



# 2016 Minerals Yearbook

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**TUNGSTEN [ADVANCE RELEASE]**

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# TUNGSTEN

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In 2016, a slight decrease in global tungsten mine production coupled with a slight increase in global consumption resulted in a reduction of the surplus that has characterized the tungsten market in recent years. The decrease in world production of tungsten in concentrate was mainly because of the closure of Canada's sole tungsten mine in late 2015 (table 15). Despite an upward trend in tungsten prices in Europe, China, and the United States during 2016, most annual average prices were lower than those of 2015. The annual average U.S. spot price for tungsten concentrate was \$148 per metric ton unit, a 51% decrease from the annual average price of \$302 per metric ton unit in 2015. Tungsten concentrate prices were estimated to be below the cash costs of production for at least one-half of mining companies, worldwide (Seddon, 2016, p. 29; Argus Tungsten Monthly Outlook, 2017; China Molybdenum Co., Ltd., 2017, p. 14–15).

In 2016, there was no known domestic commercial production of tungsten concentrates and no tungsten was shipped from the National Defense Stockpile (NDS). Most of the U.S. supply of tungsten raw materials consisted of imports and scrap. 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. total reported consumption decreased by 6% from that of 2015 (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 ( $WO_3$ ). The short ton unit, which is used in the United States, is 1% of a short ton (20 pounds), and  $WO_3$  is 79.3% tungsten by weight. A short ton unit of  $WO_3$ , therefore, equals 20 pounds of  $WO_3$  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  $WO_3$ , therefore, equals 10 kg of  $WO_3$  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 tungsten ores and concentrates or tungsten metal powder during fiscal year 2016 (October 1, 2015, through September 30, 2016) or calendar year 2016. The quantities of tungsten materials remaining in the stockpile at the end of the calendar year are listed in tables 1 and 2 (U.S. Department of Defense, 2017, p. 8, 14).

The Annual Materials Plan for fiscal year 2016, which represented the maximum quantities of tungsten materials that could be sold, is listed in table 2. The quantity of tungsten ores and concentrates available for sale during fiscal year 2017 (October 1, 2016, through September 30, 2017) remained unchanged; less than 0.1 metric ton (t) of tungsten metal scrap was available for sale, and 35 t of tungsten metal powder was available for upgrade or disposal (Defense Logistics Agency Strategic Materials, 2016).

**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 defined “conflict minerals” as cassiterite, columbite-tantalite, gold, wolframite, or their derivatives. It 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 2016, 1,230 companies filed conflict minerals disclosures for 2015 (1,281 companies filed disclosures in 2015 for 2014). A U.S. Government Accountability Office analysis of a sample of 2016 filings estimated that 49% of the reporting companies were able to determine the country of origin of their conflict minerals, the same percentage as in 2015. The ability of reporting companies 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 (U.S. Government Accountability Office, 2017, p. 3–7).

Companies whose conflict minerals originated in Congo (Kinshasa) or an adjoining country were required to submit a

report on their due diligence on the source and chain of custody of the conflict minerals in their products. Of those companies reporting their due diligence, an estimated 55% reported that they could not confirm the source of the conflict minerals and about 99% reported that they could not determine whether the minerals financed or benefited armed groups. Although reporting companies were not required to identify which conflict minerals they used, of those that did, 58% 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, 2017, p. 3–7).

## 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. There was no known commercial production of tungsten concentrates in 2016.

Scheelite Metals LLC (Wendover, UT) sought financing to operate the Fraction Lode Mine in Gold Hill, UT, and beneficiation plant southeast of the mine in Callao, UT; the mine and mill are both in Tooele County (Alper, 2016). Curtis Tungsten, Inc. (Upland, CA) had no production or shipments from the Andrew Mine northeast of Los Angeles, CA, during the year.

Silver Predator Corp. (Vancouver, British Columbia, Canada) held negotiations for the sale of its Springer complex in Pershing County, NV. The complex consisted of 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). By mid-January 2017, Silver Predator had reached an agreement with Till Capital Ltd., the company from which it had purchased the Springer complex in 2014, and Resource Re Ltd. (a wholly owned subsidiary of Till Capital) to exchange the remaining balance in principal and interest due to Resource Re for 100% of the shares in Springer Mining Co. The agreement was subject to receipt of any required regulatory approvals (Silver Predator Corp., 2017).

Thor Mining PLC (London, United Kingdom) received regulatory approval for drilling programs at its Pilot Mountain tungsten project, approximately 200 kilometers (km) southeast of Reno, NV. The approval covered two of the four deposits in the project—the Desert Scheelite tungsten-copper deposit and the Garnet tungsten deposit. The other two tungsten deposits are Gunmetal and Good Hope (Thor Mining PLC, 2017, p. 2–3).

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 24% more than that of 2015 (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 2016 to avoid disclosing company proprietary data pertaining to scrap consumption.

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 2016 was 6% less than that of 2015. Consumption to make cemented carbides, steels, and superalloys was less than that of 2015; consumption to make other alloys was greater than that of 2015; and estimated consumption to make mill products and for chemical applications was similar to that of 2015. Compared with consumption in 2015, U.S. end users consumed less ferrotungsten, tungsten carbide powder, and tungsten scrap. Estimated consumption of tungsten compounds in chemical applications and tungsten metal powder 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 mid-May, and then increased through yearend. The average number of weekly operating rigs in 2016 was 48% less than the average number of operating rigs in 2015 (509 rigs in 2016 as compared with 978 rigs in 2015) (Baker Hughes Inc., 2017).

## Prices

The weekly U.S. spot price for tungsten ore concentrate reported by Platts Metals Daily began the year at \$125 to \$130 per short ton unit (\$138 to \$143 per metric ton unit) and then gradually trended upward to \$130 to \$135 per short ton unit (\$143 to \$149 per metric ton unit) in November. In late November, the price increased sharply to \$170 to \$180 per short ton unit (\$187 to \$198 per metric ton unit). The annual average of Platts’ U.S. tungsten ore concentrate prices was 51% lower than that of 2015 (table 1).

The weekly U.S. APT price reported by Platts gradually trended upward from \$170 to \$180 per short ton unit (\$187 to \$198 per metric ton unit) at the beginning of the year to \$190 to \$200 per short ton unit (\$209 to \$220 per metric ton unit) at the end of the year. The annual average of Platts’ U.S. APT prices was 34% lower than that of 2015 (table 1).

The ferrotungsten price reported by Platts trended upward in 2016. The first week of January, the price was \$22 to \$24 per kilogram of contained tungsten. At yearend, it was \$35 to \$42 per kilogram of contained tungsten. The annual average price was essentially unchanged from that of 2015 (table 1).

