Wolframite, one of two principal minerals mined for tungsten, was included in the list of conflict minerals. Section 1502 required companies for which conflict minerals or their derivatives were necessary to the functionality or manufacture of their products to disclose annually whether any of those minerals originated in Congo (Kinshasa) or an adjoining country (U.S. Securities and Exchange Commission, 2012, p. 56274–56275).

In 2015, 1,283 companies filed conflict minerals disclosures for 2014 (1,321 companies filed disclosures in 2014 for 2013). A U.S. Government Accountability Office analysis of a sample of 2015 filings estimated that 49% of the reporting companies were able to determine the country of origin of their conflict minerals, compared with 30% in 2014. The ability of reporting companies

¹Deceased.

to identify the country of origin of their conflict minerals was hindered when there were multiple tiers of suppliers between the reporting company and the upstream concentrate-processing facility. For those reporting companies that identified the country of origin of their conflict minerals, a majority could not determine whether the minerals financed or benefited armed groups in the covered countries. This was because of uncertainties about source and chain of custody of the conflict minerals processed at the processing facilities. Although reporting companies were not required to identify which conflict minerals they used, of those that did, 37% reported using tungsten. Tungsten concentrate production from Congo (Kinshasa) and adjoining countries has been only 1% to 2% of world production in recent years (table 15) (U.S. Government Accountability Office, 2016, p. 16–23).

Production

Domestic production statistics for tungsten are based on data collected by the U.S. Geological Survey (USGS) by means of two separate voluntary surveys. Statistics that result from these surveys are listed in tables 1 and 3. The annual “Tungsten Ore and Concentrate Survey” covered the production, purchase, disposition, and stocks of tungsten ores and concentrates. In 2015, Curtis Tungsten, Inc. (Upland, CA) produced and shipped scheelite concentrates from the Andrew Mine northeast of Los Angeles, CA. By yearend, Scheelite Metals LLC (Wendover, UT) had completed construction of a mill near Callao, UT, which was to produce tungsten concentrate from ore mined at the Fraction Lode Mine, northwest of Callao; the mine and mill are both in Tooele County (Scheelite Metals LLC, undated).

Silver Predator Corp. (Vancouver, British Columbia, Canada) sought a joint-venture partner or buyer for its Springer complex in Pershing County, NV. The complex comprised a former underground scheelite mine, a beneficiation plant, and a processing circuit designed to produce either ammonium paratungstate (APT) or calcium tungstate (also known as synthetic scheelite). A 2012 preliminary economic assessment on the operation proposed production of scheelite concentrate containing an average of 1,070 metric tons per year (t/yr) of tungsten during an initial 5-year mine life. Silver Predator stated that all major permits were in place and forecast that production could begin within 12 months of obtaining funding (Silver Predator Corp., 2015, p. 4, 10, 15, 22).

Thor Mining PLC (Marleston, South Australia, Australia) evaluated options—including fundraising, project finance, or securing a joint-venture partner—for obtaining financing for exploration at its Pilot Mountain tungsten project. The project, approximately 200 kilometers (km) southeast of Reno, NV, comprised four deposits—Desert Scheelite, Gunmetal, Garnet, and Good Hope—within 3 km of one another (Thor Mining PLC, 2016a, p. 3; 2016b).

The USGS monthly “Tungsten Concentrate and Tungsten Products Survey” canvassed companies that produced tungsten carbide powder, tungsten chemicals, and (or) tungsten metal powder from APT, tungsten-bearing scrap, and tungsten concentrate. Where possible, data for nonrespondents to the survey were estimated based on prior survey results or

information from other sources. U.S. processors of tungsten materials are listed in table 4. Total net production of tungsten metal powder and tungsten carbide powder was 4% less than that of 2014 (table 3).

Consumption

U.S. apparent consumption of all tungsten materials, as calculated from net imports, secondary production, and changes in Government and industry stock levels, was withheld in 2015 to avoid disclosing company proprietary data pertaining to scrap consumption. Primary U.S. production was not available to include in the calculation.

Statistics on consumption of tungsten in end-use applications by U.S. metal consumers were developed from the voluntary “Consolidated Consumers Survey.” For this survey, more than 50 tungsten consumers were canvassed on a monthly or annual basis. Reported consumption and stocks data in tables 1 and 5 include estimates to account for nonrespondents.

Total U.S. reported consumption of tungsten materials to make end-use products in 2015 was 5% less than that of 2014. Consumption to make steels and superalloys was greater than that of 2014; consumption to make cemented carbides and other alloys was less than that of 2014; and consumption to make mill products was similar to that of 2014. Compared with consumption in 2014, U.S. end users consumed more ferrotungsten and less tungsten carbide powder, tungsten metal powder, and tungsten scrap. Estimated consumption of tungsten compounds in chemical applications remained unchanged.

Weekly reports of the number of operating drilling rigs give an indication of the demand for tungsten carbide in the form of cemented carbide components used by industry to explore for or produce oil and natural gas. The number of rigs operating each week in the United States trended steeply downward from January until early May, was more or less the same for 4 months, and then gradually decreased from September to yearend. The average number of weekly operating rigs in 2015 was 47% less than the average number of operating rigs in 2014 (978 rigs in 2015 as compared with 1,862 rigs in 2014) (Baker Hughes Inc., undated).

Prices

The weekly U.S. spot price for tungsten ore concentrate reported by Platts Metals Daily trended downward from \$300 to \$320 per short ton unit (\$331 to \$353 per metric ton unit) in January to \$280 to \$290 per short ton unit (\$309 to \$320 per metric ton unit) in November. In mid-November, the price dropped sharply to \$180 to \$200 per short ton unit (\$198 to \$220 per metric ton unit) and then dropped again in mid-December to \$125 to \$130 per short ton unit (\$138 to \$143 per metric ton unit). The annual average of Platts’ U.S. tungsten ore concentrate prices was 13% lower than that of 2014 (table 1).

The weekly U.S. APT price reported by Platts followed the same trend, beginning the year at \$310 to \$320 per short ton unit (\$342 to \$353 per metric ton unit) and ending the year at \$170 to \$180 per short ton unit (\$187 to \$198 per metric ton unit). The annual average of Platts’ U.S. APT prices was 16% lower than that of 2014.

The ferrotungsten price reported by Platts trended downward in 2015. The first week of January, the price was \$36 to \$37 per kilogram of contained tungsten. In December, it was \$22 to \$24 per kilogram of contained tungsten. The annual average price, at \$30.21 per kilogram of contained tungsten, was 35% less than the annual average of \$46.74 per kilogram of contained tungsten in 2014.

Tungsten materials were traded on two Chinese exchanges—the Tianjin International Mining Exchange and the Fanya Metal Exchange (FYME). Before FYME ceased operations and its web site was suspended in November, the exchange held nearly 30,000 t, gross weight, of APT. Concern about releases from this large quantity of tungsten intermediate was expected to suppress increases in tungsten prices into the future (Metal Bulletin Daily, 2016a; Xu, 2016; Tianjin International Mining Exchange, undated).

