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2019 Minerals Yearbook

SELENIUM AND TELLURIUM [ADVANCE RELEASE]

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Selenium and Tellurium

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In 2019, selenium and tellurium were not refined in the United States. Three copper refineries produced either semirefined selenium and tellurium or selenium- and tellurium-containing copper anode slimes, and all production was exported for further processing or discarded into tailings. U.S. imports and exports of selenium increased in 2019 compared with those in 2018, and imports and exports of tellurium decreased in 2019 compared with those in 2018. The average Platts Metals Week New York dealer price for 99.5%-pure selenium in 2019 increased by 5% to $20.00 per pound from $18.97 per pound in 2018. The average price for 99.99%-pure tellurium (in warehouse, Rotterdam), as reported by Argus Metals International, decreased by 18% in 2019 to $60.45 per kilogram from $73.64 per kilogram (revised) in 2018 (table 1).

Except for two mines in China that began mining tellurium as a principal product in 2010 and one mine in Sweden that recovered tellurium from gold-telluride ores, selenium and tellurium were recovered as byproducts of nonferrous metal mining in 2019, principally from anode slimes produced during the electrolytic refining of copper. Selenium and tellurium also can be recovered as byproducts of gold, lead, nickel, platinum-group metals, and zinc.

Production

Two primary electrolytic copper refineries produced selenium- and tellurium-containing intermediate products in the United States in 2019. ASARCO LLC's (Tucson, AZ) copper refinery in Amarillo, TX, produced semirefined selenium and tellurium, which were exported to Mexico for further processing. Rio Tinto Kennecott's [a subsidiary of Rio Tinto plc (United Kingdom)] copper refinery in Garfield, UT, generated selenium- and tellurium-containing slimes, which were discarded into tailings. Most of the selenium and tellurium came from copper ores mined in Arizona. Domestic production data for selenium and tellurium were withheld to avoid disclosing company proprietary data.

Legislation and Government Programs

On October 4, 2019, the Defense Logistics Agency Strategic Materials, U.S. Department of Defense, announced their Annual Materials Plan for fiscal year 2020 for potential acquisitions. Cadmium-zinc-tellurium (CZT) substrates were included in this plan, with a ceiling of 32,000 square centimeters (cm^2). CZT substrates have been on the DLA Strategic Minerals acquisition plan since 2014, in quantities ranging from 16,000 cm^2 to 40,000 cm^2. CZT substrates are used as a foundation to build mercury-cadmium-telluride-based infrared focal plane arrays, which are used in improvised explosive device detectors, medical imaging, night vision systems, and radiation detectors (U.S. Department of Defense, 2019).

The Small Business Administration's Small Business Innovation Research program awarded a contract to a private company, through the U.S. Department of Energy, to develop a producer of commercially viable CZT substrates within the United States. A new growth method called the Accelerage Crucible Rotation Technique by Modified Vertical Bridgman, developed at Washington State University, potentially allows for 10 to 20 times faster growth rates than current methods and threefold reduction in costs for the final detector (U.S. Small Business Administration, 2019).

Consumption

Selenium

The main metallurgical end use for selenium in 2019 was for the production of electrolytic manganese in China, where selenium dioxide (SeO_2) was substituted for sulfur dioxide to reduce the power required to operate electrolytic cells. Consumption of SeO_2 in China in 2019 was estimated to be 970 metric tons (t), unchanged from estimated consumption in 2018. In other metallurgical applications, selenium was used with bismuth to substitute for lead as a free-machining agent in brass plumbing fixtures. Metallurgical-grade selenium also was used as an additive to cast iron, copper, lead, and steel alloys (Xu, 2019, p. 11).

There are three other uses of selenium: it is used in the glass industry, as a micronutrient, and as a compound for pigments. In the glass industry, selenium was used to decolorize the green tint caused by iron impurities in container glass and other soda-lime silica glass. It also was used in art and other glass to produce a ruby red color and in architectural plate glass to reduce solar heat transmission through glass.

Selenium is a micronutrient essential to human and animal health, and in areas with selenium-poor soils, selenium was added to fertilizer and applied to acreage used to grow animal feed to increase selenium in the diet of animals and, in turn, the diet of humans. This practice was more common outside the United States.

