USGS
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2018 Minerals Yearbook

NIOBIUM [ADVANCE RELEASE]

U.S. Department of the Interior
U.S. Geological Survey

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Niobium

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In 2018, U.S. niobium apparent consumption (measured in contained niobium) was 10,100 metric tons (t), an increase of 30% compared with a revised 7,780 t in 2017 (table 1). No domestic mine production of niobium ore was reported. The niobium content of world mine production was 68,200 t, slightly greater than that of the previous year (tables 1, 4). The United States imported 11,200 t of niobium contained in niobium-bearing metal, alloys, ores, and concentrates, an increase of 20% compared with a revised 9,330 t in 2017 (table 1). In the same period, the United States exported 955 t of niobium contained in niobium-bearing alloys, ores, and concentrates, a decrease of 36% from that in 2017. World trade of niobium materials included ferroniobium and niobium metal, ores and concentrates, and scrap. Ferroniobium was the leading traded niobium material by weight as well as value. The leading reported end use of niobium was as an alloying element in superalloys, followed by carbon steel and stainless steel (table 2).

Legislation and Government Programs

Niobium was first added to the U.S. Government stockpile in 1943 (as columbite ore), and the U.S. Congress designated niobium as a strategic and critical material in 1946 by means of the Strategic and Critical Materials Stock Piling Act as amended through P.L. 79–520, July 23, 1946 (DeMille, 1947, p. 135). The Defense Logistics Agency Strategic Materials (DLA Strategic Materials), U.S. Department of Defense, did not designate niobium materials for potential disposal from the National Defense Stockpile under its fiscal year 2019 Annual Materials Plan (Defense Logistics Agency Strategic Materials, 2018b); however, DLA Strategic Materials designated a maximum quantity of 209 t of ferroniobium for potential acquisition (Defense Logistics Agency Strategic Materials, 2018a).

In May 2018, the U.S. Department of the Interior, in coordination with other executive branch agencies, published a list of 35 critical minerals, including niobium (U.S. Department of the Interior, 2018). This list was developed to serve as an initial focus, pursuant to Executive Order 13817, "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals," issued in December 2017 by the President of the United States aimed at reducing the vulnerability of supply-chain disruptions for critical minerals. The Executive order defined a critical mineral as (1) a non-fuel mineral or mineral material essential to the U.S. economy and national security, (2) vulnerable to supply-chain disruption, and (3) essential in the manufacturing of a product whose absence would have significant consequences for the U.S. economy and national security (Trump, 2017).

Production

Globally, pyrochlore is the leading mineral mined for niobium. Niobium minerals are typically converted to ferroniobium and other value-added products at the mine site. The primary marketable niobium materials are ferroniobium and niobium metal, ore, and oxide. Most niobium resources in the United States are of low grade and not commercially recoverable at current prices. As a result, domestic supply has been a concern during every national military emergency since World War I. In 2018, no domestic niobium mine production was reported. Recycled materials and stocks were the only domestic sources of niobium.

NioCorp Developments Ltd. (Centennial, CO), a resource company developing a niobium deposit in Elk Creek, NE, announced a new mine design that was expected to reduce the time to complete its planned underground mine. The new design, which incorporates ground freezing technology during construction of the production and ventilation shafts, would eliminate the need for soil and bedrock dewatering operations (a 12- to 18-month process) prior to commencing excavation for the shafts. In addition, the company determined that with the new design, a waterline to the Missouri River that would have discharged groundwater during dewatering operations was no longer needed, thereby eliminating the need for additional U.S. Clean Water Act section 404 and U.S. Rivers and Harbors Act of 1899 section 408 permits (NioCorp Developments Ltd., 2018a, b). At yearend, NioCorp was focused on project financing efforts as well as ongoing efforts to secure the remaining permits required prior to the onset of construction, including a U.S. Clean Air Act Prevention of Significant Deterioration Permit (NioCorp Developments Ltd., 2018c). The Elk Creek project would be the only niobium mine and primary niobium processing facility in the United States. NioCorp had previously announced that commercial production might begin in 2021, with a planned production rate of 7,060 metric tons per year (t/yr) of ferroniobium during the expected mine life of 32 years (NioCorp Developments Ltd., 2017).