Foreign Trade

The tungsten content of U.S. exports was 3,760 t, a 44% decrease from the revised 6,730 t exported in 2014 (tables 6–10). The tungsten content of U.S. imports was 10,200 t, 21% less than the revised 12,900 t imported in 2014 (tables 11–14). China, which continued to be the leading supplier of imported tungsten to the United States, provided 28% of all tungsten imports in 2015. The tungsten content of imports from China decreased by 38% to 2,880 t in 2015, from 4,610 t in 2014. The distribution of materials imported from China was as follows: APT, 26%; tungsten metal powders, 20%; tungsten oxides and wrought tungsten, 12% each; unwrought tungsten, 10%; tungsten carbide powder, 9%; tungsten waste and scrap, 6%; ferrotungsten, 3%; other tungstates, 1%; and other tungsten compounds and tungsten ores and concentrates, less than 1% each. Other significant suppliers of tungsten materials to the United States were as follows: Canada, 12%; Bolivia and Germany, 10% each; and Spain, 8%.

The tungsten contained in U.S. imports of ores and concentrates was 3% less than that of 2014. In 2015, the leading suppliers of imports of tungsten ores and concentrates were Bolivia (26%), Canada (25%), Spain (21%), Portugal (9%), Australia (7%), and Mongolia (5%) (table 11).

U.S. imports of APT were 29% lower than those of 2014 (table 12). China continued to be the leading supplier, although the portion of APT imports from China has decreased from 94% in 2012 to 60% in 2015; most of the remaining APT imports in 2015 were from Germany. Imports of other tungsten materials are presented in tables 13 and 14.

Net import reliance as a percentage of apparent consumption is one measure of the adequacy of current domestic production to meet U.S. demand. Net import reliance is defined as imports minus exports plus adjustments for Government and industry stock changes. Releases from stocks, including shipments from the NDS, were counted as part of import reliance, regardless of whether they were imported or produced in the United States. In 2015, U.S. net import reliance for tungsten as a percentage of apparent consumption was withheld to avoid disclosing company proprietary data. In recent years, net import reliance has been about 40%, which means that about 40% of U.S. tungsten supply was from imports and stock releases, and about

60% was from scrap materials generated in the United States. Actual net import reliance might have been lower if data for U.S. production of tungsten concentrates had been available to be included in the calculation of apparent consumption.

World Review

Estimated world production of tungsten concentrates was slightly greater than that of 2014, primarily because of increases in production from China and Vietnam. China continued to be the leading producer of tungsten concentrates, accounting for 82% of total world production in 2015. Vietnam was the second-ranked producing country, with 6% of world production; and Russia was ranked third, with 3%. Combined production outside of China increased slightly compared with that of 2014 (table 15). World tungsten mine production was supplemented by tungsten recovered from scrap. Based on information from the International Tungsten Industry Association, about 70% of global tungsten consumption was from tungsten concentrates and 30% was from scrap in 2015 (International Tungsten Industry Association, 2016).

Australia.—Tasmania Mines Ltd. (Sydney, New South Wales) produced a small amount of scheelite concentrate from its Kara open pit magnetite mine south of Burnie in Tasmania.

Almonty Industries Inc. (Toronto, Ontario, Canada) produced 234 t of tungsten in concentrate from the Wolfram Camp tungsten-molybdenum mine and beneficiation plant west of Cairns, Queensland (comparable data not available for 2014). Following acquisition of the mine in September 2014, Almonty completed an exploration program and worked to optimize production from the mine and plant. During the year, Almonty reduced fresh ore mining to conserve costs and began blending Wolfram Camp tungsten concentrate with concentrate from other sources to dilute impurities introduced during the optimization process (Almonty Industries Inc., 2016, p. 9–11).

Carbine Tungsten Ltd. (Bungalow, Queensland) conducted project development activities related to funding and permitting and maintained its Mt. Carbine tungsten project, west of Port Douglas in northern Queensland, in a project-ready status while waiting for market conditions to improve and tungsten concentrate prices to increase. Carbine Tungsten planned to develop the project in two stages—first produce tungsten concentrate from low-grade stockpiled ore and then begin open pit mining (Carbine Tungsten Ltd., 2016, p. 3–4).

Thor Mining worked to secure financing for its Molyhil tungsten-molybdenum project northeast of Alice Springs, Northern Territory. The project was to comprise an open pit operation with a 6-year mine life and a beneficiation plant, which would use x-ray ore sorting and flotation to produce scheelite and molybdenite concentrates. Annual production was forecast to average 1,030 t/yr of tungsten in concentrate (130,000 metric ton units per year). Thor had a letter of intent from Global Tungsten & Powders Corp. (GTP) to purchase 70% to 75% of Molyhil's tungsten concentrate production and held discussions regarding offtake for the balance of concentrate production. Thor expected that concentrate production would begin 12 months after securing project financing (Thor Mining PLC, 2015, 2016b).

Vital Metals Ltd. (Subiaco, Western Australia) gained full control of the Watershed project when its joint-venture partner, Japan Oil, Gas and Metals National Corp., was unable to transfer its 30% interest to a Japanese partner by yearend. The project, northwest of Cairns, Queensland, comprised an open pit mine and beneficiation plant that would use ore sorting, gravity separation, and flotation to produce a high-grade scheelite concentrate. During an initial 9-year mine life, average production would be about 2,100 t/yr of tungsten in concentrate. During the 10th year of operation, concentrate production would be from low-grade stockpiles. In 2015, Vital Metals worked to reduce capital and operating costs on the project. The company planned to bring in an investment partner to help develop the project (Vital Metals Ltd., 2014, p. 1, 4, 22; 2016, p. 1–2).

King Island Scheelite Ltd. (KIS) (Sydney, New South Wales) worked to finalize a definitive feasibility study for reestablishing mining and processing operations at the former King Island Scheelite Mine on King Island, northwest of Tasmania. The company planned to mine ore from an open pit in the Dolphin deposit for 8 to 9 years; the mine life might then be extended by moving operations underground and (or) developing the nearby Bold Head deposit. Ore would be processed in a newly constructed plant using gravity and flotation methods to produce approximately 2,000 t/yr of tungsten in concentrate. KIS was evaluating x-ray ore-sorting technology to upgrade the run-of-mine ore prior to processing to increase plant capacity and reduce operating costs. Before project construction could begin, KIS would need to update environmental and development approvals, finalize the feasibility study, secure offtake agreements, and obtain project financing (King Island Scheelite Ltd., 2015).

Austria.—Wolfram Bergbau und Hütten AG (WBH, owned by Sandvik AB, Sandviken, Sweden) operated the Mittersill scheelite mine and beneficiation plant in the State of Salzburg, and the Bergla tungsten processing plant and a tungsten recycling unit near St. Martin in the State of Styria. The Mittersill Mine supplied some of the concentrate feed for the Bergla processing plant; the remainder was imported.

Brazil.—In recent years, most tungsten production has been from small mining companies producing scheelite concentrate in Rio Grande do Norte State and a lesser amount has been produced as wolframite concentrate in Para State. In October 2015, Bodó Mineração Ltda. (a subsidiary of Brazilian Tungsten Holdings Ltd.) suspended production from its underground Bodo Mine, Rio Grande do Norte State, to focus on mine development. The beneficiation plant continued to process stockpiled reject material and produced scheelite concentrate, which was sold to customers in Europe (Departamento Nacional de Produção Mineral, 2016, p. 112; Evocutis plc, 2016).

