



2017 Minerals Yearbook

TUNGSTEN [ADVANCE RELEASE]

TUNGSTEN

By Kim B. Shedd

Domestic survey data and tables were prepared by Annie Hwang, statistical assistant.

In 2017, global tungsten mine production, supply [mine production plus secondary (scrap) consumption], and consumption each increased compared with those of 2016. Although supply remained higher than consumption, the annual surplus decreased for the second consecutive year. These factors, in combination with production shutdowns in China as a result of environmental inspections that began during the year, caused tungsten prices in Europe, China, and the United States to trend upward during 2017. The annual average U.S. spot price for tungsten concentrate was \$245 per metric ton unit, a 66% increase from the annual average price of \$148 per metric ton unit in 2016, but it was still below the annual average price of \$302 per metric ton unit in 2015. In 2016, tungsten concentrate prices were estimated to be below the cash costs of production for at least one-half of mining companies, worldwide (Argus Media group, 2017a, p. 7; 2018b, p. 1–2, 5–7; Roskill Information Services Ltd., 2019, p. 1–5, 59–64).

In 2017, there was no known domestic production of tungsten concentrates. Most of the U.S. supply of tungsten raw materials consisted of imports, scrap, and sales from the National Defense Stockpile (NDS). The United States imported a record level of tungsten materials in 2017. 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. production of tungsten materials, apparent consumption, and reported consumption each increased compared with those of 2016 (tables 1, 3, 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 U.S. Department of Defense, Defense Logistics Agency Strategic Materials (DLA Strategic Materials) resumed sales of tungsten ores and concentrates under its basic ordering agreement. During fiscal year 2017 (October 1, 2016, through September 30, 2017), the agency sold 1,240 metric tons (t) of tungsten in ores and concentrates; 1,560 t of tungsten in ores and concentrates were sold during calendar year 2017. The quantities of tungsten materials remaining in the stockpile at the end of the calendar year are listed in tables 1 and 2 (Defense Logistics Agency Strategic Materials, 2017c).

The Annual Materials Plan for fiscal year 2017 provided the maximum quantities of tungsten materials available for disposal (defined as any sale, barter, upgrade, recovery, or rotation), as listed in table 2. The quantity of tungsten ores and concentrates available during fiscal year 2018 (October 1, 2017, through September 30, 2018) remained unchanged; the quantity of tungsten metal powder available increased from 35 t to 125 t. In addition to disposals, DLA Strategic Materials listed the possible acquisition of 5 t, gross weight, of tungsten-rhenium metal in fiscal year 2017, up from 2.5 t in fiscal year 2016. The quantity of tungsten-rhenium metal that could be acquired in fiscal year 2018 remained at 5 t (Defense Logistics Agency Strategic Materials, 2015, 2016a, b, 2017a, b).

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 the Democratic Republic of the Congo [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 2018, the U.S. Government Accountability Office (GAO) reported that the conflict minerals disclosures submitted for 2016 showed trends similar to those for filed for 2014 and 2015. A GAO analysis of a sample of 2017 filings estimated that 53% of the companies were able to determine the country of origin of their conflict minerals, an increase compared with 49% of the companies that filed in 2015 and 2016. The ability of reporting companies to identify the country of origin of their conflict minerals continued to be hindered by lack of access to suppliers and complex supply chains involving many suppliers and processing facilities. After conducting due diligence on the source and chain of custody of the conflict minerals in their products, an estimated 47% of the companies reported that they could not definitively confirm the source of the conflict minerals in their products, and almost all the companies that conducted due diligence 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, 59% 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, 2018, p. 9–12).

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 production of tungsten concentrates in 2017.

Thor Mining PLC (London, United Kingdom) published a revised resource estimate for its Pilot Mountain project, approximately 200 kilometers (km) southeast of Reno, NV. The indicated and inferred resources at the Desert Scheelite tungsten-copper deposit and Garnet tungsten deposit were reported as 11.73 million metric tons with an average grade of 0.28% WO_3 , which represented 32,720 t of WO_3 (approximately 25,900 t of contained tungsten). Thor planned to begin a scoping study and metallurgical test work for the project in early 2018 (Thor Mining PLC, 2018, p. 3).

In January, Silver Predator Corp. (Vancouver, British Columbia, Canada) transferred its 100% ownership in the Springer mine complex in Pershing County, NV, to its parent company, Till Capital Ltd. (Hamilton, Bermuda). 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). Till Capital intended to sell the property (Till Capital Ltd., 2018, p. 11–12, 42–43).

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 on the basis of 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 3% more than that of 2016 (table 3).

In 2017, U.S. tungsten processor Global Tungsten & Powders Corp. (GTP) acquired a 19.9% stake in Almonty Industries Inc. (Toronto, Ontario, Canada) in exchange for terminating a loan agreement. This represented the first time in GTP’s history that the company has taken a direct ownership position in a tungsten concentrate producer. Almonty has tungsten mines in Australia, Portugal, and Spain, and tungsten mine development projects in Republic of Korea and Spain (Almonty Industries Inc., 2017).

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 2017 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, 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 2017 was 8% more than that in 2016. Consumption to make cemented carbides and superalloys was 14% and 21% more than consumption in 2016, respectively; consumption to make steels and other alloys was less for each than consumption in 2016; and estimated consumption to make mill products and for chemical applications was essentially unchanged from consumption in 2016. Compared with consumption in 2016, U.S. end users consumed more tungsten carbide powder and tungsten metal powder, and less ferrotungsten and tungsten scrap. Estimated consumption of tungsten compounds in chemical applications remained unchanged (table 5).

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. In 2017, the number of rigs operating each week in the United States trended upward. The average number of weekly operating rigs in 2017 was 72% more than the average number of operating rigs in 2016 (876 rigs in 2017 compared with 509 rigs in 2016) (Baker Hughes Inc., 2018).

Prices

The weekly U.S. spot price for tungsten ore concentrate reported by Platts Metals Daily began the year at \$170 to \$180 per short ton unit (\$187 to \$198 per metric ton unit) and trended upward to \$265 to \$275 per short ton unit (\$292 to \$303 per metric ton unit) by yearend. The annual average of Platts’ U.S. tungsten ore concentrate prices was 66% higher than that of 2016 but still 32% less than that in 2013, 30% less than that in 2014, and 19% less than that in 2015 (table 1).