Consumption

Domestic consumption data for niobium materials were developed by the U.S. Geological Survey by means of the "Columbium (Niobium) and Tantalum," "Consolidated Consumers," and "Specialty Ferroalloys" surveys. For niobium materials, no consumers responded to the "Columbium (Niobium) and Tantalum" canvass, 16 responded to the "Consolidated Consumers" canvass, and 1 responded to the "Specialty Ferroalloys" canvass.

Total apparent domestic consumption of niobium (measured in contained niobium) was 10,100 t in 2018, a 30% increase compared with that in 2017 (table 1). Reported consumption of niobium by the steel industry was 5,310 t in 2018, a 7% decrease compared with 5,680 t in the previous year (table 2). AK Steel Corporation (West Chester, OH), ArcelorMittal USA LLC (Chicago, IL), ATI Specialty Alloys and Components (Pittsburgh, PA), Global Advanced Metals Pty Ltd. (GAM) (Waltham, MA), H.C. Starck Inc. (Newton, MA), Praxair Surface Technologies Inc. [an Indianapolis, IN, subsidiary of Praxair, Inc. (Danbury, CT)], Precision Castparts Corp. (Portland, OR), and Reading Alloys, Inc. [a Robesonia, PA, subsidiary of AMETEK Specialty Metal Products Inc. (Collegeville, PA)] consumed niobium feed materials to produce intermediate niobium materials used in industrial manufacturing processes and products. Ferroniobium, the most commonly traded niobium material, was typically consumed in the production of high-strength low-alloy (HSLA) steel. Other uses included the fabrication of nonferrous and niobium alloys and production of niobium carbides and chemicals.

Prices

Niobium materials were not openly traded on exchanges. Purchase contracts were confidential between buyer and seller. Based on U.S. Census Bureau data for 2018, the average unit value of traded (imported plus exported) niobium-containing materials was $35.03 per kilogram for niobium oxide, $15.08 per kilogram for niobium ores and concentrates, and $21.11 per kilogram for ferroniobium (table 1).

Foreign Trade

According to the U.S. Census Bureau, the United States exported niobium materials valued at $19.7 million in 2018 (a decrease of 41% from that in 2017) and imported niobium materials valued at $476 million (an 27% increase from that in 2017) (table 3). Traded niobium materials included ferroniobium and niobium concentrates, metal, ores, and oxide. The large decrease in exports was largely attributed to a significant increase in the apparent domestic consumption of ferroniobium by the steel industry. In 2018, the United States imported 20% more ferroniobium and exported 37% less ferroniobium compared with 2017. Ferroniobium accounted for 59% of total imports and 82% of total exports by value. In 2018, Brazil continued to be the leading supplier of ferroniobium and niobium metal and oxides (table 3). Mexico and Canada continued to be the leading destinations of United States ferroniobium exports.

World Industry Structure

Niobium ore was primarily mined in Brazil, Canada, China, and countries in the Great Lakes region of Africa, and was typically beneficiated to concentrates containing about 55% to 60% niobium oxide (Nb_2O_5). Concentrates were further processed to produce ferroniobium or niobium metal and oxides. Ferroniobium, the leading commercial niobium-containing material, typically contained about 66% niobium (Roskill Information Services Ltd., 2018, p. 67).

In 2018, world production of niobium contained in cassiterite, columbite-tantalite, loparite, and pyrochlore concentrates was estimated to be 68,200 t (table 4), a slight increase compared with a revised 66,800 t in 2017. World production of ferroniobium, in terms of niobium content, was 66,800 t, slightly more than that in 2017 (table 5). Brazil and Canada were the leading producers of ferroniobium (table 5) and niobium mineral concentrates (table 4), accounting for more than 99% of global ferroniobium production and nearly 98% of global niobium mineral concentrates production. In Brazil, the leading producers were Companhia Brasileira de Metalurgia e Mineração (CBMM) and Niobras Mineração Ltda. [a subsidiary of China Molybdenum Co., Ltd. (China)]. In Canada, the leading producer was Niobec (a subsidiary of Magris Resources Inc.).

World Review

Brazil.—CBMM reported that it produced 93,800 t in gross weight of niobium products in 2018, including 82,900 t of standard grade ferroniobium, at its mining and industrial complex in Araxa, Minas Gerais. This represented a 23% increase from total production in 2017. The company also reported a 28% increase in sales of ferroniobium, which it attributed to the increased use of niobium in steel applications driven by considerable increases in the prices of vanadium and manganese, which are substitutes for niobium in those applications (Companhia Brasileira de Metalurgia e Mineração, 2019, p. 25–26). In 2018, CBMM started a new process to recover niobium from the slag generated during the metallurgical process. The company expected this new operation to result in reduced waste and increased efficiency in its overall production process (Companhia Brasileira de Metalurgia e Mineração, 2019, p. 42–43).