Canada.—According to preliminary statistics from Natural Resources Canada (2016), North American Tungsten Corp. Ltd. (NATC) (Vancouver, British Columbia) produced about 1,680 t of tungsten in scheelite concentrates from its Cantung operation in the Northwest Territories (table 15). This was a 28% decrease from the production reported by NATC for 2014. In June, owing to liquidity issues, NATC filed for protection under the Companies' Creditors Arrangement Act. Following an unsuccessful attempt to sell the assets

of the company, the Cantung beneficiation plant was shut down in late October and the mine was placed on care-and-maintenance status. NATC's Mactung scheelite deposit on the border of Yukon and the Northwest Territories was sold to the government of the Northwest Territories (North American Tungsten Corp. Ltd., 2015).

Northcliff Resources Ltd. (Vancouver, British Columbia) worked to advance the environmental impact assessment (EIA), project financing, and offtake agreement for its Sisson tungsten-molybdenum project. By yearend, the Provincial government had approved the EIA and a decision from the Federal Government was pending. The project, in east-central New Brunswick, comprised an open pit mine, a beneficiation plant to produce tungsten and molybdenum concentrates, and an onsite processing plant to convert the scheelite concentrate to APT. APT production was expected to average approximately 4,420 t/yr of contained tungsten during the 27-year life of the mine. Todd Corp. (Wellington, New Zealand) held an 11.5% interest in the project (Northcliff Resources Ltd., 2016, p. 5, 7–8).

China.—In 2015, China's production of concentrates increased slightly to an estimated 73,000 t of contained tungsten. The distribution of production by Province or Autonomous Region was as follows: Jiangxi (35%); Hunan (33%); Henan (17%); Yunnan (6%); Fujian, Guangdong, and Guangxi (2% each); Gansu and Heilongjiang (1% each); and Hubei, Nei Mongol, Xinjiang, and Zhejiang (less than 1% each). Despite its position as the world's leading miner of tungsten, China has imported significant quantities of tungsten concentrates in recent years. In 2015, China imported approximately 2,490 t of tungsten in concentrates. Scrap recycling also contributed to China's tungsten raw materials supply. Based on supply (mine production plus imports), consumption, and exports, one analyst estimated that, in 2015, the Chinese market had a tungsten surplus of 20,518 t (Tungsten & Molybdenum Monthly, 2016; United Nations Statistics Division, undated).

The Government of China maintained a program to conserve its tungsten resources and to ensure that its tungsten supply would meet anticipated demand. The program included regulating the production of tungsten concentrates by requiring exploration and mining licenses (new applications for exploration and mining were suspended until June 30, 2015), setting production quotas and prohibiting foreign investment in tungsten exploration and mining; regulating the processing of tungsten concentrates, including restricting foreign investment in tungsten processing; and regulating tungsten exports by issuing export licenses. Through 2014, China had export duties and export quotas that restricted the quantities and types of tungsten materials that could be exported. The export quotas were terminated January 1, 2015, and the export duties were terminated May 2, 2015, to comply with a 2014 World Trade Organization (WTO) ruling that they constituted a breach of WTO rules (Xiao, 2014, p. 42; Ministry of Commerce, 2015; Tungsten & Molybdenum Monthly, 2015b; Office of the United States Trade Representative, undated).

For 2015, China's tungsten concentrate production quota was increased to 91,300 t (65% WO₃) with 80% as primary mine production and 20% as comprehensive recovery from other

sources. China's concentrate production is typically greater than the quota. For example, the 2015 quota of 91,300 t (65% WO₃) was equivalent to approximately 47,100 t of contained tungsten, but production was estimated to be 73,000 t of contained tungsten. The excess production has been attributed to excess production under the comprehensive recovery category; production as a byproduct of other metals or by trading companies, which were not controlled by the quota; and double-counting (Xiao, 2014, p. 8; Argus Tungsten Monthly Outlook, 2016b; Shi, 2016, p. 15).

In 2015, China's Ministry of Finance and its State Administration of Taxation changed the basis for calculating the tax on tungsten resources from quantity produced to sales value. In addition, the Government was studying the feasibility of implementing a production quota on APT (Tungsten & Molybdenum Monthly, 2015a, b).

By early July, the price of tungsten concentrates reportedly fell below the production costs for most Chinese mining companies. As a result, China Molybdenum Co., Ltd. (CMOC) announced a plan to establish a special purpose fund to acquire tungsten raw materials, primarily concentrates. CMOC was considering a stockpile equivalent in quantity to approximately one-third of China's 2014 tungsten concentrate production. Jiangxi Tungsten Industry Group and a third unnamed company reportedly also were considering building stockpiles of tungsten concentrates (China Molybdenum Co., Ltd., 2015; Metal Bulletin Daily, 2015).

In 2015, China's State Bureau of Material Reserve reportedly held two tenders for the purchase of tungsten concentrates for its national stockpile, but neither was successful. Additional tenders were planned for 2016 (Metal Bulletin Daily, 2016b).

The Ganzhou Tungsten Association issued monthly recommended prices for wolframite concentrate, APT, and tungsten carbide powder; China Minmetals Corp. issued monthly recommended prices for scheelite and wolframite concentrates.

Congo (Kinshasa).—As discussed in the "Legislation and Government Programs" section of this report, companies reporting to the United States SEC are subject to the conflict minerals rules in the Dodd-Frank Wall Street Reform and Consumer Protection Act with regard to tungsten exports from Congo (Kinshasa) and adjoining countries. Congo (Kinshasa), Burundi, and Rwanda each participated in the International Tin Research Institute's ITRI Tin Supply Chain Initiative (iTSCi) to assist companies with due diligence and responsible sourcing of minerals from high risk areas by establishing traceability in the supply chains for tungsten, tantalum, tin, and gold from the mines to the processors (International Tin Research Institute, undated).

Korea, Republic of.—Woltech Korea Co., Ltd. built a ferrotungsten smelter in Cheonbuk-myeon, Gyeongju City, North Gyeongsang Province.

Almonty acquired Woulfe Mining Corp. (Vancouver, British Columbia, Canada) and its Sangdong tungsten project southeast of Seoul in Gangwon Province. Based on an updated feasibility study, ore from the underground mine would be processed by mineral flotation to produce a scheelite concentrate during a mine life of 8 years. The initial capacity of the project would be approximately 2,000 t/yr of tungsten in concentrate. Almonty planned to begin construction in the first

half of 2016 (Almonty Industries Inc., 2016, p. 13; Wheeler and Wells, 2016, p. 14, 193, 282).

New Zealand.—OceanaGold Corp. (Melbourne, Victoria, Australia) began a feasibility study on its Round Hill project, which entailed developing a new process plant with a circuit to recover tungsten from ore mined at its Macraes gold operation on the South Island. Results of the study were expected in mid-2016 (OceanaGold Corp., 2016, p. 69).

Peru.—Minera Tungsteno Malaga del Peru S.A. produced tungsten concentrate from the Pasto Bueno Mine and beneficiation plant in the Ancash region. The company reportedly suspended its plans for expanding the operation, owing to low prices (Argus Tungsten Monthly Outlook, 2016a).