Cadmium sulfoselenide compounds were used as pigments in ceramics, glazes, paints, and plastics. Selenium pigments have good heat stability, react well to moisture, and are resistant to ultraviolet or chemical exposure. These pigments produce a wide range of red, orange, and maroon colors but, because of the relatively high cost and the toxicity of cadmium-based pigments, their use was limited to applications where cost was not the prevailing factor and human contact was limited, such as art pieces (Selenium Tellurium Development Association, 2010).

Tellurium

In 2019, three major types of thin-film photovoltaic (PV) cells were in global commercial production. They were, in descending order of gigawatts (GW) produced in 2019, cadmium telluride (CdTe) (5.7 GW), copper indium gallium diselenide (1.6 GW), and amorphous silicon (0.2 GW). However, thin-film solar cells accounted for only 5% of all solar cells produced in 2019; the majority of PV solar cell production continued to be dominated by the conventional crystalline silicon technology. Global PV cell and module production in 2019 was 136.8 GW. China produced about 90 GW of solar cells and modules in 2019. Worldwide cumulative installations of solar cells were led by China with 210 GW (36%), North America with 70 GW (12%), Japan with 64 GW (11%), Germany with 47 GW (8%), India with 35 GW (6%), and the rest of the world with 158 GW (27%), totaling 584 GW installed cumulatively at the end of 2019, the highest annual installation. Annual production of CdTe cells increased to 5.7 GW from an estimated 2.7 GW in 2018 (Fraunhofer-Institut für Solare Energiesysteme ISE, 2020, p. 15, 20–23).

Within the United States, First Solar, Inc. (Tempe, AZ) shipped 5.4 GW of CdTe cells in 2019 from 5.7 GW of CdTe cells produced. Commercial production began at their new facilities in the United States and Vietnam, bringing their total facilities and nameplate capacities in Vietnam to 2.4 gigawatts per year (GW/yr); Lake Township, OH, to 1.3 GW/yr; Malaysia to 1.2 GW/yr; and Perrysburg, OH, to 0.6 GW/yr . Tellurium consumption for CdTe-based solar panels was estimated to be 91 metric tons per gigawatt, based on information from 2010 (Zweibel, 2010; First Solar, Inc., 2020, p. 50).

Other uses for tellurium included thermal imaging, thermoelectric cooling, an additive in steel manufacturing, and a vulcanizing agent for rubber. In thermal-imaging devices for infrared sensors and heat-seeking missiles, mercury-cadmium-telluride was built on a base of cadmium-zinc-telluride and used to convert the raw image into a crisp screen picture in a cryo-cooled environment. Semiconducting bismuth telluride was used in thermoelectric cooling devices. These devices consisted of a series of semiconducting material couples that, when connected to a direct current, caused one side of the thermoelement to cool and the other side to heat. Thermoelectric coolers were used in electronics and military applications, such as the cooling of infrared detectors, integrated circuits, laser diodes, and medical instrumentation, as well as in high-end automobiles to cool cup holders and seats. In China, these devices were used in refrigerators, water dispensers, and other home appliances.

In metallurgy, tellurium was used in steel as a free-machining additive, in copper to improve machinability without reducing conductivity, in lead to improve resistance to vibration and fatigue, in cast iron to help control the depth of chill, and in malleable iron as a carbide stabilizer.

Tellurium was used as a vulcanizing agent, as an accelerator in the processing of rubber, and in catalysts for synthetic fiber production. Other applications included the use of tellurium as a pigment to produce blue and brown colors in ceramics and glass (Selenium Tellurium Development Association, 2010).

Prices

The annual average New York dealer price for 99.5%-pure selenium, as reported by S&P Global Platts Metals Week, was $20.00 per pound in 2019, 5% more than the annual average price in 2018 (table 1). In 2019, the average monthly price of selenium in January was $20.00 per pound and remained steady through the year.

The average annual price for 99.99%-pure tellurium (in warehouse, Rotterdam), as reported by Argus Metals International, decreased by 18% in 2019 to $60.45 per kilogram from $73.64 per kilogram in 2018 (table 1). The average monthly tellurium price was $65.91 per kilogram in January 2019, continuing the rise from the low of $29 per kilogram in the last quarter of 2016, but declined steadily throughout the year until it reached a monthly average of $51.84 per kilogram in December 2019.