Mineração Taboca S.A. [a subsidiary of MINSUR S.A. (Peru)] operated the Pitinga-Pirapora Mine complex in the State of Amazonas. The company reported that it produced 3,980 t in gross weight of niobium and tantalum ferroalloys with an average combined niobium and tantalum content of 59%. This represented a 28% increase from total ferroalloy production in 2017 (MINSUR S.A., 2019, p. 28).

Niobras Mineração operated the Boa Vista Mine and ferroalloy plant in the State of Goias. The company reported that it produced 8,960 t of niobium contained in ferroniobium in 2018, a 3% increase compared with that in 2017. The company also announced that it had built a new crusher for ore processing at the Boa Vista Mine in September (China Molybdenum Co., Ltd., 2019, p. 21, 30).

Canada.—In November, NioBay Metals Inc. announced an increase in resources at its James Bay niobium project in northern Ontario owing to changes in the tonnage factor used in its calculations. NioBay reported updated mineral resource estimates in accordance with National Instrument 43–101 standards of 26.1 million metric tons (Mt) of indicated resources with a grade of 0.53% Nb_2O_5 and 25.3 Mt of inferred resources with a grade of 0.51% Nb_2O_5. At yearend, the company was focused on securing a permit to conduct exploration drilling at James Bay (NioBay Metals Inc., 2018).

In February, Commerce Resources Corp. announced that a 1.3-t sample of mixed niobium and tantalum ore from its Blue

River project in British Columbia was successfully processed into niobium and tantalum products using new patented technology. The company expected the new technology to lower operating costs of the project and was working towards acquiring the global rights to it (Commerce Resources Corp., 2018).

China.—New strength standards for reinforcing steel bar (rebar) went into effect in November. The new standards require rebar used for the reinforcement of concrete to meet a higher minimum tensile strength. The new standard also introduced a higher strength rebar grade aimed at increasing earthquake resistance in building construction. Higher tensile strengths in rebar were typically achieved through microalloying with elements such as vanadium or niobium. Owing to the lower and comparatively more stable prices of ferroniobium relative to ferrovanadium in China, steel mills were considering increasing their use of niobium in combination with vanadium in the manufacturing of high-strength rebar (Radford, 2018).

Japan.—In July, JX Metals Deutschland GmbH (Germany), a newly established subsidiary of JX Nippon Mining & Metals Corp., completed the acquisition of all shares of H.C. Starck Tantalum and Niobium GmbH (Germany), which was headquartered in Munich and operated a processing facility in Lower Saxony State, Germany, where it developed and produced high-purity niobium metal products. The acquisition also included niobium processing and manufacturing facilities operated by subsidiaries H.C. Starck Co., Ltd. in Rayong Province, Thailand; H.C. Starck Ltd. in Ibaraki Prefecture, Japan; and H.C. Starck Smelting GmbH & Co. KG in Baden-Wurttemberg, Germany; as well as assets of H.C. Starck North American Trading, LLC (Newton, MA) related to H.C. Starck's tantalum-niobium business (JX Nippon Mining & Metals Corp., 2018a, b).

Kenya.—In October, the International Centre for Settlement of Investment Disputes (Dubai, United Arab Emirates) issued a ruling on a case between the Government of Kenya and Cortec Mining Kenya Ltd. (a subsidiary of Cortec (pty) Ltd. [United Kingdom] and Stirling Capital Ltd. [United Kingdom]) over the revocation of the company's license for mining niobium and rare-earth minerals at its Mrima Hill project in Kwale County. The Government of Kenya voided the mining license in 2013 stating that it was issued against regulations that banned exploration of minerals in a national forest reserve and that the company did not obtain a required environmental impact assessment license. In 2016, Cortec sued the Government of Kenya arguing that its project had been unexpectedly nationalized following the 2013 election in Kenya, and the company sought compensation for its 6 years of investments in exploration and development of the project. The international court ruled that the license was not a protected investment and ordered Cortec to pay the Government of Kenya about $3.5 million for legal fees and expenses related to the case (Obulutsa and Malalo, 2018).