Portugal.—Sojitz Beralt Tin and Wolfram (Portugal) S.A. produced wolframite (ferberite) concentrate from the Panasqueira Mine and beneficiation plant in Covilha, Castelo Branco. Concentrate from Panasqueira was sent to Japan, the United States, and elsewhere to be processed. In 2015, the ore production rate was decreased in response to low tungsten prices and, as a result, the mill was not operated continuously. In early January 2016, Almonty concluded the acquisition of the mine from Sojitz Tungsten Resources, Inc. (Wheeler, 2015, p. 17, 102; Almonty Industries Inc., 2016, p. 14).

W Resources PLC (London, United Kingdom) worked on mine development planning for its Régua deposit 95 km east of Porto in north-central Portugal. The company planned to begin with an open pit operation, followed by a larger scale high-grade underground mine (W Resources PLC, 2016, p. 3).

Russia.—In 2015, five companies mined tungsten and produced concentrates. The companies, listed in order of their share of estimated production, were as follows: JSC A&IR Mining, which produced concentrates from ores mined by Primorsky GOK in Primorskiy Krai; Russkaya Gornorudnaya Kompaniya (the Russian Ore Mining Company), which managed JSC Novoorlovsky GOK in Zabaykal'sk Krai; KGUP Primteploenergo, which had the exploration and mining license for the Lermontov Mine in Primorskiy Krai; Wolfram Company CJSC, which owned CJSC Buryat Wolfram in Zakamensk, Buryatiya Republic; and prospectors' cooperative Artel Quartz Ltd. (Kvarz) in Zabaykal'sk Krai. In addition, Wolfram Company (Moscow) produced concentrate from tailings generated during previous mining (Gorbachev, 2015, p. 14).

In 2015, Wolfram Company began producing ferrotungsten at a new plant in Unecha, Bryansk Oblast. The plant had the capacity to produce 2,000 t/yr of ferrotungsten (containing about 1,500 t/yr of tungsten). Wolfram Company's Hydrometallurg plant at Nalchik, Kabardino-Balkariya Republic, produced APT and yellow tungsten oxide, and Kirovgradskiy Zavod Tverdykh Splavov OAO's Kirovgrad Hard Alloys plant in Sverdlovsk Oblast produced APT and tungsten anhydride (Gorbachev, 2015, p. 21; Hack, 2015b).

RT Global Resources LLC (a subsidiary of state-owned Rostec Corp.) worked on plans for a feasibility study on developing the Tyrynyuz tungsten deposit in Kabardino-Balkariya Republic. A tender for the development was to take place in mid-2016, with production forecast to begin by 2020 (RT Global Resources LLC, 2015).

Rwanda.—Rwanda had numerous tungsten mining operations; most were artisanal, some were small-scale semi-industrial operations. In many of the operations, tungsten (as wolframite) was the principal commodity being mined; in some, wolframite was mined as a byproduct of tin (as cassiterite) and (or) niobium and tantalum (as coltan). Tinco Investments Ltd. (London, United Kingdom) planned to double production of tungsten concentrate from its Nyakabingo tungsten mine in the Rulindo District, Nord Province, from 25 metric tons per month (t/mo), gross weight, to 50 t/mo by yearend 2016. Rwanda is included in the Dodd-Frank legislation discussed in the “Legislation and Government Programs” section of this chapter and participated in the iTSCi program described in the “Congo (Kinshasa)” section (Metal Bulletin, 2015; Republic of Rwanda, Ministry of Natural Resources, undated).

Spain.—Daytal Resources Spain, S.L. (a subsidiary of Almonty) produced 826 t of tungsten in concentrate from its Los Santos Mine and beneficiation plant in Salamanca Province, 10% more than the 749 t produced in 2014. In 2015, more ore was mined and the tungsten recovery rates at the plant were higher than those of 2014. During the year, Almonty worked to extend the main plant and processing circuit to remove a bottleneck and improve the tungsten recovery rate, and evaluated a process for recovering tungsten from tailings stockpiled at Los Santos (Almonty Industries Inc., 2016, p. 8–9).

W Resources produced a small amount of tungsten concentrate at its La Parrilla tailings processing plant in the Extremadura region in the Provinces of Badajoz and Caceres. The company planned to develop its La Parrilla open pit mine in two stages—a smaller fast-track operation designed to produce approximately 675 t/yr of tungsten in concentrate beginning in 2016, followed in 2017–18 by a larger operation designed to produce approximately 2,700 t/yr of tungsten in concentrate (W Resources PLC, 2015).

Ormonde Mining PLC (Dublin, Ireland) finalized its capital funding, began the engineering design and plant procurement stage, and started the final procedures for land acquisition for its Barruecopardo tungsten project in Salamanca Province. Ormonde planned to develop a 9-year open pit operation, with a potential later expansion underground. Ore was to be beneficiated using gravity methods to produce scheelite concentrates containing approximately 2,000 t/yr of tungsten, with commissioning in late 2017. Ormonde had an offtake agreement with Noble Resources International Pte. Ltd., under which Noble would purchase all of the tungsten concentrate produced from the mine during its first 5 years of operation (Ormonde Mining PLC, 2016a, p. 2; 2016b, p. 8, 18).

United Kingdom.—Wolf Minerals Ltd. (Subiaco, Western Australia, Australia) completed construction of its Hemerdon tungsten and tin project, began production, and shipped its first tungsten concentrate. The project, in Devon, northeast of Plymouth, comprised the Drakelands open pit mine and a beneficiation plant, which were expected to produce approximately 2,740 t/yr of tungsten in wolframite concentrate and 450 t/yr of tin in concentrate for nearly 12 years. During the year, Wolf Minerals began a 6-month trial to determine whether the processing plant could operate continuously (7 days per week and 24 hours per day) and still meet required noise limits. An increase from operating 5½ days per week to 7 days per week

could boost mine capacity by about 25%. Wolf Minerals had offtake contracts for tungsten concentrate with GTP and WBH (Wolf Minerals Ltd., 2015, p. 1, 3, 29, 45; 2016, p. 2).

Uzbekistan.—The Uzbekistan-Korea Tungsten joint venture [Shindong Resources Co. Ltd. (Republic of Korea) and State Committee of the Republic of Uzbekistan on Geology and Mineral Resources] planned to complete a bankable feasibility study on the Sautbay project by yearend. The project comprised a tungsten mining and processing complex in Navoi region capable of producing 1,500 t/yr of tungsten concentrate. Uzbekistan-Korea Tungsten intended to obtain production licenses and financing during the first half of 2016, so that construction could begin in the second half of 2016 (Azizov, 2015).

Vietnam.—Nui Phao Mining Co. Ltd. (Masan Resources Corp., Ho Chi Minh City) produced 5,123 t of tungsten in concentrate (4,134 t in 2014) at its Nui Phao polymetallic mine about 80 km north of Hanoi in Thai Nguyen Province. The increase in production was attributed to post-commissioning rampup, improved head grades, and higher processing recoveries. During the year, the Nui Phao H.C. Starck Tungsten Chemicals Manufacturing joint venture commissioned its onsite APT and tungsten oxides plant and ramped up production. All of Nui Phao’s tungsten concentrate was to be processed at the joint venture’s APT plant (Masan Resources Corp., 2015, 2016).