The weekly U.S. APT price reported by Platts trended upward from \$190 to \$200 per short ton unit (\$209 to \$220 per metric ton unit) at the beginning of the year to \$295 to \$325 per short ton unit (\$325 to \$358 per metric ton unit) at the end of the year. The annual average of Platts' U.S. APT prices was 40% higher than that of 2016 but still 25% less than that in 2013, 22% less than that in 2014, and 7% less than that in 2015 (table 1).

The U.S. free market ferrotungsten price reported by Platts fluctuated during 2017. The price was lowest in April, when it dropped to \$30 to \$34 per kilogram of contained tungsten, and highest in early December, when it was \$38 to \$49 per kilogram of contained tungsten. The annual average price was 25% higher than that of 2016 and 23% higher than that of 2015 but still 21% less than that in 2013 and 20% less than that in 2014 (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 2017. Concern continued throughout 2017 that releases from this large quantity of tungsten intermediate, estimated to be equivalent to almost 3 months of China's APT production, could suppress increases in global tungsten prices (Metal Bulletin Daily, 2016; Xu, 2017b).

Foreign Trade

The tungsten content of U.S. exports was 3,520 t, a 4% increase from the 3,380 t exported in 2016 (tables 6–10). The tungsten content of U.S. imports was a record high of 13,700 t, 39% more than the 9,880 t imported in 2016; imports of most materials were higher in 2017 than in 2016 (tables 11–14). More than one-half of the increase in imports was from China, the leading supplier of imported tungsten to the United States (accounting for 34% of all tungsten imports in 2017). The tungsten content of imports from China increased by 71% to 4,700 t in 2017 from 2,760 t in 2016. The distribution of materials imported from China was as follows: APT, 30%; tungsten oxides, 17%; tungsten carbide powder and tungsten metal powders, 14% each; wrought tungsten, 10%; tungsten waste and scrap, 8%; unwrought tungsten, 4%; ferrotungsten, 2%; ores and concentrates, other tungstates, and other tungsten compounds, less than 1% each. Other countries that supplied 5% or more of United States tungsten imports were as follows: Bolivia, 9%; Germany, 8%; Russia and Vietnam, 6% each; and the United Kingdom, 5%.

The tungsten contained in U.S. imports of ores and concentrates was 10% more than that of 2016. In 2017, the leading suppliers of imports of tungsten ores and concentrates were Bolivia (32%), Russia (18%), the United Kingdom (15%), Portugal (14%), and Spain (13%) (table 11).

U.S. imports of APT were more than double those of 2016 (table 12). In 2017, China supplied 63% of United States APT imports, Germany supplied 27%, and Vietnam supplied 10%. 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 2017, U.S. net import reliance for tungsten as a percentage of apparent consumption was more than 50%. The actual value was withheld to avoid disclosing company proprietary data.

World Review

Estimated world production of tungsten concentrates increased by 3% from that of 2016 (revised) but remained below record-high production levels in 2014 and 2015. The increase was primarily because of increased production from China, which continued to be the leading producer of tungsten concentrates with 82% of total world production in 2017. Vietnam was the second-ranked producing country, with 8% of world production; and Russia was ranked third, with 3%. Combined production outside of China decreased for the third consecutive year (table 15). World tungsten mine production was supplemented by tungsten recovered from scrap to supply global consumption. Industry analysts estimated that, in 2017, tungsten concentrates represented 70% to 76% of global tungsten supply, and tungsten scrap represented 24% to 30% (International Tungsten Industry Association, 2018, 6–7; Roskill Information Services, 2019, p. 16–17).

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. The scheelite was sold to Europe and United States (Tasmania Mines Ltd., undated).

Production at Almonty Industries' Wolfram Camp tungsten-molybdenum mine and beneficiation plant west of Cairns, Queensland, remained suspended throughout the year. Almonty began the suspension in early 2016 to construct a new tailings dam and to upgrade the beneficiation plant. The decision to restart mining and beneficiation was not expected until forecasts of APT prices improved (Almonty Industries Inc., 2018, p. 4, 10).

Specialty Metals International Ltd. (formerly Carbine Tungsten Ltd., Melbourne, Victoria) investigated the viability of recommissioning the tailings retreatment plant at its Mt. Carbine project, west of Port Douglas in northern Queensland, and was evaluating the possibility of ore sorting and selectively beneficiating higher grade ore from the project's low-grade stockpile. The company planned to produce tungsten concentrates from stockpiled tailings and low-grade ore before beginning open pit mining. During the year, Specialty Metals held preliminary offtake discussions with potential customers for its concentrates (Specialty Metals International Ltd., 2018).

Thor Mining announced improved results from X-ray ore sorting test work on its Molyhil tungsten-molybdenum project northeast of Alice Springs, Northern Territory, and commissioned a revised ore reserve study. In early 2018, Thor announced increased reserves, which would extend the mine life to 7 years as an open pit operation, and identified the potential for underground mining. Thor planned to update its 2015 feasibility study, which reported average production of tungsten in scheelite concentrate of approximately

1,000 metric tons per year (t/yr) (130,000 metric ton units per year of WO₃) during a 6-year mine life (Thor Mining PLC, 2015, 2018, p. 4).

Vital Metals Ltd. (Subiaco, Western Australia) continued to optimize its fully permitted, development-ready Watershed tungsten project while holding discussions with potential offtake partners. The project, northwest of Cairns, Queensland, consisted of an open pit mine and beneficiation plant that would produce approximately 2,100 t/yr of tungsten in concentrate (Vital Metals Ltd., 2014, p. 1, 22; 2018, p. 6–7).

King Island Scheelite Ltd. (KIS) (Sydney, New South Wales) received approval from the Tasmanian Environmental Protection Agency to reestablish open pit mining and processing operations at the former King Island Scheelite Mine on King Island, northwest of Tasmania. During the year, KIS worked on preparing detailed operating plans and tested fine ore crushing in place of ore grinding to improve scheelite recovery to concentrate. The company planned to finalize the definitive feasibility study, an offtake agreement, and financing before making an investment decision (King Island Scheelite Ltd., 2018, p. 3–4).