Russia.—LLC Lovozero GOK operated the Lovozero Mine in the Murmansk region. The company produced loparite mineral concentrates that were consumed by JSC Solikamsk Magnesium Works to produce niobium compounds at its facility in the Perm region. Solikamsk reported 467 t of niobium contained in shipments of niobium compounds in 2018, a 3% increase compared with that in 2017 (JSC Solikamsk Magnesium Works, 2019, p. 12–14).

Venezuela.—In May, the Government of Venezuela exported columbite-tantalite ore from artisanal mining for the first time in the country's history. In addition, in October, the Government announced that it commissioned the country's first columbite-tantalite ore concentration mill. The mill, which was located in the State of Bolivar and was operated by state-owned CVG Ferrominera Orinoco C.A., had an ore-processing capacity of 160 metric tons per day (Depablos, 2018a, b). According to the U.S. Census Bureau, the United States imported approximately 13 t of columbite-tantalite concentrates from Venezuela in 2018.

Outlook

Currently, operating niobium mines have adequate reserves to meet global demand for the foreseeable future. The steel industry is the largest consumer of niobium (mainly in HSLA steel), and niobium content of HSLA steel is greatest in developed countries, indicating that niobium use in steel could increase in developing nations. Potential new sources of niobium are typically associated with the production of other mineral deposits with niobium as a byproduct. Several potential new niobium sources were in development during 2018, including the Blue River and James Bay projects in Canada, the Dubbo project in Australia, the Elk Creek project in the United States, and the Panda Hill project in Tanzania. However, these projects were not expected to come into production in 2018, and thus no significant change in production distribution is anticipated.

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Tantalum-Niobium International Study Center.

TABLE 1
SALIENT NIOBIUM STATISTICS[1]

		2014	2015	2016	2017	2018
United States:						
Exports:						
Niobium ores and concentrates, gross weight	metric tons	60	73	14	7	5
Synthetic concentrates, gross weight	do.	200	138	379	113	198
Tantalum ores and concentrates, gross weight	do.	225	98	162	109	48
Niobium-containing ores and concentrates, Nb content[e, 2]	do.	60	42	64	26	28
Ferroniobium, Nb content	do.	1,050	1,390	1,410	1,460	926
Total exports, Nb content	do.	1,110	1,430	1,480	1,490	955
Imports for consumption:						
Niobium ores and concentrates, gross weight	do.	2	--	1	1	31
Synthetic concentrates, gross weight	do.	--	--	9	15	12
Tantalum ores and concentrates, gross weight	do.	897	730	675	1,010	1,050
Niobium-containing ores and concentrates, Nb content[e, 2]	do.	101	82	77	115	126
Niobium metal, Nb content[3]	do.	1,870	886	1,240	1,410 [r]	1,800
Niobium oxide, Nb content[e]	do.	1,020	983	855	895	964
Ferroniobium, Nb content[e]	do.	8,120	6,570	6,080	6,910 [r]	8,290
Total imports, Nb content	do.	11,100	8,520	8,250	9,330 [r]	11,200
Reported consumption, Nb content:						
Raw materials	do.	W	W	W	W	W
Ferroniobium and nickel niobium	do.	8,210	7,510	7,370	7,640 [r]	7,130
Apparent consumption, Nb content	do.	10,000	7,080	6,730	7,780 [r]	10,100
Unit value,[4] gross weight:						
Niobium ores and concentrates	dollars per kilogram	14.94	7.59	7.81 [r]	20.69	15.08
Niobium oxide	do.	37.04	36.19	33.66	31.20	35.03
Ferroniobium	do.	25.78	24.27	20.56	19.83	21.11
World, production of niobium concentrates, Nb content	metric tons	69,200 [r]	65,700 [r]	58,400 [r]	66,800 [r]	68,200 [e]

[e]Estimated. [r]Revised. do. Ditto. W Withheld to avoid disclosing company proprietary data. -- Zero.
[1]Table includes data available through March 30, 2020. Data are rounded to no more than three significant digits, except unit values; may not add to totals shown.
[2]Includes natural and synthetic niobium-containing ores and concentrates. Niobium (Nb) content of ores and concentrates was estimated assuming the following Nb_2O_5 contents: 30% in niobium ore, 16% in synthetic concentrates, and 16% in tantalum ore. The Nb content of Nb_2O_5 is 69.904%.
[3]Includes niobium and articles made of niobium.
[4]Weighted average value of imported plus exported materials.