Tungsten-tin mining took place at a state-owned operation in Tuyen Quang Province, northwest of Hanoi. Two companies produced APT and downstream tungsten materials from concentrates and scrap in southern Vietnam—Sanher Tungsten Vietnam Co. Ltd. in Dong Nai Province and Tejing (Vietnam) Tungsten Co., Ltd. in Tay Ninh Province (Zeiler, 2015, p. 8, 13).

Vietnam Youngsun Tungsten Industry Co., Ltd. reportedly reduced production from its ferrotungsten plant in Halong City, Quang Ninh Province, by 60% in 2015. The decrease in production was attributed to European ferrotungsten prices dropping below the cost of production for Chinese and Vietnamese producers (Hack, 2015a).

Asia Tungsten Products Co. Ltd. (ATC) (60% Hazelwood Resources Ltd. and 40% Mr. Chen Guang Yu) operated its ferrotungsten plant in the Vinh Bao district near the port of Haiphong on a campaign basis. During the fiscal year ending June 2015, ATC produced and shipped approximately 50% less ferrotungsten than it did during the prior fiscal year, owing to more potential ferrotungsten sellers than buyers. In September, ATC and three customers based in Japan signed sales contracts for 45% to more than 65% of ATC’s planned production during the following 6 months. ATC reportedly produced 300 t of ferrotungsten during the 6 months ending December 31, 2015 (Hazelwood Resources Ltd., 2015a, p. 2; 2015b; Metal Bulletin Daily, 2016c).

Zimbabwe.—In June, RHA Tungsten Pvt. Ltd. (National Indigenisation and Economic Empowerment Fund and Premier African Minerals Ltd.) restarted production from the former RHA tungsten mine in the Kamativi Tin Belt of northwestern Zimbabwe. The company originally planned to produce approximately 46 t/mo of tungsten in wolframite concentrate from the open pit for 18 months and then shift to underground mining. To improve the operation’s profitability, RHA temporarily suspended open pit mining, accelerated development of the

underground mine, and began underground ore production in late 2015. RHA had an offtake agreement with Noble Resources International Pte. Ltd. (Singapore) for the sale of its concentrate (Premier African Minerals Ltd., 2015a–c).

Outlook

World tungsten supply will likely continue to be dominated by China's production and exports. The Chinese Ministry of Land and Resources kept the total tungsten production quota for 2016 at 91,300 t (65% WO₃) (Shi, 2016, p. 15).

In the next few years, tungsten concentrate production from Australia, Portugal, Rwanda, Spain, the United Kingdom, Vietnam, and Zimbabwe is expected to increase as producers ramp up production at recently started mines or improve production from established mines. Other existing operations might increase production if tungsten prices increased from the low levels in 2015. In addition, as discussed in the "World Review" section of this chapter, numerous companies worked to develop tungsten deposits, produce tungsten concentrate from stockpiled tailings or operations where tungsten was not being recovered, or restart production from inactive mines in Asia, Australasia, Europe, and North America. Some of these potential new operations would include processing tungsten concentrates onsite to APT. The amount, location, and timing of new production will depend, in part, on the companies' ability to acquire funding. Scrap will continue to be an increasingly important source of raw material for the tungsten industry worldwide.

Tungsten consumption is strongly influenced by general economic conditions. Future consumption of tungsten in cemented carbides, which is the leading end-use sector, will depend on the performance of the following industries: automotive and aircraft production; construction; electronics manufacturing, where cemented carbide microdrills are used on circuit boards; general manufacturing; large equipment manufacturing; mining; and oil and gas drilling. Tungsten use is also influenced by Government spending for defense applications.

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TABLE 1
SALIENT TUNGSTEN STATISTICS¹

(Metric tons, tungsten content and dollars per metric ton unit, unless otherwise specified)

	2011	2012	2013	2014	2015
United States:					
Concentrates:					
Production	NA	NA	NA	NA	NA
Consumption	W	W	W	W	W
Exports	188 ^r	186 ^r	1,050 ^r	1,230	398
Imports for consumption	3,660 ^r	3,610 ^r	3,690	4,080	3,970
Stocks, December 31:					
Consumer	W	W	W	W	W
U.S. Government ²	15,800	14,000	11,900	11,600	11,600
Price:					
U.S. spot quotation ³	248	358	358	348	302
European ^{4,5}	150	XX	XX	XX	XX
Ammonium paratungstate:					
Production	W	W	W	W	W
Consumption ⁶	W	W	W	W	W
Exports	1,010	833	1,600	653	310
Imports for consumption	2,020	1,500	2,220	1,780	1,270
Stocks, December 31, producer and consumer	W	W	W	W	W
Price:					
U.S. free market ^{4,7}	370	XX	XX	XX	XX
U.S. market ³	397	449	369	358	299
European free market ⁸	431	386	372	357	227
Ferrotungsten:					
Production	--	--	--	--	--
Consumption	115	165	97	107	227
Exports	22	2	31	76	29
Imports for consumption	206	316	470	454	269
Stocks, December 31, consumer	18	W	W	W	35
Price, U.S. free market ^{3,9}	51.18	50.18	47.22	46.74	30.21
Primary products:					
Net production ¹⁰	7,790	6,360	6,150	6,310	6,080
Consumption ¹¹	12,300	11,400	10,700	11,600	11,100
Stocks, December 31:					
Producer ¹⁰	682	653	769	674	493
Consumer ¹¹	558	706	646	676	541
U.S. Government ²	125	125	125	125	125
World, production of concentrate	73,900	76,900 ^r	83,800 ^r	87,000 ^r	89,400 ^c

⁶Estimated. ^rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data. XX Not applicable. -- Zero.

¹Data are rounded to no more than three significant digits.

²Source: Defense Logistics Agency Strategic Materials.

³Annual average calculated from weekly prices reported by Platts Metals Week.

⁴Annual average calculated from semiweekly prices reported by Metal Bulletin.

⁵Price discontinued October 26, 2012.

⁶Reported by tungsten processors.

⁷Price discontinued July 18, 2012.

⁸Data for 2011–12 are annual averages calculated from semiweekly prices reported by Metal Bulletin. Data for 2013–15 are annual averages calculated from monthly prices reported by Metal Bulletin.

⁹Dollars per kilogram contained tungsten.

¹⁰Includes tungsten metal powder and tungsten carbide powder produced from metal powder; excludes cast and crystalline tungsten carbide powder and chemicals.

¹¹Includes ammonium paratungstate and other tungsten chemicals, ferrotungsten, tungsten metal powder, tungsten carbide powder, and tungsten scrap.

TABLE 2
U.S. GOVERNMENT NATIONAL DEFENSE STOCKPILE
TUNGSTEN STATISTICS IN 2015¹

(Metric tons, tungsten content)

Material	Inventory, yearend ²		Annual Materials Plan ³
	Fiscal year ³	Calendar year	
Ores and concentrates	11,600	11,600	1,360
Tungsten metal powder	125	125	35
Total	11,800	11,800	1,400

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

²No sales or inventory changes during fiscal or calendar year.