Foreign Trade

Selenium.—Exports of selenium in 2019 more than doubled to 361 t from 158 t in 2018. In descending order of quantity, Canada, Hong Kong, Egypt, Mexico, and Indonesia were the leading destinations for selenium exports in 2019 and collectively accounted for 90% of the export tonnage. Exports increased to Canada (by 98 t), Egypt (by 44 t), Mexico (by 36 t), Hong Kong (by 28 t), and Indonesia (by 20 t), but were partially offset by decreases in exports to the Republic of Korea (by 30 t) and China (by 14 t). Argentina, Brazil, Finland, Germany, and Saudi Arabia received a total of 3 t in 2018, but these countries did not receive exports in 2019. The Dominican Republic, Ecuador, the Netherlands, and Peru were not export destinations in 2018 but received a total of 17 t in 2019. Based on unrounded data, the annual average unit value of exports in 2019 was $18.00 per kilogram ($8.16 per pound), slightly less than the 2018 annual average (table 2).

In 2019, imports for consumption of selenium, including SeO_2, increased by 9% to 501 t from 458 t. Based on unrounded data, the annual average unit value of all imported selenium materials, by selenium content, in 2019 was $30.65 per kilogram ($13.91 per pound), 26% less than that in 2018 (table 3).

In 2019, imports of selenium metal increased by 11% to 496 t from 445 t in 2018. The Philippines, Germany, Mexico, China, and Japan, in descending order of quantity, collectively accounted for 74% of the imports of selenium metal into the United States in 2019. Imports increased from Germany (by 42 t), Mexico (by 40 t), Japan (by 25 t), and Chile (by 11 t), whereas imports decreased from China (by 51 t), Canada (by 18 t), and Belgium (by 13 t). Based on unrounded data, the annual average unit value of all imported selenium metal in 2019 was $30.60 per kilogram ($13.88 per pound), 26% less than that in 2018 (table 3).

In 2019, imports for consumption of SeO_2, by selenium content, decreased by 63% to 4.6 t from 12.3 t in 2018. Three countries—Germany, the Republic of Korea, and China, in decreasing order of quantity—collectively supplied the United States with 96% of the SeO_2 imports in 2019. There were

no imports of SeO_2 from the Philippines in 2019, a decrease from 5 t in 2018. Based on unrounded data, the annual average unit value of SeO_2 imports, with respect to selenium content, was $36.58 per kilogram ($16.59 per pound), a 26% decrease compared with that in 2018 (table 3).

Tellurium.—In 2019, tellurium exports were 827 kilograms (kg), an 80% decrease compared with the exports in 2018. The main destinations were Canada and Jordan, which collectively accounted for 94% of total tellurium exports. There were no exports of tellurium to the Netherlands, a decrease from 3,300 kg in 2018. Based on unrounded data, the annual average unit value of tellurium exports was $425.56 per kilogram ($192.99 per pound, a 304% increase compared with that in 2018 (table 4).

Imports for consumption of tellurium in 2019 decreased by 69% compared with imports in 2018. The leading suppliers were, in descending order of quantity, Germany, the Philippines, and Canada, which collectively accounted for 93% of the total imports of tellurium into the United States. Imports from Canada and China decreased by 122,000 kg and 31,900 kg, respectively, whereas imports from Germany increased by 21,800 kg. Based on unrounded data, the annual average unit value of tellurium imports in 2019 was $103.13 per kilogram ($46.77 per pound), a 20% increase compared with that in 2018 (table 5).

World Review

Global selenium and tellurium output cannot be determined with certainty because some companies and countries did not report production, and trade in scrap and semirefined products may have been included with refined metal trade data. World production of selenium, excluding output from Australia, Iran, Kazakhstan, Mexico, the Philippines, Uzbekistan, and the United States, was estimated to have remained essentially unchanged at 2,880 t in 2019 compared with the revised production in 2018 (table 6). World production of tellurium, excluding Australia, Belgium, Chile, Colombia, Germany, Kazakhstan, Mexico, the Philippines, Poland, and the United States, was estimated to have increased by 3% to 519 t from the revised total of 503 t in 2018 (table 7).

China.—China was the leading global producer of selenium and tellurium and accounted for an estimated 38% and 63% of world production, respectively. China produced an estimated 1,100 t of selenium in 2019, a 5% increase from that in 2018. Estimated production of tellurium in China was 325 t, a 6% increase from the revised production in 2018 (tables 6, 7).