Tungsten Mining NL worked to develop its Mt. Mulgine tungsten project approximately 350 km north-northeast of Perth, Western Australia. During the year, Tungsten Mining updated its resource estimate, performed metallurgical test work, worked on environmental approvals and permitting, and acquired a nearly new modular processing plant with ball milling and gravity recovery circuits that would be used to produce concentrate. Towards the end of the year, Tungsten Mining and Xiamen Tungsten Co., Ltd. (XTC) entered a memorandum of understanding to negotiate for XTC to have the right to purchase Mt. Mulgine's tungsten concentrate in exchange for XTC's technical support to improve Mt. Mulgine's concentrate grades and recovery rates (Tungsten Mining NL, 2017, p. 8–10; 2018, p. 12).

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. The Mittersill Mine supplied some of the concentrate feed for WBH's Bergla processing plant near St. Martin in the State of Styria. The Bergla plant also processed tungsten concentrates imported from artisanal, small-scale, and large-scale (industrial) mines; secondary raw materials (scrap); and intermediate products such as APT and tungsten oxides (Wolfram Bergbau und Hütten AG, 2018, p. 1–2, 6).

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 (Departamento Nacional de Produção Mineral, 2018, p. 104).

Canada.—In mid-2017, the Government of Canada approved the environmental impact assessment submitted by the Sisson Project Limited Partnership [Northcliff Resources Ltd. (Vancouver, British Columbia) and Todd Minerals Ltd. (Wellington, New Zealand)]. During the year, Northcliff Resources and its consultants focused on collecting information needed for mine permits and leases; continued engineering studies to optimize the project's mining and metallurgical

recoveries; discussed offtake contracts with interested parties; and signed a cooperation agreement with the Woodstock First Nation, whose traditional territory is in the project area. The Sisson 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 mine life (Northcliff Resources Ltd., 2018, p. 5–8).

China.—In 2017, China's production of concentrates increased by 5% to an estimated 67,000 t of contained tungsten, which accounted for 82% of world production (table 15). During the year, supplies of tungsten concentrates were constrained by a number of factors, including increased enforcement of the mining quota, reduced operating rates resulting from environmental and safety inspections or weather, mine closures because of ore depletion, voluntary production cuts owing to increasing production costs, a reluctance by some producers to sell all their output, reduced concentrate inventories, and Government efforts to reduce illegal mining. The domestic price of tungsten concentrate increased from that of 2016, when it reportedly fell below the cost of production for some Chinese mining companies (Argus Media group, 2017b, p. 7; 2018b, p. 7; Qi, 2017, p. 13, 19, 46–47; Tungsten & Molybdenum Monthly, 2017; China Molybdenum Co., Ltd., 2018, p. 14–15, 57).

Despite its position as the world's leading producer of mined tungsten, China has imported significant quantities of tungsten concentrates in recent years. In 2017, China imported approximately 2,040 t of tungsten in concentrates, which was 14% of global production outside China. Scrap recycling also contributed to China's tungsten raw materials supply. Based on half-year statistics for supply (mine production plus imports), consumption, and exports, the China Tungsten Industry Association estimated that supply and demand were nearly in balance in 2017, following 2 years of stock drawdowns (Qi, 2017, p. 47; 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 had standards for the tungsten industry, which included minimum production levels and operational lives for mines; minimum production capacities for APT, ferrotungsten, and recycling 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 permits, setting production quotas, performing environmental inspections, 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 in China. Following environmental inspections that year, all APT producers in Ganzhou, Jiangxi Province, ceased production while their processing plants were being upgraded to meet environmental standards; some of the closures continued into 2017. In 2017, environmental inspections resulted in closures of some APT plants in Hunan Province. The Government regulated tungsten exports by issuing export licenses (Argus Media group, 2017b, p. 7; Metal Bulletin Daily, 2017b; Ministry of Commerce, 2017; Qi, 2017, p. 11, 13, 15, 17; Wu and Li, 2018).

For 2017, China's tungsten concentrate production quota remained at 91,300 t (65% WO₃) with 80% as primary mine production and 20% as comprehensive recovery from other sources. The quota was distributed among 17 Provinces, 4 of which received 82% of the total—Jiangxi, 42%; Hunan, 26%; and Henan and Yunnan, 7% each. China's concentrate production was typically greater than the quota. For example, the 2017 quota of 91,300 t (65% WO₃) was equivalent to approximately 47,100 t of contained tungsten, but production was estimated to be 67,000 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 Media group, 2017a, p. 7; Metal Bulletin Daily, 2017a; Qi, 2017, p. 17–18; Sun, 2018, p. 21).

The Ganzhou Tungsten Association issued monthly guide prices for wolframite concentrate, APT, and tungsten carbide powder.

Congo (Kinshasa).—In 2017, artisanal miners produced tungsten concentrate from the following Provinces: Sud-Kivu, 48%; Nord-Kivu, 32%; and Maniema, 21%. 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 (Ministère des Mines, 2018, p. 52; 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) continued to work on financing alternatives, development, and permitting for its Sangdong tungsten project southeast of Seoul in Gangwon Province. By yearend, Almonty had received the necessary surface permits to begin mine construction and entered into an engineering, procurement, and construction contract for the development and construction of a beneficiation plant. Almonty planned to begin mine construction once funding had been secured. Based on an updated feasibility study, ore from the underground mine would be processed by mineral flotation to produce a

scheelite concentrate during an 8-year mine life. The capacity of the project would be approximately 2,000 t/yr of tungsten in concentrate (Wheeler and Wells, 2016, p. 193, 282; Almonty Industries Inc., 2018, p. 11, 40).

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, 2018).

Portugal.—During the year, Almonty continued to focus on cost reduction at the Panasqueira Mine and beneficiation plant in Covilha, Castelo Branco. Production of tungsten in concentrate increased by more than 30% from that of 2016. The increase was attributed to continued increases in the grade of ore mined under the revised mine plan implemented after Almonty's acquisition of the operation in 2016. In May, Almonty entered an agreement with Cronimet Mining Processing SA Pty. Ltd. to install and operate X-ray transmission ore sorting equipment to treat tailings generated by Panasqueira's heavy-media separation unit. This equipment was expected to increase the mine's overall tungsten recovery rate by 10%, beginning around mid-2018. Almonty also continued to evaluate the potential for recovering tungsten, copper, and tin from tailings that had accumulated during more than 40 years of production. Wolframite (ferberite) concentrate from Panasqueira was sold to customers under 1-year fixed-price contracts (Almonty Industries Inc., 2018, p. 13–14).