Although the Fanya Metal Exchange ceased operations in 2015 following an investment scandal, the exchange reportedly held 29,651 t, gross weight, of APT (containing nearly 20,900 t of tungsten) at yearend 2016. 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, 2017).

## Foreign Trade

The tungsten content of U.S. exports was 3,380 t, a 10% decrease from the 3,760 t exported in 2015 (tables 6–10). The tungsten content of U.S. imports was 9,880 t, 3% less than the 10,200 t imported in 2015 (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 2016. The tungsten content of imports from China decreased by 4% to 2,760 t in 2016, from 2,880 t in 2015. The distribution of materials imported from China was as follows: tungsten metal powders, 20%; APT, 15%; unwrought tungsten, 14%; wrought tungsten, 13%; tungsten carbide powder and tungsten oxides, 11% each; tungsten waste and scrap, 10%; ferrotungsten, 4%; other tungstates, 1%; and other tungsten compounds, less than 1% each. Other countries that supplied 5% or more of United States tungsten imports were as follows: Bolivia, 11%; Germany, 9%; Spain, 8%; Austria, 7%; the United Kingdom, 6%; and Portugal and Russia, 5% each.

The tungsten contained in U.S. imports of ores and concentrates was 10% less than that of 2015. In 2016, the leading suppliers of imports of tungsten ores and concentrates were Bolivia (30%), Spain (21%), Portugal (15%), the United Kingdom (11%), and Mongolia and Russia (8% each) (table 11).

U.S. imports of APT were 20% lower than those of 2015 (table 12). In 2016, Germany supplied 55% of United States APT imports. The portion of APT imports from China has decreased from 94% in 2012 to 41% in 2016. 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 2016, U.S. net import reliance for tungsten as a percentage of apparent consumption was more than 25%. The actual value was withheld to avoid disclosing company proprietary data.

## World Review

Estimated world production of tungsten concentrates was slightly less than that of 2015, primarily because of the closure of Canada's Cantung Mine in late 2015. Large increases in production from Mongolia, the United Kingdom, and Vietnam were more than balanced by decreases in production from other countries. China continued to be the leading producer of tungsten concentrates, accounting for 82% of total world production in 2016. Vietnam was the second-ranked producing country, with 7% of world production; and Russia was ranked

third, with 4%. Combined production outside of China decreased for the second consecutive year (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 2016 (International Tungsten Industry Association, Sydney, 2017).

**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.

In early 2016, Almonty Industries Inc. (Toronto, Ontario, Canada) suspended production at the Wolfram Camp tungsten-molybdenum mine and beneficiation plant west of Cairns, Queensland. The suspension took place during a period of declining APT prices and allowed the company to focus on building a new tailings dam and to work on plant optimization. During the calendar year, Wolfram Camp produced 23 t of tungsten in concentrate (234 t in 2015) (Almonty Industries Inc., 2016, p. 10, 23; 2017, p. 10–11).

Thor Mining worked to reduce capital and operating expense forecasts and secure financing for its Molyhil tungsten-molybdenum project northeast of Alice Springs, Northern Territory. The initial project was to consist of 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 metric tons per year (t/yr) of tungsten in concentrate (130,000 metric ton units of WO<sub>3</sub> per year). During the year, Thor Mining worked to add additional ore sources to extend mine life and improve plant throughput rates. The company expected that concentrate production would begin 12 months after starting development. Thor Mining had a letter of intent from Global Tungsten & Powders Corp. (GTP) to purchase 70% to 75% of Molyhil's tungsten concentrate production during the life of the mine (Thor Mining PLC, 2017, p. 3, 5; undated).

Carbine Tungsten Ltd. (Melbourne, Victoria) maintained its Mt. Carbine project, west of Port Douglas in northern Queensland, in a development-ready status while waiting for market conditions to improve and tungsten concentrate prices to increase. The company had planned to produce tungsten concentrate from low-grade stockpiled ore, followed by production from open pit mining (Carbine Tungsten Ltd., 2016, p. 3).

Vital Metals Ltd. (Subiaco, Western Australia) maintained its fully permitted Watershed tungsten project in a development-ready status while waiting for tungsten prices to reach higher levels. The project, northwest of Cairns, Queensland, consisted of an open pit mine and beneficiation plant that would produce about 2,100 t/yr of tungsten in concentrate (Vital Metals Ltd., 2014, p. 1, 22; 2017).

King Island Scheelite Ltd. (KIS) (Sydney, New South Wales) worked on revising its definitive feasibility study for reestablishing open pit mining and processing operations at the former King Island Scheelite Mine on King Island, northwest of Tasmania. The company was considering developing the project in stages, with the first stage producing a lower grade concentrate in a lesser amount than initially planned. As part of the approval process, KIS submitted a revised environmental

assessment report for an 8-year open pit mine to the Tasmanian Environmental Protection Agency (King Island Scheelite Ltd., 2017, p. 4).

**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. During the year, WBH did preparatory work in advance of planned testing of a new hard-rock tunneling machine in 2017. The Mittersill Mine supplied some of the concentrate feed for WBH's Bergla processing plant near St. Martin in the State of Styria; the remainder was imported (Bundesministerium für Wissenschaft, Forschung, und Wirtschaft, 2017, p. 26–27).

**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 2016, Bodó Mineração Ltda. (a subsidiary of Brazilian Tungsten Holdings Ltd.) increased monthly production of scheelite concentrate from its underground Bodo Mine, Rio Grande do Norte State (Departamento Nacional de Produção Mineral, 2016, p. 112; Gunsynd plc, 2017).

**Canada.**—The Sisson Project Limited Partnership [Northcliff Resources Ltd. (Vancouver, British Columbia) and Todd Minerals Ltd. (Wellington, New Zealand)] worked to advance the environmental impact assessment process through the Canadian Federal Government. The project, in east-central New Brunswick, consisted of 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 (Northcliff Resources Ltd., 2017, p. 5–6).

**China.**—In 2016, China's production of concentrates decreased slightly to an estimated 72,000 t of contained tungsten. The decrease was attributed to oversupply, destocking, a request by the China Tungsten Industry Association for its members to reduce production in response to poor market conditions, and increased supervision for environmental protection. The domestic price of tungsten concentrate did not increase substantially from the low prices during the second half of 2015, which reportedly were below the cost of production for most Chinese mining companies. As a result, 51 tungsten operations (mines, processing plants, and downstream cemented carbide and tungsten products plants) operated at a loss and some mines reduced or ceased production. The distribution of concentrate production by Province or Autonomous Region was as follows: Jiangxi (40%); Hunan (29%); Henan (16%); Yunnan (6%); Fujian (3%); Guangdong and Guangxi (2% each); Gansu (1%); and Hubei, Nei Mongol, Xinjiang, and Zhejiang (less than 1% each) (Metal Bulletin Daily, 2016b; China Molybdenum Co., Ltd., 2017, p. 57; Qi, 2017, p. 13, 45; Tungsten & Molybdenum Monthly, 2017a, b).