³Twelve-month period ending September 30, 2015.

Source: Defense Logistics Agency Strategic Materials.

TABLE 3
U.S. NET PRODUCTION AND STOCKS OF TUNGSTEN PRODUCTS^{1,2}

(Metric tons, tungsten content)

	Tungsten metal powder	Tungsten carbide powder	Total
Net production: ³			
2014	W	W	6,310
2015	W	W	6,080
Producer stocks:			
December 31, 2014	W	W	674
December 31, 2015	W	W	493

W Withheld to avoid disclosing company proprietary data.

¹Data are rounded to no more than three significant digits.

²Data for cast and crystalline tungsten carbide powder and tungsten chemicals are withheld to avoid disclosing company proprietary data; not included in "Total."

³Net production equals receipts plus gross production minus quantity used to make other products listed.

TABLE 4
U.S. PROCESSORS OF TUNGSTEN IN 2015¹

Company	Plant location
Buffalo Tungsten Inc.	Depew, NY.
Chem-Met Co., The	Clinton, MD.
Elmet Technologies, Inc.	Lewiston, ME.
General Electric Co.	Euclid, OH.
Global Tungsten & Powders Corp. ²	Towanda, PA.
Kennametal Inc.	Fallon, NV.
Do.	Huntsville, AL.
Do.	Latrobe, PA.
Niagara Refining LLC ³	Depew, NY.
Tundra Companies	White Bear Lake, MN.

Do. Ditto.

¹Consumers of ammonium paratungstate, tungsten-bearing scrap, tungsten concentrates, and (or) tungsten oxides.

²A division of Plansee Group.

³A joint venture of Sumitomo Electric Carbide Inc. and New York Tungsten LLC (a subsidiary of Buffalo Tungsten Inc.).

TABLE 5
U.S. REPORTED CONSUMPTION AND STOCKS OF TUNGSTEN PRODUCTS^{1,2,3}

(Metric tons, tungsten content)

	2014	2015
Consumption by end use:		
Steels	82	205
Superalloys	562	588
Other alloys ⁴	W	W
Cemented carbides ⁵	6,880	6,270
Mill products made from metal powder	W	W
Chemical	88	88
Total	11,600	11,100
Consumption by form:		
Ferrotungsten	107	227
Tungsten metal powder	W	W
Tungsten carbide powder	7,030	6,400
Tungsten scrap ⁶	W	W
Other tungsten materials ⁷	88	88
Total	11,600	11,100
Consumer stocks, December 31:		
Ferrotungsten	W	35
Tungsten metal powder	35	33
Tungsten carbide powder	417	417
Tungsten scrap ⁶	W	43
Other tungsten materials ⁷	13	13
Total	676	541

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

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

²Does not include materials used in making primary tungsten products.

³Includes estimates.

⁴Includes welding and hard-facing rods and materials, wear- and corrosion-resistant alloys, and nonferrous alloys.

⁵Includes diamond tool matrices, cemented and sintered carbides, and cast carbide dies or parts.

⁶Includes tungsten bars.

⁷Includes tungsten chemicals.

TABLE 6
U.S. EXPORTS OF TUNGSTEN ORES AND CONCENTRATES, BY COUNTRY¹

Country of destination	2014			2015		
	Quantity		Value (thousands)	Quantity		Value (thousands)
	Gross weight (metric tons)	Tungsten content ² (metric tons)		Gross weight (metric tons)	Tungsten content ² (metric tons)	
Canada	4	2	\$54	--	--	--
China	217	112	3,780	13	7	\$85
Czech Republic	61	32	1,010	--	--	--
Hong Kong	66	34	1,290	27	14	478
Italy	--	--	--	50	26	550
Luxembourg	36	19	708	--	--	--
Malaysia	(3)	(3)	5	1	(3)	44
Netherlands	192	99	3,940	--	--	--
Russia	1,020	527	11,000	508	262	4,820
Singapore	(3)	(3)	3	50	26	548
Trinidad and Tobago	--	--	--	2	1	16
United Kingdom	--	--	--	10	5	28
Vietnam	792	409	12,700	109	56	186
Other	2 ³	1	177 ³	2	1	128
Total	2,390	1,230	34,700	771	398	6,890

¹Revised. -- Zero.

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

²Content estimated from reported gross weight.

³Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7
U.S. EXPORTS OF AMMONIUM PARATUNGSTATE, BY COUNTRY^{1,2}

Country of destination	2014		2015	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Brazil	--	--	1	\$5
Denmark	--	--	8	68
France	--	--	5	40
Germany	495	\$7,110	259	2,830
Hungary	96	1,480	--	--
India	49	436	33	294
Italy	2	22	--	--
Japan	--	--	5	43
Singapore	--	--	(3)	3
Switzerland	7	63	--	--
United Kingdom	3	31	--	--
Total	653	9,140	310	3,280

-- Zero.

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

²Includes other ammonium tungstates, such as ammonium metatungstate.

³Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8
U.S. EXPORTS OF TUNGSTEN METAL POWDERS, BY COUNTRY^{1,2}

Country of destination	2014			2015		
	Quantity		Value (thousands)	Quantity		Value (thousands)
	Gross weight (metric tons)	Tungsten content ³ (metric tons)		Gross weight (metric tons)	Tungsten content ³ (metric tons)	
Australia	2	1	\$74	(4)	(4)	\$30
Austria	--	--	--	10	8	389
Belgium	1	1	94	2	2	150
Brazil	22	18	1,250	6	5	373
Canada	86	69	5,930	91	73	5,130
Chile	6	5	192	5	4	126
China	7	6	566	6	5	386
Ecuador	1	1	42	2	2	73
France	9	7	362	16	13	562
Germany	48	38	2,940	25	20	2,040
Hong Kong	14	11	602	3	3	192
India	47	37	2,250	28	22	1,060
Ireland	9	8	477	8	7	490
Israel	6	5	317	7	5	279
Italy	6	5	254	--	--	--
Japan	48	39	3,630	33	26	1,460
Korea, Republic of	5	4	336	12	9	823
Luxembourg	2	2	94	--	--	--
Mexico	13	10	866	14	11	927
Netherlands	7	5	358	3	2	112
Peru	7	6	432	6	5	353
Saudi Arabia	93	75	5,770	60	48	3,680
Singapore	38	30	2,210	18	14	1,640
South Africa	10	8	869	12	10	1,220
Switzerland	2	2	160	1	1	85
Taiwan	6	5	428	1	1	138
Turkey	14	11	566	9	7	508
United Arab Emirates	3	3	331	1	1	61
United Kingdom	39	31	1,410	6	5	326
Other	9 ^r	7 ^r	444 ^r	6	5	370
Total	560	448	33,300	390	312	23,000

^rRevised. -- Zero.

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

²May include tungsten alloy powders.

³Content estimated from reported gross weight.