W Resources PLC (London, United Kingdom) secured all approvals for developing 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. 2; 2018, p. 3–4).

Russia.—In recent years, 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—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 was in the construction stage of developing the Zabytoe tungsten-tin deposit in Primorskiy Krai. The mine was expected to produce 400 t/yr of tungsten in concentrate beginning in 2019. In 2017, the company obtained a license to develop the nearby Lazurnoe deposit, which would expand the reserve base for the project (Gorbachev, 2017, p. 10, 19; Roberts, 2018, p. 9, 13).

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-molybdenum mine in

Kabardino-Balkariya Republic. In 2017, Elbrus Mining Company LLC was established to construct a mining complex consisting of an underground mine, a beneficiation plant, and a hydrometallurgical plant with planned output of 4,500 t/yr of WO₃ (approximately 3,600 t/yr of tungsten) and 300 t/yr of molybdenum oxide. Tyrnauz was the largest tungsten deposit in Russia (Werner and others, 2014, p. 72; Gorbachev, 2017, p. 18; Elbrus Mining Company LLC, undated a, b).

Rwanda.—Rwanda had numerous tungsten mining operations; most were artisanal and 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.

Spain.—Daytal Resources Spain, S.L. (a subsidiary of Almonty) produced 560 t of tungsten in concentrate from its Los Santos Mine and beneficiation plant in Salamanca Province, 13% less than the 645 t produced in 2016. The decrease was the result of a lower average grade of ore mined compared to that of the previous year. Almonty continued to focus on controlling and reducing costs and expected its operating costs to trend downward as the grade of ore processed returned to optimal levels for the beneficiation plant. In 2017, 80% of the scheelite concentrate from Los Santos was sold under a 1-year fixed-price contract (Almonty Industries Inc., 2018, p. 9).

W Resources worked to finance and develop the next stage of its La Parrilla open pit mine in the Extremadura region in the Provinces of Badajoz and Caceres. In this stage, 2 million metric tons per year (Mt/yr) of run-of-mine ore would be crushed, screened, subjected to X-ray ore sorting and advanced jig technology, then concentrated by gravity techniques, followed by flotation and electrostatic separation to produce 2,700 t/yr of tungsten concentrate containing approximately 1,450 t/yr of tungsten and more than 400 t/yr of tin concentrate. During the year, W Resources raised funds for the project and awarded contracts for major plant components. The company hoped to begin production in 2019. In the third year of production, W Resources planned to increase run-of-mine ore production to 3.5 Mt/yr, which would increase output to approximately 2,100 t/yr of tungsten in concentrate (W Resources PLC, 2017, p. 2–3, 6–7, 10; 2018, p. 2, 5).

Saloro SLU, the project operating company for the Barruecopardo joint venture [Oaktree Capital Management, L.P. and Ormonde Mining PLC (Dublin, Ireland)], began construction on the Barruecopardo tungsten project in Salamanca Province. The company planned to develop a 9-year open pit operation, with a potential for later expansion underground. Ore was to be beneficiated using gravity methods to produce approximately 2,060 t/yr of tungsten in scheelite concentrate at full production after a 1-year rampup period. Saloro 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, 2014; 2018, p. 10, 12).

United Kingdom.—Wolf Minerals Ltd. (Subiaco, Western Australia, Australia) continued to ramp 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, Wolf Minerals developed and implemented a plan to improve plant availability, throughput, and recovery rates and to bring production up to design levels. The plant’s performance during the initial years of production was hindered by processing the fine-particle-sized, weathered, near-surface ore that was being mined. Ore feed blending and changes in ore characteristics as the pit deepened improved the quality of plant feed; this and plant modifications helped improve plant performance. Wolf Minerals had offtake contracts for tungsten concentrate with GTP and WBH (Wolf Minerals Ltd., 2015; 2017, p. 5–6; 2018, p. 3).

Vietnam.—Nui Phao Mining Co. Ltd. (Masan Resources Corp., Ho Chi Minh City) produced 6,483 t of tungsten in concentrate at its Nui Phao polymetallic mine in Thai Nguyen Province, slightly more than the 6,357 t produced in 2016. The record-high production was attributed to increased throughput at the beneficiation plant, which resulted in approximately 7% more ore being processed in 2017 compared with 2016, and an increase in the tungsten recovery rate from 63% to 67% following upgrades to the tungsten circuit. This allowed Nui Phao Mining to mine and process lower grade ores in 2017 and still produce more tungsten in concentrate. 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. Masan planned to expand its business by acquiring technology to create unique downstream products (Masan Resources Corp., 2018, p. 12, 18, 29, 68).

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.

In 2017, Vietnam Youngsun Tungsten Industry Co., Ltd. reportedly expected to produce approximately 600 t of ferrotungsten (approximately 450 t of contained tungsten) at its plant in Halong City, Quang Ninh Province. The feed materials for the plant included off-grade ferrotungsten from Europe or Russia and low-grade tungsten concentrates from South Africa, which required purification or upgrading prior to processing. As a result, the plant typically operated every other month, producing approximately 100 t of ferrotungsten each month that it operated (Xu, 2017a).

In 2016, Asia Tungsten Products Vietnam Ltd. [Asia Tungsten Products Co., Ltd. (Hong Kong), a joint venture between ATC Alloys Ltd. and a private businessman] suspended production at its ferrotungsten plant in the Vinh Bao district near the Port of Haiphong following a dispute over how to manage the plant. During 2017, the joint-venture partners tried to resolve the dispute. By early 2018, ATC Alloys reached a preliminary

agreement with the businessman to acquire the shares that it did not already own so that it would have full ownership of the plant (ATC Alloys Ltd., 2018, p. 4–5).