Despite its position as the world's leading producer of mined tungsten, China has imported significant quantities of tungsten concentrates in recent years. In 2016, China imported approximately 2,100 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, Beijing Antaika Information Development Co., Ltd. estimated that China's tungsten market surplus decreased to 16,900 t from a revised 22,228 t in 2015; stocks of tungsten concentrates, APT, and tungsten carbide powder each decreased in 2016 (Qi, 2017, p. 19, 23, 25, 45; Tungsten & Molybdenum Monthly, 2017a; United Nations Statistics Division, undated).

The Government of China maintained a program to conserve energy and its tungsten resources, to protect the environment, and to ensure that its tungsten supply would meet anticipated demand. As part of this program, the Ministry of Industry and Information Technology prepared standards for the tungsten industry, which were implemented in February 2016. The standards included the following: minimum production levels of 150,000 t/yr of ore for open pit mines and 60,000 t/yr of ore for underground mines; a minimum mine life of 10 years; minimum production capacities of 5,000 t/yr of APT and 6,000 t/yr of ferrotungsten for new or renovated plants; minimum production capacities of 5,000 t/yr of tungsten catalyst scrap, 500 t/yr of tungsten alloy scrap, and 1,500 t/yr of other tungsten-bearing scrap materials for new, renovated, and existing plants; and detailed requirements for comprehensive use of resources and energy consumption, environmental protection, equipment, production safety and skills, product quality, and regulatory management (Tungsten & Molybdenum Monthly, 2016; China Molybdenum Co., Ltd., 2017, p. 39).

The Government continued to regulate the production of tungsten concentrates by requiring exploration and mining licenses, setting production quotas, and prohibiting foreign investment in tungsten exploration and mining. Regulation of the processing of tungsten concentrates included restricting foreign investment. In 2016, tungsten refining residue and process wastewater sludge generated during APT production were classified as hazardous waste, resulting in added costs and temporary shutdowns following inspections of tungsten processing plants. The Government regulated tungsten exports by issuing export licenses (Ministry of Commerce, 2015; Qi, 2017, p. 11; Tungsten & Molybdenum Monthly, 2017a, c).

For 2016, China's tungsten concentrate production quota remained at 91,300 t (65%  $WO_3$ ) 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 2016 quota of 91,300 t (65%  $WO_3$ ) was equivalent to approximately 47,100 t of contained tungsten, but production was estimated to be 72,000 t of contained tungsten. In recent years, the excess production has been attributed to production as a byproduct of other metals or by trading companies, which were not controlled by the quota; illegal mining; and double counting (Xiao, 2014, p. 8; Argus Tungsten Monthly Outlook, 2017; Tungsten & Molybdenum Monthly, 2017a).

In 2016, China's State Bureau of Material Reserve (SRB) held six tenders for the purchase of tungsten concentrates for its national stockpile. SRB reportedly purchased more than 30,500 t of concentrate (65%  $WO_3$ ), estimated to contain more than 15,700 t of tungsten. At each successful tender, the purchase price reportedly was higher than the prevailing market price (Metal Bulletin Daily, 2016a; Qi, 2017, p. 14).

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.**—Almonty Korea Tungsten Corp. (a wholly owned subsidiary of Woulfe Mining Corp., which is fully owned by Almonty) worked on financing alternatives, pre-construction development, and permitting for 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 capacity of the project would be approximately 2,000 t/yr of tungsten in concentrate. Almonty planned to begin commercial production at the mine in the second half of 2018, subject to securing financing (Wheeler and Wells, 2016, p. 193, 282; Almonty Industries Inc., 2017, p. 14).

**Peru.**—According to monthly reports from Peru’s Ministerio de Energía y Minas, Minera Tungsteno Malaga del Peru S.A. did not produce any tungsten concentrate from the Pasto Bueno Mine and beneficiation plant in the Ancash region (Ministerio de Energía y Minas, 2017).

**Portugal.**—In early 2016, Almonty concluded the acquisition of the Panasqueira Mine and beneficiation plant in Covilha, Castelo Branco, from Sojitz Tungsten Resources, Inc. by acquiring Beralt Ventures Inc. and its wholly owned subsidiary Beralt Tin and Wolfram Portugal S.A. from Sojitz Tungsten Resources Inc. Wolframite (ferberite) concentrate from Panasqueira was sent to Japan and elsewhere to be processed. During the year, Almonty implemented a revised mine plan, which resulted in increased grade of ore mined and reduced operating costs. In addition, Almonty evaluated the potential for recovering tungsten, copper, and tin from tailings produced since the 1970s (Almonty Industries Inc., 2017, p. 16–18).

W Resources PLC (London, United Kingdom) completed an initial mine development plan 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, 2016a, p. 2).

**Russia.**—In 2016, JSC A&IR Mining produced tungsten concentrates from ores mined by Primorsky GOK in Primorskiy Krai; JSC Novoorlovsky GOK [managed by Russkaya Gornorudnaya Kompaniya (the Russian Ore Mining Company)] produced concentrates from ores mined in Zabaykal’sk Krai; and Wolfram Company CJSC, which owned CJSC Buryat Wolfram in Zakamensk, Buryatiya Republic, produced

concentrates from tailings. Two hydrometallurgical tungsten processing plants operated in 2016—Kirovgradskiy Zavod Tverdykh Splavov OAO’s Kirovgrad Hard Alloys plant in Sverdlovsk Oblast and Wolfram Company’s Hydrometallurg plant at Nalchik, Kabardino-Balkariya Republic. Ferrotungsten was produced by Wolfram Company in Unecha, Bryansk Oblast and by OOO Moliren, in Roshal, Moscow region (Gorbachev, 2017, p. 7).

Wolfram Company, RT Global Resources LLC (a subsidiary of state-owned Rostec Corp.), and the Government of Kabardino-Balkariya Republic worked to restart production from the former Tyrnyauz tungsten mine in Kabardino-Balkariya Republic. Tyrnyauz was the largest tungsten deposit in Russia (Gorbachev, 2017, p. 18).

**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). 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 (Republic of Rwanda, Ministry of Natural Resources, undated).