On October 11, the Yunnan Provincial government announced an auction of the stocks of selenium and tellurium that were previously held by the Fanya Metal Exchange. The stocks were 337.8 t of selenium and 170 t of tellurium to be auctioned on October 27 and 28, with starting bids of 30.94 million yuan ($445,000) and 51.95 million yuan ($748,000), respectively. The selenium lot was purchased by Kunming Rongke New Materials Co., and Vital Materials Co., Ltd. purchased the tellurium lot. Kunming Rongke New Materials was established in September 2019 and was a vehicle to purchase the stocks for Vital Materials (Argus Metals International, 2019c; Daly, 2019, 2020).

According to the China Nonferrous Industry Association, the estimated selenium consumption in China remained steady at 2,100 t in 2019, unchanged from the previous year. The electrolytic manganese industry remained the leading consumer of selenium in China, followed by glass production, agriculture, electronics, and pigments. Selenium consumption was estimated to be less than selenium supply. Estimated consumption of tellurium in China increased to 170 t in 2019 from 150 t in 2018. Tellurium in China was consumed in the following areas: thermal coolers (50%), metallurgy (25%), photovoltaics (10%), petroleum chemicals (5%), and other (10%). Tellurium consumption in China was estimated to be less than production in 2019 (Mai and Xiaohui, 2019, p. 10–11, 15; Xu, 2019).

Germany.—Calyxo TS Solar GmbH, the only European producer of CdTe solar cells, increased production of solar cells to 60 megawatts per year in 2019. In April 2018, Calyxo had filed for bankruptcy owing to the cancellation of a major order and was later purchased by TS Group GmbH on July 2, 2018. In December 2019, Calyxo TS Solar GmbH filed for insolvency (Argus Metals International, 2019b; Enkhardt, 2020).

India.—In December 2018, Adani Enterprises Ltd. sought to develop a new copper cathode plant in Mundra, Gujarat State, and submitted an environmental impact assessment report to India's environment ministry for environmental clearance. The Mundra copper project was projected to produce 1,000,000 metric tons per year (t/yr) of copper cathode 500,000 t/yr of copper rod as the main products and 504 t/yr of copper telluriude, 288 t/yr of selenium, and 96 t/yr of tellurium as byproducts. Other byproducts included aluminum fluoride, gold, phosphoric acid, silver, and sulfuric acid. The copper concentrate was to be sourced from overseas. Adani expected to complete the project in 30 months once all necessary clearances had been obtained (Argus Metals International, 2019a; Ministry of Environment, Forest and Climate Change, Government of India, 2019a, p. 26–27; 2019b, p. ES-4).

Sweden.—Tellurium production at Boliden AB's Kankberg gold-tellurium mine decreased by 8% in 2019 to 40,953 kg from 44,641 kg in 2018. Boliden reopened the Kankberg Mine in 2012, and the mine's life was expected to extend into 2020 (Boliden AB, 2020, p. 112).

Outlook

The supply of selenium and tellurium is directly affected by the production of the principal product from which it is derived—copper—and, to a lesser extent, by the production of gold, lead, nickel, platinum-group metals, and zinc produced from sulfide ores. Recovery rates of selenium and tellurium from copper slimes are not expected to increase if selenium and (or) tellurium prices remain at or near those at yearend 2019. Tellurium markets are expected to remain slightly oversupplied in the near future (to 2020), whereas selenium markets are expected to have a slight shortage owing to increased agricultural use in China. Production of CdTe solar cells is expected to be unchanged in 2020 at 5.7 GW of cells being produced (Mai and Xiaohui, 2019, p. 15; Xu, 2019; First Solar, Inc., 2020, p. 50).

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TABLE 1
SALIENT SELENIUM AND TELLURIUM STATISTICS[1]

(Kilograms, contained metal, unless otherwise specified)

	2015	2016	2017	2018	2019
Selenium:					
United States:					
Production, primary refined	W	W	W	W	W
Exports	468,000	150,000	242,000	158,000	361,000
Imports for consumption[2]	457,000	433,000	469,000	458,000	501,000
Price, average, commercial grade,[3] dollars per pound	22.09	23.69	10.78	18.97	20.00
World, refinery production	2,600,000 r	2,670,000 r	2,790,000	2,890,000 r	2,880,000
Tellurium:					
United States:					
Production, primary refined	W	W	W	W	W
Exports	40,800	2,620	2,310	4,150	827
Imports for consumption	76,000	72,700	163,000	192,000	59,300
Price, average,[4] dollars per kilogram	77.00 r	37.50 r	37.63	73.64 r	60.45
World, refinery production	411,000	423,000 r	467,000	503,000 r	519,000

rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Table includes data available through July 16, 2020. Data are rounded to no more than three significant digits, except prices.
[2]Includes selenium metal and the selenium content of selenium dioxide.
[3]Annual average New York dealer price for 99.5% selenium. Source: S&P Global Platts Metals Week.
[4]Annual average price published by the Argus Media group–Argus Metals International for duties unpaid in warehouse, Rotterdam, 99.99% tellurium.