Zimbabwe.—RHA Tungsten Pvt. Ltd. [National Indigenisation and Economic Empowerment Fund (NIEEF) and Premier African Minerals Ltd.] commissioned vertical shaft upgrades at the underground mine at its RHA tungsten operation in northwestern Zimbabwe and installed an X-ray ore sorter at its beneficiation plant. Despite improved wolframite recoveries after installation of the ore sorter, ore grades both at the open pit and extracted during development of the underground mine were lower than anticipated and were not able to sustain profitable operations. As a result, RHA stopped mining the open pit and suspended production at the beneficiation plant while it developed the underground mine to access anticipated higher grade stopes. During the year, Premier African Minerals negotiated with NIEEF about increasing its share in RHA Tungsten to 90%. In early 2018, the operation was placed on care-and-maintenance status until Premier African Minerals could resolve its ownership negotiations and raise additional equity funds (Premier African Minerals Ltd., 2018, p. 3–4, 11).

Outlook

World tungsten supply likely will continue to be dominated by China's production and exports. China's Ministry of Natural Resources increased the total tungsten production quota for 2018 to 100,000 t (65% WO₃), equivalent to approximately 51,500 t of contained tungsten. Most of the increase from the 2017 quota is in the comprehensive use category, which represents tungsten produced as a coproduct or byproduct. In addition to maintaining production quotas, China's Government is expected to continue its efforts to reduce illegal mining and enforce environmental policies. A new environmental tax on pollutants, effective January 1, 2018, is expected to increase the cost of tungsten mining and processing (Qi, 2017, p. 12; Argus Media group, 2018a, p. 1; Sun, 2018, p. 14, 21, 23).

In the next few years, tungsten concentrate production from Portugal and Spain is expected to increase as producers improve output from established mines. 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 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 material, will depend on the performance of the following industry sectors: 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.

The transportation sector is estimated to account for approximately one-third of global tungsten consumption. Future

growth in tungsten use is expected to be strongly influenced by trends in vehicle production. Although the production of electric vehicles (EV) requires less tungsten for machining engine and gearbox parts than the production of vehicles with internal combustion engines, forecasts of strong growth in EV production are expected to partly counterbalance any decrease in unit consumption of tungsten per vehicle (Argus Media group, 2018a, p. 5).

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TABLE 1
SALIENT TUNGSTEN STATISTICS¹

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

	2013	2014	2015	2016	2017
United States:					
Concentrates:					
Production	NA	NA	NA	--	--
Consumption	W	W	W	W	W
Exports	1,050	1,230	398	183	532
Imports for consumption	3,690	4,080	3,970	3,580	3,930
Stocks, December 31:					
Consumer	W	W	W	W	W
U.S. Government ²	11,900	11,600	11,600	11,600	10,200
Price, U.S. spot quotation ³	358	348	302	148	245
Ammonium paratungstate:					
Production	W	W	W	W	W
Consumption ⁴	W	W	W	W	W
Exports	1,600	653	310	108	97
Imports for consumption	2,220	1,780	1,270	1,020	2,230
Stocks, December 31, producer and consumer	W	W	W	W	W
Price:					
U.S. market ³	369	358	299	198	278
European free market ⁵	372	357	227	191	242
Ferrotungsten:					
Production	--	--	--	--	--
Consumption	97	107	227	100 ^r	97
Exports	31	76	29	23	45
Imports for consumption	470	454	269	236	209
Stocks, December 31, consumer	W	W	35	36	36
Price, U.S. free market ^{3,6}	47.22	46.74	30.21	29.88	37.28
Primary products:					
Net production ⁷	6,150	6,310	6,080	7,500	7,760
Consumption ⁸	10,700	11,600	11,100	10,400	11,300
Stocks, December 31:					
Producer ⁷	769	674	493	544	621
Consumer ⁸	646	676	541	531	551
U.S. Government ²	125	125	125	125	125
World, production of concentrate	79,400 ^r	82,600 ^r	83,800 ^r	79,600 ^r	82,100

¹Revised. NA Not available. W Withheld to avoid disclosing company proprietary data. -- Zero.

¹Table includes data available through July 10, 2019. Data are rounded to no more than three significant digits, except prices.

²Source: Defense Logistics Agency Strategic Materials.

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

⁴Reported by tungsten processors.

⁵Annual averages calculated from monthly prices reported by Metal Bulletin.

⁶Dollars per kilogram of contained tungsten.

⁷Includes tungsten metal powder and tungsten carbide powder produced from metal powder; excludes cast and crystalline tungsten carbide powder and chemicals.

⁸Includes 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 2017¹

(Metric tons, tungsten content)

Material	Inventory, yearend ²		Annual Materials Plan ^{3,4}	Sales		Inventory decrease from previous year	
	Fiscal	Calendar		Fiscal	Calendar	Fiscal	Calendar
	year ³	year		year ³	year	year ³	year
Ores and concentrates	10,400	10,200	1,360	1,240	1,560	1,240	1,460
Tungsten metal powder	125	125	35	--	--	(5)	(5)
Total	10,500	10,300	1,400	1,240	1,560	1,240	1,460

-- Zero.

¹Table includes data available through July 10, 2019. Data are rounded to no more than three significant digits; may not add to totals shown.

²The yearend inventories included 1 metric ton, gross weight, of tungsten alloy.

³Twelve-month period ending September 30, 2017.

⁴Potential disposals, sales, or upgrades. The Annual Materials Plan also included the potential sale of less than ½ metric ton, gross weight, of tungsten metal scrap and the possible acquisition of 5 metric tons, gross weight, of tungsten-rhenium metal.

⁵Less than ½ unit increase.

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			
2016	W	W	7,500
2017	W	W	7,760
Stocks, December 31, producer:			
2016	W	W	544
2017	W	W	621

W Withheld to avoid disclosing company proprietary data.

¹Table includes data available through July 10, 2019. Data 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 2017^{1,2}

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

Do. Ditto.

¹Table includes data through July 10, 2019.

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

³A division of Plansee Group.