**Spain.**—Daytal Resources Spain, S.L. (a subsidiary of Almonty) produced 645 t of tungsten in concentrate from its Los Santos Mine and beneficiation plant in Salamanca Province, 22% less than the 826 t produced in 2015. The decrease was the result of lower tonnage and average grade of ore mined compared to those of the previous year. During the year, Almonty completed an extension of 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., 2017, p. 9–10).

W Resources completed a mine optimization plan for the fast-track stage of its La Parrilla open pit mine in the Extremadura region in the Provinces of Badajoz and Caceres. By nearly doubling the design feed rate and installing new equipment, W Resources planned to be able to produce approximately 1,300 t/yr of tungsten in concentrate by mid-2017. During the year, W Resources arranged financing and offtake arrangements for the fast-track startup, began hard-rock mining, and produced and shipped tungsten concentrate. W Resources planned to double production at the mine, beginning in 2020 (W Resources PLC, 2016a; 2016b, p. 8, 10).

Saloro SLU, the project operating company for the Barruecopardo joint venture [Oaktree Capital Management, L.P. and Ormonde Mining PLC (Dublin, Ireland)], completed acquisition of all land needed to develop the Barruecopardo tungsten project in Salamanca Province. During the year, Saloro placed orders for plant equipment and awarded the contract for plant construction. The company 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 to begin during the third quarter of 2018. Ormonde had an offtake agreement with Noble

Resources International Pte. Ltd., under which Noble would purchase all the tungsten concentrate produced from the mine during its first 5 years of operation (Ormonde Mining PLC, 2017a, p. 8–10; 2017b, p. 8).

**United Kingdom.**—Wolf Minerals Ltd. (Subiaco, Western Australia, Australia) ramped up production from its Hemerdon tungsten and tin project in Devon, northeast of Plymouth. The project consisted of the Drakelands open pit mine and a beneficiation plant, which were expected to have an average production of 2,680 t/yr of tungsten in wolframite concentrate and 455 t/yr of tin in concentrate after rampup. During the year, metal recovery rates in the beneficiation plant continued to be adversely affected by processing the fine-particle-sized, weathered, near-surface ore that was being mined. Wolf Minerals began to make equipment changes and design modifications to allow continuous operation at capacity and to improve recovery rates. In November, the Devon County Council gave permanent approval for Wolf Minerals to operate 7 days per week and 24 hours per day and extended the planning permission to 2036. These approvals were expected to increase production, reduce unit costs, and fully mine the identified ore reserve. Wolf Minerals had offtake contracts for tungsten concentrate with GTP and WBH (Wolf Minerals Ltd., 2016, p. 1, 6, 30; 2017, p. 1).

**Vietnam.**—Nui Phao Mining Co. Ltd. (Masan Resources Corp., Ho Chi Minh City) produced 6,357 t of tungsten in concentrate at its Nui Phao polymetallic mine in Thai Nguyen Province, 24% more than the 5,123 t produced in 2015. The record-high production was attributed to productivity optimization initiatives that were commissioned during the first half of the year and throughput levels at the beneficiation plant that were higher than planned. Nui Phao Mining planned to increase tungsten recovery rates at the beneficiation plant from the design rate of 65% to nearly 80% by 2018. The company's tungsten concentrate was processed to APT, blue tungsten oxide, and yellow tungsten oxide at the nearby Nui Phao H.C. Starck Tungsten Chemicals Manufacturing joint-venture processing plant. In 2016, Masan announced plans to expand its business by acquiring technology to create unique downstream products (Masan Resources Corp., 2017a, p. 5, 25, 36; 2017b).

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.

Vietnam Youngsun Tungsten Industry Co., Ltd. reportedly completed construction of a circuit to produce tungsten metal powders and began production in May. The addition to its ferrotungsten plant in Halong City, Quang Ninh Province, had a capacity of 4,000 t/yr of APT (3,000 t/yr of contained tungsten) and would use raw materials from Vietnam and elsewhere to produce APT, which would then be converted to tungsten oxide, tungsten metal powder, and tungsten carbide powder (Metal Bulletin Magazine, 2016; Xu, 2016).

Asia Tungsten Products Vietnam Ltd. [Asia Tungsten Products Co., Ltd. (Hong Kong), a joint venture between ATC Alloys Ltd. and a private businessman] operated its ferrotungsten plant in the Vinh Bao district near the port of Haiphong on a campaign basis. From January through March, the plant produced more than 400 t of ferrotungsten, containing

approximately 300 t of tungsten, which was similar to the amount produced in 2015. Production was suspended in April to conduct a full review of operations. ATC Alloys was concerned about the operation and performance of the plant, about the quality of ferrotungsten being produced, and with its joint-venture partner's ties to the companies for which it was toll processing (ATC Alloys Ltd., 2016).

**Zimbabwe.**—RHA Tungsten Pvt. Ltd. (National Indigenisation and Economic Empowerment Fund and Premier African Minerals Ltd.) accelerated the development of its underground operation at its RHA tungsten mine in the Kamativi Tin Belt of northwestern Zimbabwe and began processing ore early in the year. During the year, RHA modified its beneficiation plant and commissioned and optimized the process in phases. Because of variability in the tungsten mineralization, RHA undertook extended sampling and reevaluation of the underground and open pit areas of the mine and determined that enough ore was available to support 3 years of mining at up to 40,000 metric tons per month of ore. At this level of production, the company could produce about 1,000 t/yr of tungsten in wolframite concentrate (10,000 to 11,500 metric ton units per month of  $WO_3$ ). RHA had an offtake agreement with Noble Resources International Pte. Ltd. (Singapore) for the sale of its concentrate (Premier African Minerals Ltd., 2017, p. 5–6).

## Outlook

World tungsten supply will likely continue to be dominated by China's production and exports. China's Ministry of Land and Resources kept the total tungsten production quota for 2017 at 91,300 t (65%  $WO_3$ ), equivalent to approximately 47,100 t of contained tungsten. In addition to maintaining production quotas, China's Government was expected to continue its efforts to reduce illegal mining and enforce stricter environmental policies (Qi, 2017, p. 10–13, 17).