TABLE 2
U.S. EXPORTS OF SELENIUM[1]

	2018		2019	
Country or locality	Selenium content (kilograms)	Value	Selenium content (kilograms)	Value
Argentina	1,350	$20,900	--	--
Australia	767	9,700	200	$16,400
Brazil	488	11,100	--	--
Bulgaria	132	4,630	364	15,100
Canada	1,030	32,000	99,000	2,780,000
China	14,400	225,000	222	3,580
Dominican Republic	--	--	1,010	29,100
Ecuador	--	--	470	17,500
Egypt	24,100	555,000	68,300	1,060,000
Finland	823	12,800	--	--
Germany	233	4,100	--	--
Hong Kong	55,400	1,110,000	83,800	664,000
India	3,050	47,300	3,680	57,100
Indonesia	6,610	102,000	26,600	412,000
Japan	360	5,570	3,870	60,000
Korea, Republic of	30,000	503,000	275	6,000
Mexico	10,200	150,000	45,800	990,000
Netherlands	--	--	9,000	135,000
Peru	--	--	6,930	107,000
Philippines	4,440	31,300	4,410	37,000
Saudi Arabia	118	5,610	--	--
South Africa	127	3,790	1,090	16,900
Venezuela	4,600	71,300	5,530	85,800
Total	158,000	2,900,000	361,000	6,490,000

-- Zero.
[1]Table includes data available through July 16, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 3
U.S. IMPORTS FOR CONSUMPTION OF SELENIUM[1]

Class and country or locality	2018 Selenium content (kilograms)	2018 Value	2019 Selenium content (kilograms)	2019 Value
Selenium:				
Belgium	32,100	$1,080,000	19,300	$392,000
Canada	51,900	1,580,000	33,800	742,000
Chile	22,000	774,000	33,000	627,000
China	111,000	3,550,000	59,500	878,000
Germany	37,300 r	1,860,000	79,600	2,450,000
Hong Kong	11,000	517,000	--	--
India	9	5,400	200	5,000
Italy	--	--	168	8,270
Japan	28,100	2,380,000	53,500	2,910,000
Korea, Republic of	7,020	224,000	17,000	301,000
Luxembourg	54	12,100	--	--
Mexico	37,000	906,000	76,500	1,280,000
Netherlands	768	34,100	3	7,780
New Zealand	1,000	7,200	1,000	7,360
Philippines	96,500	5,140,000	96,100	5,130,000
Poland	9,140	209,000	14,000	177,000
Russia	1,000	37,800	3,000	72,800
Singapore	--	--	9,500	204,000
Total	445,000	18,300,000	496,000	15,200,000
Selenium dioxide:[2]				
China	4,610	242,000	710	13,000
Germany	1,940	111,000	1,940	74,200
Ireland	1	3,500	--	--
Japan	386	27,900	193	12,600
Korea, Republic of	--	--	1,780	69,000
Malaysia	426	51,900	--	--
Philippines	4,990	171,000	--	--
Total	12,300	606,000	4,620	169,000
Grand total	458,000	18,900,000	501,000	15,400,000

rRevised. -- Zero.
[1]Table includes data available through June 25, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Selenium content calculated as 71% of gross weight of material.

Source: U.S. Census Bureau.

TABLE 4
U.S. EXPORTS OF TELLURIUM[1]

Country or locality	2018 Tellurium content (kilograms)	2018 Value	2019 Tellurium content (kilograms)	2019 Value
Canada	310	$154,000	429	$253,000
Chile	1	5,110	--	--
Indonesia	--	--	3	2,540
Jordan	331	49,700	352	52,800
Korea, Republic of	--	--	43	43,500
Mexico	180	9,050	--	--
Netherlands	3,330	216,000	--	--
Romania	1	2,760	--	--
Total	4,150	436,000	827	352,000

-- Zero.