⁴A 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)

	2016	2017
Consumption by end use:		
Steels	94	87
Superalloys	513	619
Other alloys ⁴	W	W
Cemented carbides ⁵	5,760	6,550
Mill products made from metal powder	W	W
Chemical	88	88
Total	10,400	11,300
Consumption by form:		
Ferrotungsten	100	97
Tungsten metal powder	W	W
Tungsten carbide powder	5,900	6,640
Tungsten scrap ⁶	W	W
Other tungsten materials ⁷	88	88
Total	10,400	11,300
Stocks, December 31, consumer:		
Ferrotungsten	36	36
Tungsten metal powder	30	32
Tungsten carbide powder	420	420
Tungsten scrap ⁶	31	51
Other tungsten materials ⁷	13	13
Total	531	551

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

¹Table includes data available through July 10, 2019. Data 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 COUNTRY OR LOCALITY^{1,2}

Country or locality	2016			2017		
	Quantity		Value (thousands)	Quantity		Value (thousands)
	Gross weight (metric tons)	Tungsten content ³ (metric tons)		Gross weight (metric tons)	Tungsten content ³ (metric tons)	
Austria	--	--	--	785	405	\$8,420
China	32	17	\$342	--	--	--
France	--	--	--	2	1	169
Germany	(4)	(4)	9	7	4	138
Korea, Republic of	--	--	--	21	11	460
Netherlands	67	35	876	--	--	--
Portugal	--	--	--	76	39	698
Vietnam	253	130	770	139	72	649
Other	3 ^r	1	81 ^r	1	(4)	16
Total	355	183	2,080	1,030	532	10,500

^rRevised. -- Zero.

¹Table includes data available through November 9, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

²Harmonized Tariff Schedule of the United States code 2611.00.0000.

³Estimated from reported gross weight using 51.6% tungsten.

⁴Less than ½ unit.

Source: U.S. Census Bureau.

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

Country or locality	2016		2017	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Denmark	--	--	54	\$476
Ecuador	--	--	21	273
Germany	36	\$602	3	50
Hungary	5	96	16	145
Indonesia	3	30	--	--
Ireland	10	85	--	--
Japan	41	872	1	10
Mexico	3	25	(3)	3
Panama	4	36	(3)	10
Spain	2	14	--	--
United Kingdom	3	25	--	--
Other	2	19	2	20
Total	108	1,800	97	987

-- Zero.

¹Table includes data available through November 9, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

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

³Less than ½ unit.

Source: U.S. Census Bureau.

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

Country or locality	2016			2017		
	Quantity		Value (thousands)	Quantity		Value (thousands)
	Gross weight (metric tons)	Tungsten content ³ (metric tons)		Gross weight (metric tons)	Tungsten content ³ (metric tons)	
Austria	6	5	\$161	6	5	\$296
Brazil	5	4	255	5	4	242
Canada	94	75	4,830	122	98	6,010
Chile	5	4	187	5	4	175
China	5	4	226	4	3	222
Czechia	18	15	356	30	24	579
France	9	7	337	9	7	339
Germany	69	55	2,890	67	53	2,640
India	97	77	3,260	10	8	647
Ireland	5	4	272	1	1	53
Japan	14	11	788	4	4	217
Korea, Republic of	10	8	885	12	9	1,130
Mexico	17	14	1,170	30	24	1,690
Peru	3	2	176	8	6	436
Russia	2	1	128	3	3	190
Saudi Arabia	(4)	(4)	8	101	81	4,840
South Africa	9	8	812	10	8	1,040
Other	18 ^r	14 ^r	1,120 ^r	32	26	1,690
Total	385	308	17,900	458	367	22,500

^rRevised.

¹Table includes data available through November 9, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

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

³Estimated from reported gross weight using 80% tungsten.

⁴Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9
U.S. EXPORTS OF TUNGSTEN CARBIDE POWDER, BY COUNTRY OR LOCALITY^{1,2}

Country or locality	2016		2017	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Australia	25	\$778	30	\$1,000
Austria	62	714	191	1,670
Brazil	7	428	12	614
Canada	145	6,350	176	9,390
Chile	3	188	2	98
China	14	922	37	2,120
Czechia	138	4,500	57	1,630
Denmark	5	193	4	143
Dominican Republic	--	--	5	846
France	2	97	4	193
Germany	178	8,960	151	8,930
Hong Kong	1	52	3	191
India	13	672	13	768
Ireland	3	81	3	38
Japan	35	2,560	44	3,020
Korea, Republic of	13	1,160	20	1,680
Luxembourg	10	279	1	36
Malaysia	2	99	4	151
Mexico	1	103	3	146
Netherlands	4	111	2	110
Peru	5	99	2	117
Philippines	5	418	5	456
Saudi Arabia	5	316	19	956
Singapore	15	960	13	1,260
Taiwan	37	2,180	58	2,990
Thailand	1	55	13	136
United Kingdom	20	1,210	19	1,740
Other	17 ^r	1,150 ^r	14	952
Total	763	34,600	901	41,400

^rRevised. -- Zero.

¹Table includes data available through November 9, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

²Harmonized Tariff Schedule of the United States code 2849.90.3000.

Source: U.S. Census Bureau.

TABLE 10
U.S. EXPORTS OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY OR LOCALITY¹

Product and country or locality	HTS ² code	2016		2017	
		Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Ferrotungsten and ferrosilicon tungsten:	7202.80.0000				
Brazil		5	\$12	8	\$41
Canada		1	38	2	75
Dominican Republic		--	--	3	13
Germany		--	--	2	116
Hong Kong		(3)	41	5	13
Japan		2	107	1	77
Mexico		12	47	2	84
South Africa		2	4	14	45
United Kingdom		--	--	2	6
Other		1 ^r	60 ^r	7	204
Total		23	308	45	673
Unwrought tungsten: ^{4, 5, 6}	8101.94.0000				
Australia		--	--	30	109
Austria		154	2,910	230	4,960
Canada		361	1,740	90	1,990
China		63	264	1	38
Costa Rica		6	24	(3)	4
Finland		68	1,320	86	1,850
Germany		114	500	5	242
Korea, Republic of		4	15	1	36
Luxembourg		--	--	32	672
Mexico		56	311	11	478
Netherlands		237	2,620	202	3,030
Singapore		38	158	6	252
Spain		36	153	10	184
Taiwan		48	201	5	29
Thailand		20	85	2	38
United Arab Emirates		--	--	4	16
Vietnam		18	164	--	--
Other		13 ^r	103 ^r	9	452
Total		1,230	10,600	725	14,400
Waste and scrap: ⁷	8101.97.0000				
Austria		29	650	--	--
Belgium		27	944	--	--
Canada		95	1,460	101	1,380
China		4	37	13	154
Finland		43	1,060	50	1,520
Germany		72	878	108	1,990
Israel		1	9	11	153
Japan		24	301	19	207
Korea, Republic of		32	273	16	136
Luxembourg		7	148	--	--
Malaysia		5	44	--	--
Netherlands		48	1,050	42	248
Philippines		4	32	5	39
Sweden		--	--	5	42
Taiwan		9	78	2	17
United Kingdom		20	189	71	1,590
Other		15 ^r	152 ^r	8	64
Total		435	7,310	450	7,540

See footnotes at end of table.