In the next few years, tungsten concentrate production from Portugal, 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 increase. 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 restart production from inactive mines in Asia, Australia, Europe, and North America. The amount, location, and timing of new production will depend, in part, on higher tungsten prices and (or) 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 STATISTICS<sup>1</sup>

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

	2012	2013	2014	2015	2016
<b>United States:</b>					
<b>Concentrates:</b>					
Production	NA	NA	NA	NA	--
Consumption	W	W	W	W	W
Exports	186	1,050	1,230	398	183
Imports for consumption	3,610	3,690	4,080	3,970	3,580
<b>Stocks, December 31:</b>					
Consumer	W	W	W	W	W
U.S. Government <sup>2</sup>	14,000	11,900	11,600	11,600	11,600
Price, U.S. spot quotation <sup>3</sup>	358	358	348	302	148
<b>Ammonium paratungstate:</b>					
Production	W	W	W	W	W
Consumption <sup>4</sup>	W	W	W	W	W
Exports	833	1,600	653	310	108
Imports for consumption	1,500	2,220	1,780	1,270	1,020
Stocks, December 31, producer and consumer	W	W	W	W	W
<b>Price:</b>					
U.S. market <sup>3</sup>	449	369	358	299	198
European free market <sup>5</sup>	386	372	357	227	191
<b>Ferrotungsten:</b>					
Production	--	--	--	--	--
Consumption	165	97	107	227	128
Exports	2	31	76	29	23
Imports for consumption	316	470	454	269	236
Stocks, December 31, consumer	W	W	W	35	36
Price, U.S. free market <sup>3,6</sup>	50.18	47.22	46.74	30.21	29.88
<b>Primary products:</b>					
Net production <sup>7</sup>	6,360	6,150	6,310	6,080	7,500
Consumption <sup>8</sup>	11,400	10,700	11,600	11,100	10,400
<b>Stocks, December 31:</b>					
Producer <sup>7</sup>	653	769	674	493	544
Consumer <sup>8</sup>	706	646	676	541	531
U.S. Government <sup>2</sup>	125	125	125	125	125
World, production of concentrate	77,700 <sup>r</sup>	85,400 <sup>r</sup>	88,500 <sup>r</sup>	89,700 <sup>r</sup>	88,100

<sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data. -- Zero.

<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits, except prices.

<sup>2</sup>Source: Defense Logistics Agency Strategic Materials.

<sup>3</sup>Annual average calculated from weekly prices reported by Platts Metals Week.

<sup>4</sup>Reported by tungsten processors.

<sup>5</sup>Datum for 2012 is annual average calculated from semiweekly prices reported by Metal Bulletin. Data for 2013–2016 are annual averages calculated from monthly prices reported by Metal Bulletin.

<sup>6</sup>Dollars per kilogram of contained tungsten.

<sup>7</sup>Includes tungsten metal powder and tungsten carbide powder produced from metal powder; excludes cast and crystalline tungsten carbide powder and chemicals.

<sup>8</sup>Includes 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 2016<sup>1</sup>

(Metric tons, tungsten content)

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

<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>No sales or inventory changes during fiscal or calendar year.

<sup>3</sup>Twelve-month period ending September 30, 2016.

Source: Defense Logistics Agency Strategic Materials.

TABLE 3  
U.S. NET PRODUCTION AND STOCKS OF TUNGSTEN PRODUCTS<sup>1,2</sup>

(Metric tons, tungsten content)

	Tungsten metal powder	Tungsten carbide powder	Total
Net production: <sup>3</sup>			
2015	W	W	6,080
2016	W	W	7,500
Producer stocks, December 31:			
2015	W	W	493
2016	W	W	544

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits.

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

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

TABLE 4  
U.S. PROCESSORS OF TUNGSTEN IN 2016<sup>1,2</sup>

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. <sup>3</sup>	Towanda, PA.
Kennametal Inc.	Fallon, NV.
Do.	Huntsville, AL.
Niagara Refining LLC <sup>4</sup>	Depew, NY.
Tundra Companies	White Bear Lake, MN.
Do. Ditto.	

<sup>1</sup>Table includes data through March 26, 2018.

<sup>2</sup>Consumers of ammonium paratungstate, tungsten-bearing scrap, tungsten concentrates, and (or) tungsten oxides.

<sup>3</sup>A division of Plansee Group.

<sup>4</sup>A 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<sup>1,2,3</sup>

(Metric tons, tungsten content)

	2015	2016
Consumption by end use:		
Steels	205	94
Superalloys	588	513
Other alloys <sup>4</sup>	W	W
Cemented carbides <sup>5</sup>	6,310 <sup>r</sup>	5,760
Mill products made from metal powder	W	W
Chemical	88	88
Total	11,100	10,400
Consumption by form:		
Ferrotungsten	227	100
Tungsten metal powder	W	W
Tungsten carbide powder	6,400	5,900
Tungsten scrap <sup>6</sup>	W	W
Other tungsten materials <sup>7</sup>	88	88
Total	11,100	10,400
Consumer stocks, December 31:		
Ferrotungsten	35	36
Tungsten metal powder	33	30
Tungsten carbide powder	417	420
Tungsten scrap <sup>6</sup>	43	31
Other tungsten materials <sup>7</sup>	13	13
Total	541	531

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

<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Does not include materials used in making primary tungsten products.

<sup>3</sup>Includes estimates.

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

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

<sup>6</sup>Includes tungsten bars.

<sup>7</sup>Includes tungsten chemicals.

TABLE 6  
U.S. EXPORTS OF TUNGSTEN ORES AND CONCENTRATES, BY COUNTRY OR LOCALITY<sup>1,2</sup>

Country or locality of destination	2015			2016		
	Quantity		Value (thousands)	Quantity		Value (thousands)
	Gross weight (metric tons)	Tungsten content <sup>3</sup> (metric tons)		Gross weight (metric tons)	Tungsten content <sup>3</sup> (metric tons)	
Canada	--	--	--	1	1	\$13
China	13	7	\$85	32	17	342
Hong Kong	27	14	478	--	--	--
Italy	50	26	550	(4)	(4)	3
Malaysia	1	(4)	44	(4)	(4)	12
Netherlands	--	--	--	67	35	876
Russia	508	262	4,820	--	--	--
Singapore	50	26	548	--	--	--
Trinidad and Tobago	2	1	16	--	--	--
United Kingdom	10	5	28	--	--	--
Vietnam	109	56	186	253	130	770
Other	2	1	128	1	1	61
Total	771	398	6,890	355	183	2,080

-- Zero.

<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Harmonized Tariff Schedule of the United States code 2611.00.0000.

<sup>3</sup>Estimated from reported gross weight using 51.6% tungsten.

<sup>4</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7  
U.S. EXPORTS OF AMMONIUM PARATUNGSTATE, BY COUNTRY OR LOCALITY<sup>1,2</sup>

Country or locality of destination	2015		2016	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Brazil	1	\$5	--	--
Denmark	8	68	--	--
France	5	40	--	--
Germany	259	2,830	36	\$602
Hungary	--	--	5	96
India	33	294	--	--
Indonesia	--	--	3	30
Ireland	--	--	10	85
Jamaica	--	--	(3)	4
Japan	5	43	41	872
Mexico	--	--	3	25
Panama	--	--	4	36
Peru	--	--	1	13
Singapore	(3)	3	--	--
Spain	--	--	2	14
Thailand	--	--	(3)	3
United Kingdom	--	--	3	25
Total	310	3,280	108	1,800

-- Zero.