[1]Table includes data available through June 25, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 5
U.S. IMPORTS FOR CONSUMPTION OF TELLURIUM[1]

Country or locality	2018 Tellurium content (kilograms)	2018 Value	2019 Tellurium content (kilograms)	2019 Value
Belgium	1,500	$108,000	--	--
Canada	126,000	10,800,000	4,000	$744,000
China	32,200	2,520,000	314	74,700
Germany	24,500	2,450,000	46,300	4,570,000
Hong Kong	--	--	1,300	72,000
Japan	1,380	102,000	2,370	193,000
Netherlands	4	10,700	1	3,160
Peru	70	3,790	--	--
Philippines	5,680	444,000	4,750	442,000
Russia	--	--	284	14,200
Total	192,000	16,500,000	59,300	6,120,000

-- Zero.

[1]Table includes data available through June 25, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 6
SELENIUM: WORLD PRODUCTION, BY COUNTRY OR LOCALITY[1]

(Kilograms, selenium content)

Country or locality[2]	2015	2016	2017	2018	2019
Belgium[e]	200,000	200,000	200,000	200,000	200,000
Canada[3]	156,000	175,000	72,000	61,000	57,000 [e]
China	720,000 [r]	750,000 [r]	930,000	1,050,000 [r]	1,100,000 [e]
Finland	93,051	104,420	100,198 [r]	108,918 [r]	115,000 [e]
Germany	250,000	300,000	300,000 [e]	300,000 [e]	300,000 [e]
India[e, 4]	17,000	17,000	17,000	17,000	15,000
Japan	772,768	752,173	729,132	749,677 [r]	740,000 [e]
Peru[e]	40,000	45,000	45,000	45,000	40,000
Poland	87,000	81,660	73,900	66,360 [r]	64,000 [e]
Russia	135,000	150,000	150,000 [e]	150,000 [e]	150,000 [e]
Serbia	14,950	18,300	19,000	29,000 [r]	17,000
South Africa, anode slimes[e]	14,000 [r]	14,000 [r]	12,000	14,000 [r]	13,000
Sweden	54,000	60,000	89,000	45,000 [r]	19,000
Turkey	50,000	--	50,000 [e]	50,000 [e]	50,000 [e]
United States	W	W	W	W	W
Total	2,600,000 [r]	2,670,000 [r]	2,790,000	2,890,000 [r]	2,880,000

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data; not included in total. -- Zero.

[1]Table includes data available through June 1, 2020. 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.

[2]In addition to the countries and (or) localities listed, Australia, Iran, Kazakhstan, Mexico, the Philippines, and Uzbekistan may have produced refined selenium, but available information was inadequate to make reliable estimates of output. Australia is known to produce selenium in intermediate metallurgical products and has facilities to produce elemental selenium. In addition to having facilities for processing imported anode slimes for the recovery of selenium and precious metals, the United States has facilities for processing selenium scrap.

[3]Excludes selenium intermediates exported for refining.

[4]Production is based on fiscal year, with a starting date of April 1 of the year shown.

TABLE 7
TELLURIUM: WORLD REFINERY PRODUCTION, BY COUNTRY OR LOCALITY[1, 2]

(Kilograms, tellurium content)

Country or locality[3]	2015	2016	2017	2018	2019
Bulgaria	4,046	4,479	5,095	3,931 [r]	3,800 [e]
Canada[4]	10,000	18,000	49,000	40,000 [r, e]	40,000 [e]
China	285,000	279,000 [r]	291,000 [r]	307,000 [r]	325,000 [e]
Japan	37,356	32,911	37,754	57,231 [r]	50,000 [e]
Russia	35,000 [e]	42,900	44,000	42,000 [e]	52,000
South Africa[e]	6,600 [r]	6,700 [r]	5,300 [r]	7,700 [r]	7,700
Sweden	33,000	38,680	34,979	44,641	40,953
United States	W	W	W	W	W
Total	411,000	423,000 [r]	467,000	503,000 [r]	519,000

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data; not included in total.

[1]Table includes data available through June 1, 2020. 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.

[2]Insofar as possible, data relate to refinery output only; thus, countries and (or) localities that produced tellurium contained in copper ores, copper concentrates, blister copper, or refinery residues but did not recover refined tellurium are excluded to avoid double counting. Data were not totaled because of exclusion of data from major world producers.

[3]In addition to the countries and (or) localities listed, Australia, Belgium, Chile, Colombia, Germany, Kazakhstan, Mexico, the Philippines, and Poland may have produced refined tellurium, but available information was inadequate to make reliable estimates of output.

[4]Excludes tellurium intermediates exported for refining.