TABLE 10—Continued
U.S. EXPORTS OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS, BY COUNTRY OR LOCALITY¹

Product and country or locality	HTS ² code	2016		2017	
		Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Wrought tungsten: ^{4,8}	8101.96.0000, 8101.99.1000, 8101.99.8000				
Austria		36	\$1,840	17	\$849
Canada		18	2,270	30	4,680
China		2	575	6	1,350
Costa Rica		9	1,440	6	804
France		1	137	2	222
Germany		22	1,830	30	3,050
Hungary		6	1,410	6	858
India		2	293	4	689
Israel		13	1,420	1	336
Italy		6	756	4	435
Japan		29	9,160	95	20,700
Korea, Republic of		2	325	1	244
Mexico		118	13,400	174	18,900
Netherlands		2	185	1	130
Poland		(3)	46	3	1,030
Singapore		2	338	2	421
Taiwan		27	3,910	2	434
United Arab Emirates		6	632	10	786
United Kingdom		5	1,140	5	1,000
Other		8 ^r	1,630 ^r	12	2,290
Total		315	42,800	410	59,200
Tungsten compounds: ⁹	2841.80.0040				
Canada		4	10	9	26
China		3	179	4	280
Germany		--	--	1	62
Malaysia		3	38	4	43
Other		(3)	41	1	68
Total		11	269	19	479

^rRevised. -- Zero.

¹Table includes data available through November 9, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

²Harmonized Tariff Schedule of the United States.

³Less than ½ unit.

⁴May include alloys.

⁵Content estimated from reported gross weight using 95% tungsten.

⁶Includes bars and rods produced simply by sintering; excludes powders and waste and scrap.

⁷Content estimated from reported gross weight using 70% tungsten.

⁸Includes 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.

⁹Includes only other tungstates.

Source: U.S. Census Bureau.

TABLE 11
U.S. IMPORTS FOR CONSUMPTION OF TUNGSTEN ORES AND CONCENTRATES,
BY COUNTRY OR LOCALITY^{1,2}

Country or locality	2016		2017	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Australia	120	\$2,220	--	--
Bolivia	1,090	19,100	1,250	\$23,600
Brazil	20	309	6	119
Burma	--	--	12	264
Burundi	23	365	73	1,340
China	--	--	1	44
Congo (Kinshasa)	11	211	--	--
Japan	--	--	(3)	3
Mexico	--	--	1	47
Mongolia	271	4,650	130	2,740
Peru	11	172	--	--
Philippines	1	10	--	--
Poland	4	104	9	200
Portugal	522	10,300	548	14,000
Russia	288	5,730	696	13,800
Rwanda	13	182	38	844
Singapore	--	--	(3)	9
Spain	744	13,800	496	11,800
Thailand	34	602	25	412
Uganda	--	--	53	904
United Kingdom	407	6,570	570	12,500
Uzbekistan	--	--	9	195
Vietnam	27	719	13	438
Total	3,580	65,100	3,930	83,200

-- Zero.

¹Table includes data available through November 9, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

²Harmonized Tariff Schedule of the United States codes 2611.00.3000 and 2611.00.6000.

³Less than ½ unit.

Source: U.S. Census Bureau.

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

Country or locality	2016		2017	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
China	413	\$8,720	1,400	\$31,100
Germany	557	11,300	609	12,100
Japan	16	304	--	--
Vietnam	30	469	220	4,910
Total	1,020	20,700	2,230	48,100

-- Zero.

¹Table includes data available through November 9, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes 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^{1,2}

Country or locality	2016		2017	
	Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Canada	--	--	3	\$76
China	99	\$2,470	93	2,620
Korea, Republic of	2	36	11	300
Russia	8	199	33	759
Switzerland	--	--	17	355
United Kingdom	9	284	--	--
Vietnam	118	3,140	52	1,680
Total	236	6,130	209	5,800

-- Zero.

¹Table includes data available through November 9, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

²Harmonized Tariff Schedule of the United States code 7202.80.0000.

Source: U.S. Census Bureau.

TABLE 14
U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS,
BY COUNTRY OR LOCALITY¹

Product and country or locality	HTS ² code	2016		2017	
		Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Tungsten metal powders:³	8101.10.0000				
Austria		1	\$45	4	\$141
Canada		175	7,740	251	9,910
China		552	15,600	681	22,500
Czechia		9	185	(4)	16
Finland		23	367	(4)	22
France		4	154	7	324
Germany		18	909	30	1,550
Hong Kong		10	345	--	--
Israel		61	2,080	32	1,220
Japan		19	1,440	38	2,940
Korea, Republic of		161	6,050	242	9,420
United Kingdom		3	193	4	215
Other		2	221	7	252
Total		1,040	35,400	1,300	48,500
Tungsten carbide powder:	2849.90.3000				
Austria		380	13,000	370	13,400
Canada		22	774	266	9,320
China		307	9,670	670	22,200
Czechia		--	--	4	212
France		7	641	10	1,300
Germany		20	843	14	813
Hong Kong		5	53	--	--
Israel		13	467	81	3,540
Korea, Republic of		24	1,020	13	555
Spain		4	146	3	95
Other		(4)	90	5	335
Total		782	26,700	1,440	51,800
Unwrought tungsten:^{3,5}	8101.94.0000				
Canada		--	--	22	397
China		393	10,900	191	5,990
Netherlands		(4)	17	9	241
Russia		--	--	22	521
United Kingdom		3	164	(4)	39
Other		4 ^r	154 ^r	3	141
Total		401	11,300	247	7,330
Waste and scrap:⁶	2620.99.2000, 8101.97.0000				
Austria		240	2,110	236	1,680
Belgium		--	--	27	264
Brazil		14	239	7	122
Canada		29	484	34	565
Chile		7	120	20	356
China		280	7,200	400	11,000
Czechia		30	697	52	1,400
Finland		4	71	3	83
Germany		193	3,020	360	6,260
India		26	470	29	699
Ireland		3	36	2	22
Israel		14	282	48	1,020
Japan		20	186	85	597
Luxembourg		160	4,080	287	1,840
Mexico		199	3,420	291	5,560
Netherlands		1	15	13	186
Poland		79	1,340	185	3,890

See footnotes at end of table.