<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes other ammonium tungstates, such as ammonium metatungstate. Harmonized Tariff Schedule of the United States code 2841.80.0010.

<sup>3</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8  
U.S. EXPORTS OF TUNGSTEN METAL POWDERS, BY COUNTRY OR LOCALITY<sup>1,2</sup>

Country or locality of destination	2015			2016		
	Quantity		Value (thousands)	Quantity		Value (thousands)
	Gross weight (metric tons)	Tungsten content <sup>3</sup> (metric tons)		Gross weight (metric tons)	Tungsten content <sup>3</sup> (metric tons)	
Austria	10	8	\$389	6	5	\$161
Belgium	2	2	150	2	1	96
Brazil	6	5	373	5	4	255
Canada	91	73	5,130	94	75	4,830
Chile	5	4	126	5	4	187
China	6	5	386	5	4	226
Czechia	1	1	45	18	15	356
Ecuador	2	2	73	--	--	--
Egypt	1	(4)	38	2	2	194
France	16	13	562	9	7	337
Germany	25	20	2,040	69	55	2,890
Hong Kong	3	3	192	2	2	89
India	28	22	1,060	97	77	3,260
Ireland	8	7	490	5	4	272
Israel	7	5	279	(4)	(4)	14
Japan	33	26	1,460	14	11	788
Korea, Republic of	12	9	823	10	8	885
Mexico	14	11	927	17	14	1,170
Netherlands	3	2	112	2	1	61
Peru	6	5	353	3	2	176
Russia	--	--	--	2	1	128
Saudi Arabia	60	48	3,680	(4)	(4)	8
Singapore	18	14	1,640	(4)	(4)	17
South Africa	12	10	1,220	9	8	812
Turkey	9	7	508	1	1	57
United Arab Emirates	1	1	61	2	1	146
United Kingdom	6	5	326	2	2	170
Other	8 <sup>r</sup>	(4) <sup>r</sup>	541 <sup>r</sup>	4	(4)	278
Total	390	312	23,000	385	308	17,900

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

<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>May include tungsten alloy powders. Harmonized Tariff Schedule of the United States code 8101.10.0000.

<sup>3</sup>Estimated from reported gross weight using 80% tungsten.

<sup>4</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9  
U.S. EXPORTS OF TUNGSTEN CARBIDE POWDER, BY COUNTRY OR LOCALITY<sup>1,2</sup>

Country or locality of destination	2015		2016	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Argentina	3	\$99	2	\$72
Australia	22	854	25	778
Austria	43	750	62	714
Belgium	1	141	2	258
Brazil	17	1,220	7	428
Canada	203	11,100	145	6,350
Chile	4	189	3	188
China	133	3,070	14	922
Czechia	22	688	138	4,500
Denmark	4	224	5	193
France	9	267	2	97
Germany	187	12,300	178	8,960
Hong Kong	2	126	1	52
India	44	2,100	13	672
Indonesia	2	130	1	35
Ireland	17	745	3	81
Israel	2	102	(3)	8
Italy	4	232	2	131
Japan	29	2,770	35	2,560
Korea, Republic of	14	1,140	13	1,160
Luxembourg	11	373	10	279
Malaysia	4	267	2	99
Mexico	4	216	1	103
Netherlands	(3)	11	4	111
Peru	11	297	5	99
Philippines	3	301	5	418
Saudi Arabia	5	301	5	316
Singapore	13	1,370	15	960
South Africa	3	106	2	98
Switzerland	6	410	--	--
Taiwan	43	2,800	37	2,180
Thailand	2	138	1	55
Turkey	8	361	1	93
United Arab Emirates	2	152	1	115
United Kingdom	12	935	20	1,210
Vietnam	8	126	(3)	20
Other	3 <sup>r</sup>	164 <sup>r</sup>	5	316
Total	901	46,600	763	34,600

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

<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Harmonized Tariff Schedule of the United States code 2849.90.3000.

<sup>3</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 10  
U.S. EXPORTS OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY OR LOCALITY<sup>1</sup>

Product and country or locality of destination	HTS <sup>2</sup> code	2015		2016	
		Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Ferrotungsten and ferrosilicon tungsten:	7202.80.0000				
Brazil		6	\$14	5	\$12
Canada		(3)	5	1	38
Japan		--	--	2	107
Mexico		--	--	12	47
Netherlands		1	25	(3)	25
South Africa		--	--	2	4
Venezuela		15	36	--	--
Vietnam		7	16	--	--
Other		(3)	6	(3)	75
Total		29	102	23	308
Unwrought tungsten: <sup>4, 5, 6</sup>	8101.94.0000				
Austria		7	29	154	2,910
Brazil		16	66	2	8
Canada		495	2,240	361	1,740
China		2	14	63	264
Costa Rica		--	--	6	24
Côte d'Ivoire		22	92	--	--
Finland		--	--	68	1,320
Germany		91	381	114	500
India		14	62	(3)	4
Israel		2	9	4	15
Japan		13	53	2	10
Korea, Republic of		1	3	4	15
Mexico		78	416	56	311
Netherlands		8	35	237	2,620
Russia		21	90	--	--
Singapore		42	189	38	158
Spain		27	116	36	153
Switzerland		7	31	--	--
Taiwan		4	19	48	201
Thailand		78	329	20	85
United Kingdom		7	30	2	10
Vietnam		--	--	18	164
Other		4	25	4	56
Total		940	4,230	1,230	10,600
Waste and scrap: <sup>7</sup>	8101.97.0000				
Algeria		8	67	--	--
Austria		8	158	29	650
Belgium		75	936	27	944
Brazil		6	54	2	20
Canada		40	469	95	1,460
China		5	40	4	37
Finland		63	863	43	1,060
France		11	263	4	36
Germany		127	1,810	72	878
Israel		49	410	1	9
Japan		13	157	24	301
Korea, Republic of		5	38	32	273
Luxembourg		13	386	7	148
Malaysia		--	--	5	44
Netherlands		31	610	48	1,050
Taiwan		5	42	9	78
United Kingdom		181	2,290	20	189
Other		1	7	10	116
Total		638	8,600	435	7,310

See footnotes at end of table.