⁴Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9
U.S. EXPORTS OF TUNGSTEN CARBIDE POWDER, BY COUNTRY¹

Country of destination	2014		2015	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Argentina	(2)	\$59	3	\$99
Australia	32	1,400	22	854
Austria	158	6,260	43	750
Brazil	26	1,260	17	1,220
Canada	130	7,770	203	11,100
Chile	3	145	4	189
China	47 ^r	3,650 ^r	133	3,070
Czech Republic	54	1,460	22	688
Denmark	3	168	4	224
France	5	321	9	267
Germany	223	15,400	187	12,300
Hong Kong	3	270	2	126
India	24	2,470	44	2,100
Indonesia	3	164	2	130
Ireland	1	94	17	745
Israel	(2)	20	2	102
Italy	6	360	4	232
Japan	24	1,720	29	2,770
Korea, Republic of	15	1,250	14	1,140
Luxembourg	69	1,840	11	373
Malaysia	6	360	4	267
Mexico	12	874	4	216
New Zealand	2	64	1	31
Peru	6	405	11	297
Philippines	2	257	3	301
Saudi Arabia	5	301 ^r	5	301
Singapore	24	2,800	13	1,370
South Africa	13	678	3	106
Switzerland	3	239	6	410
Taiwan	53	3,810	43	2,800
Thailand	4	329	2	138
Turkey	1	58	8	361
United Arab Emirates	3	287	2	152
United Kingdom	23	1,870	12	935
Vietnam	--	--	8	126
Other	9 ^r	451 ^r	5	285
Total	994 ^r	58,900 ^r	901	46,600

^rRevised. -- Zero.

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

²Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 10
U.S. EXPORTS OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY¹

Product and country of destination	2014		2015	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Ferrotungsten and ferrosilicon tungsten:				
Brazil	18	\$44	6	\$14
Israel	2	5	--	--
Mexico	2	201	--	--
Netherlands	10	603	1	25
Venezuela	--	--	15	36
Vietnam	42	18	7	16
Other	(2)	23	(2)	11
Total	76	893	29	102
Unwrought tungsten:^{3,4,5}				
Austria	28	119	7	29
Brazil	28	134	16	66
Canada	543 ^r	2,380 ^r	495	2,240
China	10	62	2	14
Côte d'Ivoire	--	--	22	92
Germany	78	335	91	381
India	139	606	14	62
Italy	4	17	--	--
Japan	33	139	13	53
Korea, Republic of	18	77	1	3
Mexico	54	301	78	416
Netherlands	48	214	8	35
Panama	125	527	--	--
Russia	39	177	21	90
Singapore	110	462	42	189
Spain	5	25	27	116
Sweden	9	38	--	--
Switzerland	--	--	7	31
Taiwan	8	34	4	19
Thailand	8	34	78	329
United Arab Emirates	6	23	--	--
United Kingdom	39	166	7	30
Other	8 ^r	57 ^r	7	34
Total	1,340^r	5,920^r	940	4,230
Waste and scrap:⁴				
Algeria	--	--	8	67
Austria	--	--	8	158
Belgium	16	136	75	936
Brazil	1	10	6	54
Canada	158	1,700	40	469
China	1	6	5	40
Finland	146	1,230	63	863
France	36	1,310	11	263
Germany	350 ^r	4,520 ^r	127	1,810
Hong Kong	41	806	--	--
Israel	602	5,480	49	410
Japan	46 ^r	491 ^r	13	157
Korea, Republic of	--	--	5	38
Luxembourg	16	591	13	386
Malaysia	7	58	--	--
Netherlands	10	84	31	610
Poland	54	1,800	--	--
Russia	19	157	--	--
South Africa	78	656	--	--
Taiwan	15	167	5	42
United Kingdom	172	1,700	181	2,290
Other	4 ^r	30 ^r	1	7
Total	1,770	20,900	638	8,600

See footnotes at end of table.

TABLE 10—Continued
U.S. EXPORTS OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY¹

Product and country of destination	2014		2015	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Wrought tungsten: ^{3, 4, 6}				
Austria	38	\$3,080	52	\$2,820
Brazil	3	1,220	1	124
Canada	24 ^r	3,070 ^r	15	1,800
China	8	1,300	3	661
Costa Rica	12	1,700	11	1,520
Germany	8	1,090	6	860
Hungary	12	2,020	5	1,650
India	8	851	10	851
Israel	18	2,130	3	311
Italy	2	227	3	416
Japan	10	1,320	9	1,400
Korea, Republic of	1	203	1	251
Mexico	34	5,800	67	8,720
Singapore	4	954	5	667
United Arab Emirates	(2)	99	4	540
United Kingdom	6	1,270	7	1,520
Other	13 ^r	2,480 ^r	15	2,500
Total	201	28,800	217	26,600
Tungsten compounds: ⁷				
Canada	6	22	4	12
China	3	190	8	644
Malaysia	3	34	5	54
Other	--	--	1	50
Total	12	246	18	760

^rRevised. -- Zero.

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

²Less than ½ unit.

³May include alloys.

⁴Content estimated from reported gross weight.

⁵Includes bars and rods produced simply by sintering; excludes powders and waste and scrap.

⁶Includes bars and rods other than those produced simply by sintering; profiles, plates, sheets, strip, and foil; wire; and other wrought products.

⁷Includes only other tungstates.

Source: U.S. Census Bureau.

TABLE 11
U.S. IMPORTS FOR CONSUMPTION OF TUNGSTEN ORES AND CONCENTRATES,
BY COUNTRY¹

Country of origin	2014		2015	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Australia	158	\$5,780	279	\$7,550
Bolivia	991	30,400	1,010	25,200
Brazil	22	718	27	613
Canada	1,150 ^r	38,400 ^r	987	25,300
China	13	341	18	271
Colombia	27	679	13	483
Germany	8	205	--	--
Italy	(2)	8	--	--
Mexico	10	108	4	92
Mongolia	115	3,900	189	4,230
Peru	51	1,750	111	2,520
Poland	--	--	(2)	5
Portugal	515	20,400	356	9,160
Russia	184	6,380	45	1,170
Spain	741	26,500	817	19,800
Thailand	86	2,660	41	1,100
Uganda	16	293	--	--
United Kingdom	--	--	42	707
Vietnam	--	--	25	521
Total	4,080	139,000 ^r	3,970	98,700

^rRevised. -- Zero.

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

²Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 12
U.S. IMPORTS FOR CONSUMPTION OF AMMONIUM PARATUNGSTATE, BY COUNTRY^{1,2}

Country of origin	2014		2015	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
China	1,250	\$43,800	762	\$18,200
Germany	507	22,000	441	15,200
Japan	31	1,100	62	2,040
Total	1,780	66,800	1,270	35,500

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

²Includes other ammonium tungstates, such as ammonium metatungstate.

Source: U.S. Census Bureau.

TABLE 13
 U.S. IMPORTS FOR CONSUMPTION OF FERROTUNGSTEN AND
 FERROSILICON TUNGSTEN, BY COUNTRY¹

Country of origin	2014		2015	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
China	284	\$11,900	80	\$2,800
Sweden	--	--	(2)	4
Taiwan	16	675	--	--
United Kingdom	--	--	8	297
Vietnam	155	6,280	180	5,960
Total	454	18,800	269	9,060

-- Zero.