TABLE 14—Continued
U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS,
BY COUNTRY OR LOCALITY¹

Product and country or locality	HTS ² code	2016		2017	
		Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Waste and scrap: ⁶ —Continued	2620.99.2000, 8101.97.0000				
Romania		14	\$316	--	--
Russia		133	2,800	17	\$316
Seychelles		4	93	3	68
Singapore		6	71	8	171
Spain		19	180	32	327
United Arab Emirates		--	--	5	134
United Kingdom		210	3,270	131	2,560
Vietnam		--	--	5	137
Other		1 ^r	18 ^r	1	24
Total		1,680	30,500	2,280	39,300
Wrought tungsten: ^{3,7}	8101.96.0000, 8101.99.1000, 8101.99.8000				
Austria		31	4,020	40	4,960
Canada		2	255	4	691
China		365	25,400	461	30,600
Czechia		5	841	5	719
France		4	771	13	2,160
Germany		16	2,980	23	4,010
Hong Kong		4	216	9	380
Hungary		3	688	5	631
Japan		17	4,060	11	4,760
Mexico		4	63	3	203
Seychelles		--	--	6	879
Singapore		3	606	3	486
Sweden		2	927	5	1,610
Taiwan		14	1,810	5	752
United Kingdom		1	473	3	641
Vietnam		--	--	9	248
Other		7 ^r	1,920 ^r	6	2,050
Total		478	45,000	612	55,800
Tungsten oxides:	2825.90.3000				
China		308	7,020	803	18,600
Germany		25	585	40	698
Hong Kong		16	344	--	--
Russia		35	903	37	1,130
Vietnam		83	1,800	125	2,530
Other		3	81	5	94
Total		470	10,700	1,010	23,000
Other tungstates:	2841.80.0020, 2841.80.0050				
China		38	873	5	138
Germany		4	278	5	210
India		9	256	11	302
Vietnam		55	1,060	362	6,520
Other		1	50	(4)	28
Total		107	2,520	383	7,200

See footnotes at end of table.

TABLE 14—Continued
 U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS TUNGSTEN-BEARING MATERIALS,
 BY COUNTRY OR LOCALITY¹

Product and country or locality	HTS ² code	2016		2017	
		Quantity, tungsten content (metric tons)	Value (thousands)	Quantity, tungsten content (metric tons)	Value (thousands)
Other tungsten compounds and chemical products: ⁸	2827.39.4000, 2850.00.1000, 3824.90.3500				
Germany		10	\$236	10	\$216
Ireland		6	181	--	--
Japan		65	1,180	71	1,240
Other		4	67	1	52
Total		85	1,670	82	1,510

¹Revised. -- Zero.

¹Table includes data available through November 9, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

²Harmonized Tariff Schedule of the United States.

³May include alloys.

⁴Less than ½ unit.

⁵Includes bars and rods produced simply by sintering; excludes powders and waste and scrap. Content estimated from reported gross weight using 95% tungsten.

⁶Includes ash and residues, mainly tungsten.

⁷Includes bars and rods other than those produced simply by sintering; foil, plates, profiles, sheets, and strip; 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.

⁸Includes tungsten chlorides, hydrides, and nitrides, and mixtures containing tungsten.

Source: U.S. Census Bureau.

TABLE 15
TUNGSTEN: WORLD CONCENTRATE PRODUCTION, BY COUNTRY OR LOCALITY¹

(Metric tons, tungsten content)

Country or locality ²	2013	2014	2015	2016	2017
Australia	320	477	348	108 ^r	20 ^c
Austria	850	819	861	954	975
Bolivia ³	1,253	1,252	1,460	1,110	994
Brazil	494	510	432 ^r	200 ^{r,c}	200 ^c
Burma ^{c,4}	235 ^r	247 ^r	144 ^r	157 ^r	212
Burundi ^{c,5}	6	23	9	63 ^r	130
Canada ⁶	2,128	2,344	1,600 ^c	--	--
China	65,000 ^r	65,000 ^r	67,000 ^r	64,000 ^r	67,000
Congo (Kinshasa) ^c	55	8 ^r	51 ^r	73 ^r	120
Korea, North ^{c,7}	65	70	70	50	310
Mongolia	274	557	351	753	150 ^c
Nigeria ^{c,8}	380	290	70	60	50
Peru	28	61	110	--	--
Portugal	692	671	474	549	724
Russia	4,191	3,775	3,262	2,672 ^r	2,094
Rwanda ^{c,3}	1,100	1,000	850	820	720
Spain	510	822	835	699 ^r	564
Thailand ^{c,9}	140	99 ^r	35 ^r	33 ^r	49
Uganda	57	63	36	41 ^r	62
United Kingdom	--	--	155	736	1,086
United States	NA	NA	NA	--	--
Vietnam ¹⁰	1,660	4,500 ^c	5,600	6,500 ^c	6,600 ^c
Zimbabwe ¹¹	--	--	NA	NA	NA
Total	79,400 ^r	82,600 ^r	83,800 ^r	79,600 ^r	82,100

^cEstimated. ^rRevised. NA Not available. -- Zero.

¹Table includes data available through December 18, 2018. All data are reported unless otherwise noted. Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²In addition to the countries and (or) localities listed, Colombia and the Republic of Korea may have produced tungsten concentrates, but available information was inadequate to make reliable estimates of output.

³Reported production, based on exports.

⁴Based on fiscal year production of tungsten and tin-tungsten concentrates reported by the Central Statistical Organization.

⁵Based on gross weight reported by the Institut de Statistiques et d'Etudes Economiques du Burundi.

⁶Data for 2013–14 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.

⁷Production estimated based on imports reported by China.

⁸Production estimated based on reported imports from Nigeria.

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

¹⁰Mine production for 2013 and 2015 reported by the International Tungsten Industry Association.

¹¹Production began in 2015, but information was inadequate to make reliable estimates of output.