TABLE 10—Continued  
U.S. EXPORTS OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY OR LOCALITY<sup>1</sup>

Product and country or locality of destination	HTS <sup>2</sup> code	2015		2016	
		Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Wrought tungsten: <sup>4,8</sup>	8101.96.0000, 8101.99.1000, 8101.99.8000				
Austria		52	\$2,820	36	\$1,840
Canada		15	1,800	18	2,270
China		3	661	2	575
Costa Rica		11	1,520	9	1,440
Germany		6	860	22	1,830
Hungary		5	1,650	6	1,410
India		10	851	2	293
Israel		3	311	13	1,420
Italy		3	416	6	756
Japan		9	1,400	29	9,160
Korea, Republic of		1	251	2	325
Mexico		67	8,720	118	13,400
Netherlands		1	116	2	185
Singapore		5	667	2	338
Taiwan		2	301	27	3,910
United Arab Emirates		4	540	6	632
United Kingdom		7	1,520	5	1,140
Other		13 <sup>r</sup>	2,200 <sup>r</sup>	9	1,810
Total		217	26,600	315	42,800
Tungsten compounds: <sup>9</sup>	2841.80.0040				
Canada		4	12	4	10
China		8	644	3	179
Malaysia		5	54	3	38
Other		1	50	(3)	41
Total		18	760	11	269

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

<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

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

<sup>3</sup>Less than ½ unit.

<sup>4</sup>May include alloys.

<sup>5</sup>Content estimated from reported gross weight using 95% tungsten.

<sup>6</sup>Includes bars and rods produced simply by sintering; excludes powders and waste and scrap.

<sup>7</sup>Content estimated from reported gross weight using 70% tungsten.

<sup>8</sup>Includes bars and rods other than those produced simply by sintering; profiles, plates, sheets, strip, and foil; wire; and other wrought products. Contents estimated from reported gross weights using the following percentages: 95% tungsten for HTS codes 8101.96.0000 and 8101.99.1000; 80% tungsten for HTS code 8101.99.8000.

<sup>9</sup>Includes only other tungstates.

Source: U.S. Census Bureau.

TABLE 11  
U.S. IMPORTS FOR CONSUMPTION OF TUNGSTEN ORES AND CONCENTRATES,  
BY COUNTRY OR LOCALITY<sup>1,2</sup>

Country or locality of origin	2015		2016	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Australia	279	\$7,550	120	\$2,220
Bolivia	1,010	25,200	1,090	19,100
Brazil	27	613	20	309
Burundi	--	--	23	365
Canada	987	25,300	--	--
China	18	271	--	--
Colombia	13	483	--	--
Congo (Kinshasa)	--	--	11	211
Mexico	4	92	--	--
Mongolia	189	4,230	271	4,650
Peru	111	2,520	11	172
Philippines	--	--	1	10
Poland	(3)	5	4	104
Portugal	356	9,160	522	10,300
Russia	45	1,170	288	5,730
Rwanda	--	--	13	182
Spain	817	19,800	744	13,800
Thailand	41	1,100	34	602
United Kingdom	42	707	407	6,570
Vietnam	25	521	27	719
Total	3,970	98,700	3,580	65,100

-- Zero.

<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Harmonized Tariff Schedule of the United States codes 2611.00.3000 and 2611.00.6000.

<sup>3</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 12  
U.S. IMPORTS FOR CONSUMPTION OF AMMONIUM PARATUNGSTATE, BY COUNTRY OR  
LOCALITY<sup>1,2</sup>

Country or locality of origin	2015		2016	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
China	762	\$18,200	413	\$8,720
Germany	441	15,200	557	11,300
Japan	62	2,040	16	304
Vietnam	--	--	30	469
Total	1,270	35,500	1,020	20,700

-- Zero.

<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes other ammonium tungstates, such as ammonium metatungstate. Harmonized Tariff Schedule of the United States code 2841.80.0010.

Source: U.S. Census Bureau.

TABLE 13  
 U.S. IMPORTS FOR CONSUMPTION OF FERROTUNGSTEN AND  
 FERROSILICON TUNGSTEN, BY COUNTRY OR LOCALITY<sup>1,2</sup>

Country or locality of origin	2015		2016	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
China	80	\$2,800	99	\$2,470
Korea, Republic of	--	--	2	36
Russia	--	--	8	199
Sweden	(3)	4	--	--
United Kingdom	8	297	9	284
Vietnam	180	5,960	118	3,140
Total	269	9,060	236	6,130

-- Zero.

<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Harmonized Tariff Schedule of the United States code 7202.80.0000.

<sup>3</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 14

U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY OR LOCALITY<sup>1</sup>

Product and country or locality of origin	HTS <sup>2</sup> code	2015		2016	
		Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Tungsten metal powders: <sup>3</sup>	8101.10.0000				
Austria		6	\$339	1	\$45
Canada		126	7,490	175	7,740
China		564	20,200	552	15,600
Czechia		16	362	9	185
Finland		30	1,110	23	367
France		1	23	4	154
Germany		32	1,360	18	909
Hong Kong		--	--	10	345
Israel		118	6,320	61	2,080
Japan		32	2,180	19	1,440
Korea, Republic of		168	9,060	161	6,050
Poland		7	234	--	--
United Kingdom		3	235	3	193
Vietnam		10	208	--	--
Other		1 <sup>r</sup>	143 <sup>r</sup>	2	221
Total		1,110	49,300	1,040	35,400
Tungsten carbide powder:	2849.90.3000				
Austria		99	4,260	380	13,000
Canada		31	1,840	22	774
China		258	11,400	307	9,670
Czechia		4	126	--	--
France		14	1,220	7	641
Germany		218	9,350 <sup>r</sup>	20	843
Hong Kong		--	--	5	53
Israel		11	784	13	467
Korea, Republic of		19	1,050	24	1,020
Spain		--	--	4	146
Other		4 <sup>r</sup>	142 <sup>r</sup>	(4)	90
Total		659	30,200	782	26,700
Unwrought tungsten: <sup>3,5</sup>	8101.94.0000				
Austria		7	342	(4)	16
China		309	12,300	393	10,900
Korea, Republic of		--	--	2	67
Taiwan		10	82	--	--
United Kingdom		6	76	3	164
Other		1	44	2	88
Total		333	12,800	401	11,300
Waste and scrap:	8101.97.0000				
Australia		7	233	--	--
Austria		177	2,130	240	2,110
Belgium		14	390	--	--
Brazil		20	297	14	239
Canada		70	657	29	484
Chile		12	272	7	120
China		168	5,880	280	7,200
Czechia		39	1,070	30	697
Finland		11	134	4	71
Germany		296	5,900	193	3,020
India		68	1,960	26	470
Israel		3	85	14	282
Japan		16	227	20	186
Luxembourg		182	5,260	160	4,080
Mexico		223	4,460	199	3,420
Peru		22	636	--	--
Poland		72	2,370	79	1,340

See footnotes at end of table.