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

²Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 14
U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS,
BY COUNTRY¹

Product and country of origin	2014		2015	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Tungsten metal powders:²				
Austria	5	\$391	6	\$339
Canada	225	12,400	126	7,490
China	527	24,100	564	20,200
Czech Republic	13	574	16	362
Finland	3	173	30	1,110
Germany	103	6,360	32	1,360
Israel	100	10,500	118	6,320
Japan	12	1,420 ^r	32	2,180
Korea, Republic of	262	16,600	168	9,060
Poland	3	72	7	234
United Kingdom	3	262	3	235
Vietnam	40	1,780	10	208
Other	3 ^r	211 ^r	2	167
Total	1,300	74,900^r	1,110	49,300
Tungsten carbide powder:				
Austria	105	6,230	99	4,260
Belgium	13	726	1	24
Canada	103	6,390	31	1,840
China	410 ^r	20,300 ^r	258	11,400
Czech Republic	6	278	4	126
France	18	1,680	14	1,220
Germany	190	12,200	218	9,340
India	12	307	--	--
Israel	45	3,950	11	784
Japan	3	215	(3)	44
Korea, Republic of	18	1,280	19	1,050
Luxembourg	13	185	--	--
South Africa	5	79	2	33
Other	2	149	(3)	42
Total	944^r	54,000^r	659	30,200
Unwrought tungsten:^{2, 4, 5}				
Austria	7	478	7	342
China	223	10,600	301	12,000
Taiwan	(3)	3	10	82
United Kingdom	1	25	6	76
Vietnam	6	257	--	--
Other	1	65	1	44
Total	237	11,400	325	12,600
Waste and scrap:				
Australia	--	--	7	233
Austria	215	4,510	177	2,130
Belgium	--	--	14	390
Brazil	5	156	20	297
Canada	60	1,850 ^r	70	657
Chile	14	388	12	272
China	209	9,450	175	6,170
Czech Republic	57	1,890	39	1,070
Finland	18	569	11	134
Germany	334 ^r	9,930 ^r	296	5,900
India	108	3,950	68	1,960
Japan	27	842	16	227
Luxembourg	174	5,890	182	5,260
Mexico	245 ^r	5,600 ^r	223	4,460
Pakistan	46	1,430	--	--
Peru	--	--	22	636
Poland	108	3,780	72	2,370
Russia	--	--	132	3,650

See footnotes at end of table.

TABLE 14—Continued
 U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS,
 BY COUNTRY¹

Product and country of origin	2014		2015	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Waste and scrap—Continued:				
Saudi Arabia	24	\$640	--	--
Singapore	19	525	12	\$260
South Africa	--	--	32	673
Taiwan	52 ^r	1,540 ^r	4	126
United Arab Emirates	13	363	--	--
United Kingdom	26	606	75	1,570
Vietnam	--	--	10	335
Other	20 ^r	676 ^r	9	219
Total	1,770 ^r	54,600 ^r	1,680	39,000
Wrought tungsten ^{2, 4, 6}				
Austria	49	10,900	35	4,890
China	658	42,300	340	21,800
Czech Republic	2	678	3	818
France	2	426	4	911
Germany	17 ^r	3,580 ^r	17	2,870
Hong Kong	3	119	5	172
Hungary	4 ^r	670 ^r	4	698
Japan	24	6,130 ^r	13	4,300
Russia	9	1,090	7	802
Singapore	8	1,720	4	634
South Africa	3	142	--	--
Other	14 ^r	4,350 ^r	17	4,760
Total	794 ^r	72,200 ^r	449	42,700
Tungsten oxides:				
China	1,020	42,500	352	10,400
Germany	23	1,240	14	743
Hong Kong	--	--	16	440
Uganda	--	--	13	293
Vietnam	45	1,820	--	--
Other	2	166 ^r	2	22
Total	1,090	45,700	396	11,900
Other tungstates:				
China	20	905	30	1,060
Germany	16	384	10	728
India	19	784	9	329
Vietnam	341	10,200	--	--
Other	(3)	11	(3)	15
Total	396	12,300	50	2,130
Other tungsten compounds: ⁷				
China	3	160	1	23
Germany	8	263 ^r	12	284
Japan	33 ^r	1,080 ^r	36	1,080
Korea, Republic of	1	324	5	135
United Kingdom	(3)	2	--	--
Total	44 ^r	1,830 ^r	54	1,520

^rRevised. -- Zero.

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

²May include alloys.

³Less than ½ unit.

⁴Content estimated from reported gross weight.

⁵Includes bars and rods produced simply by sintering; excludes powders and waste and scrap.

⁶Includes bars and rods other than those produced simply by sintering; foil, plates, profiles, sheets, and strip; wire; and other wrought products.

⁷Includes tungsten chlorides.

Source: U.S. Census Bureau.

TABLE 15
TUNGSTEN: WORLD CONCENTRATE PRODUCTION, BY COUNTRY^{1,2}

(Metric tons, tungsten content)

Country ³	2011	2012	2013	2014	2015 ^e
Australia	15	290	320	477	348 ⁴
Austria	861	706	850	819 ^r	861 ⁴
Bolivia ⁵	1,124	1,247	1,253	1,252	1,461 ⁴
Brazil	244	381	494	510 ^r	510
Burma ^{e,6}	140	131 ^r	140	143 ^r	140
Burundi	200	270	6 ^r	23 ^r	20
Canada	1,966	2,194	2,128	2,344	1,680 ^{p,4}
China ^e	61,800	64,400 ^r	71,100 ^r	71,000	73,000
Congo (Kinshasa) ^{e,5}	41	35	55	12	21
Korea, North ^{e,7}	110	100	65	70	70
Mongolia	13	66	274	479	600
Peru ⁸	439	276	28	61	110 ⁴
Portugal	819	763	692	671	474 ⁴
Russia	3,314	3,537	2,973	2,659 ^r	2,600
Rwanda ^e	480	830	1,100	1,000	850
Spain	497	542	510	800	835
Thailand ^{e,9}	160	80	140	100	30
Uganda	8	34	57	63 ^r	60
United Kingdom	--	--	--	--	150
United States	NA	NA	NA	NA	NA
Vietnam ¹⁰	1,635	1,050	1,660	4,500 ^{r,e}	5,600 ⁴
Zimbabwe ¹¹	--	--	--	--	NA
Total	73,900	76,900 ^r	83,800 ^r	87,000 ^r	89,400

^eEstimated. ^pPreliminary. ^rRevised. NA Not available. -- Zero.

¹Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Includes data available through October 5, 2016.

³Tungsten concentrates were thought to be produced in Colombia, Republic of Korea, and Nigeria, but information was inadequate to make reliable estimates of output.

⁴Reported figure.

⁵Production estimated based on reported exports.

⁶Tungsten content of tungsten and tin-tungsten concentrates produced by state-owned mining enterprises under the Ministry of Mines.

⁷Production estimated based on Chinese imports.

⁸Data for 2011–12 are based on production reported by Malaga Inc.; data for 2013–14 are based on production reported by the Ministry of Energy and Mines.

⁹Based on data from the Department of Primary Industries and Mines.

¹⁰Mine production for 2011–13 and 2015 reported by the International Tungsten Industry Association.

¹¹Production began in 2015, but information was inadequate to make a reliable estimate.