TABLE 14—Continued

U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY OR LOCALITY<sup>1</sup>

Product and country or locality of origin	HTS <sup>2</sup> code	2015		2016	
		Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Waste and scrap:—Continued					
Romania		--	--	14	\$316
Russia		132	\$3,650	133	2,800
Singapore		12	260	6	71
South Africa		32	673	--	--
Spain		--	--	19	180
United Kingdom		75	1,570	210	3,270
Vietnam		10	335	--	--
Other		9	260 <sup>r</sup>	9	163
Total		1,670	38,700	1,680	30,500
Wrought tungsten: <sup>3,6</sup>					
	8101.96.0000, 8101.99.1000, 8101.99.8000				
Austria		35	4,890	31	4,020
China		340	21,800	365	25,400
Czechia		3	818	5	841
France		4	911	4	771
Germany		17	2,870	16	2,980
Hong Kong		5	172	4	216
Hungary		4	698	3	688
Japan		13	4,300	17	4,060
Mexico		2	122	4	63
Russia		7	802	1	136
Singapore		4	634	3	606
Sweden		3	1,050	2	927
Taiwan		2	525	14	1,810
Other		10 <sup>r</sup>	3,060 <sup>r</sup>	8	2,510
Total		449	42,700	478	45,000
Tungsten oxides:					
	2825.90.3000				
China		352	10,400	308	7,020
Germany		14	743	25	585
Hong Kong		16	440	16	344
Russia		--	--	35	903
Uganda		13	293	--	--
Vietnam		--	--	83	1,800
Other		2	22	3	81
Total		396	11,900	470	10,700
Other tungstates:					
	2841.80.0020, 2841.80.0050				
China		30	1,060	38	873
Germany		10	728	4	278
India		9	329	9	256
Vietnam		--	--	55	1,060
Other		(4)	15	1	50
Total		50	2,130	107	2,520
Other tungsten compounds and chemical products: <sup>7</sup>					
	2827.39.4000, 2850.00.1000, 3824.90.3500				
Germany		12	284	10	236
Ireland		5	190	6	181
Italy		4	46	--	--
Japan		37 <sup>r</sup>	1,110 <sup>r</sup>	65	1,180
Korea, Republic of		5	135	--	--
Other		3	50	4	67
Total		65 <sup>r</sup>	1,820 <sup>r</sup>	85	1,670

See footnotes at end of table.

TABLE 14—Continued

U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY OR LOCALITY<sup>1</sup><sup>r</sup>Revised. -- Zero.<sup>1</sup>Table includes data available through March 26, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.<sup>2</sup>Harmonized Tariff Schedule of the United States.<sup>3</sup>May include alloys.<sup>4</sup>Less than ½ unit.<sup>5</sup>Includes bars and rods produced simply by sintering; excludes powders and waste and scrap. Content estimated from reported gross weight using 95% tungsten.<sup>6</sup>Includes bars and rods other than those produced simply by sintering; foil, plates, profiles, sheets, and strip; wire; and other wrought products.<sup>7</sup>Includes tungsten chlorides, hydrides, and nitrides, and mixtures containing tungsten.

Source: U.S. Census Bureau.

TABLE 15

TUNGSTEN: WORLD CONCENTRATE PRODUCTION, BY COUNTRY OR LOCALITY<sup>1</sup>

(Metric tons, tungsten content)

Country or locality <sup>2</sup>	2012	2013	2014	2015	2016
Australia	290	320	477	348	40 <sup>e</sup>
Austria	706	850	819	861	954
Bolivia <sup>3</sup>	1,247	1,253	1,252	1,460 <sup>r</sup>	1,110
Brazil	381	494	510	510 <sup>e</sup>	510 <sup>e</sup>
Burma <sup>e, 4</sup>	131	140	111 <sup>r</sup>	90 <sup>r</sup>	90
Burundi	270	6	23	9 <sup>r</sup>	10 <sup>e</sup>
Canada <sup>5</sup>	2,194	2,128	2,344	1,600 <sup>r, e</sup>	--
China <sup>e</sup>	64,400	71,100	71,000	73,000	72,000
Congo (Kinshasa) <sup>e, 3</sup>	35	55	12	21	53
Korea, North <sup>e, 6</sup>	100	65	70	70	50
Mongolia	66	274	557 <sup>r</sup>	351 <sup>r</sup>	753
Nigeria <sup>e, 7</sup>	40	380	290	70	60
Peru <sup>8</sup>	276	28	61	110	--
Portugal	763	692	671	474	549
Russia	4,281 <sup>r</sup>	4,191 <sup>r</sup>	3,775 <sup>r</sup>	3,262 <sup>r</sup>	3,100 <sup>e</sup>
Rwanda <sup>e, 3</sup>	830	1,100	1,000	850	820
Spain	542	510	822 <sup>r</sup>	835	650 <sup>e</sup>
Thailand <sup>e, 9</sup>	80	140	100	30	30
Uganda	34	57	63	36 <sup>r</sup>	40 <sup>e</sup>
United Kingdom	--	--	--	155 <sup>r</sup>	736
United States	NA	NA	NA	NA	--
Vietnam <sup>10</sup>	1,050	1,660	4,500 <sup>e</sup>	5,600	6,500 <sup>e</sup>
Zimbabwe <sup>11</sup>	--	--	--	NA	NA
Total	77,700 <sup>r</sup>	85,400 <sup>r</sup>	88,500 <sup>r</sup>	89,700 <sup>r</sup>	88,100

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. -- Zero.<sup>1</sup>Table includes data available through November 14, 2017. All data are reported unless otherwise noted. Totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.<sup>2</sup>Tungsten concentrates are thought to be produced in Colombia and the Republic of Korea, but information was inadequate to make reliable estimates of output.<sup>3</sup>Production estimated based on reported exports.<sup>4</sup>Tungsten content of tungsten and tin-tungsten concentrates produced by state-owned mining enterprises under the Ministry of Mines.<sup>5</sup>Data for 2012–14 based on production reported by North American Tungsten Corp.; datum for 2015 based on half-year production from North American Tungsten Corp. and an estimate for production from July through October 2015.<sup>6</sup>Production estimated based on imports reported by China.<sup>7</sup>Production estimated based on reported imports from Nigeria.<sup>8</sup>Datum for 2012 is based on production reported by Malaga Inc.; data for 2013–16 are based on production reported by the Ministry of Energy and Mines.<sup>9</sup>Based on data from the Department of Primary Industries and Mines.<sup>10</sup>Mine production for 2012–13 and 2015 reported by the International Tungsten Industry Association.<sup>11</sup>Production began in 2015, but information was inadequate to make reliable estimates.