Sources: U.S. Census Bureau and U.S. Geological Survey.

TABLE 2
REPORTED CONSUMPTION, BY END USE, INDUSTRY STOCKS OF FERRONIOBIUM AND NICKEL NIOBIUM, AND GOVERNMENT STOCKS BY MATERIAL IN THE UNITED STATES[1]

(Metric tons, niobium content)

	2017	2018
End use:		
Steel:		
Carbon	1,170	1,200
Stainless and heat-resisting	689	624
Full alloy	310 r	289
High-strength low-alloy	(2) r	(2)
Electric	(2)	(2)
Tool	(2)	(2)
Unspecified	3,500 r	3,190
Total	5,680 r	5,310
Superalloys	1,940 r	1,800
Alloys (excluding steels and superalloys)	20	21
Grand total	7,640 r	7,130
Stocks, December 31:		
Consumer	387 r	528
Producer[3]	W	W
Total	387 r	528
National Defense Stockpile, total uncommitted inventory by material:		
Ferroniobium	104	181
Niobium metal ingots	10	10

rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Table includes data available through March 30, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Included with "Steel: Unspecified."
[3]Ferroniobium only.

TABLE 3
U.S. FOREIGN TRADE IN NIOBIUM, BY CLASS[1]

HTS[2] code	Class	2017 Gross weight (kilograms)	2017 Value (thousands)	2018 Gross weight (kilograms)	2018 Value (thousands)	Principal destinations and sources in 2018 (gross weight in kilograms and value in thousand dollars)
	Exports:					
2615.90.3000	Synthetic concentrates	113,000	$3,300	198,000	$3,020	Germany 163,000, $2,640; China 21,100, $171; Mexico 12,300, $190.
2615.90.6030	Niobium ores and concentrates	7,460	165	4,510	133	India 3,400, $98; Russia 499, $14; France 392, $11; United Kingdom 204, $6.
2615.90.6060	Tantalum ores and concentrates[3]	109,000	3,840	48,000	316	China 26,600, $172; United Kingdom 21,100, $125; Singapore 227, $14.
7202.93.0000	Ferroniobium	2,250,000	26,200	1,420,000	16,200	Mexico 990,000, $10,900; Canada 271,000, $3,520; China 91,700, $1,010.
	Total exports	XX	33,500	XX	19,700	
	Imports for consumption:					
2615.90.3000	Synthetic concentrates	14,900	1,970	11,800	186	Switzerland 11,800, $181; China 27, $5.
2615.90.6030	Niobium ores and concentrates	1,120	12	30,700	398	Venezuela 16,000, $80; Canada 13,700, $291; China 947, $27.
2615.90.6060	Tantalum ores and concentrates[3]	1,010,000	39,500	1,050,000	62,600	Rwanda 562,000, $30,100; Australia 176,000, $10,400; Congo (Kinshasa) 93,900, $5,880.
2825.90.1500	Niobium oxide	1,280,000	39,900	1,380,000	48,300	Brazil 940,000, $33,000; Russia 153,000, $4,510; Thailand 124,000, $3,790.
	Total ores, concentrates, and oxides	XX	81,400	XX	111,000	
	Ferroniobium:					
7202.93.4000	Silicon <0.4%	561,000	22,000	537,000	21,500	Brazil 352,000, $14,600; Germany 185,000, $6,910.
7202.93.8000	Other	10,100,000 r	207,000 r	12,200,000	262,000	Brazil 7,110,000, $148,000; Canada 5,110,000, $114,000.
	Total ferroniobium	10,600,000 r	229,000 r	12,800,000	283,000	
8112.92.4000	Unwrought, powders[4]	1,410,000 r	65,700 r	1,800,000	82,100	Brazil 1,540,000, $68,300; Russia 113,000, $4,910; Switzerland 70,600, $2,640.
	Total imports	XX	376,000	XX	477,000	

rRevised. XX Not applicable.
[1]Table includes data available through March 30, 2020. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Harmonized Tariff Schedule of the United States.
[3]Tantalum ores and concentrates may contain niobium.
[4]Niobium waste and scrap is included in 8112.92.0600 along with other materials. Niobium other than powders, unwrought, and waste and scrap is included in 8112.99.9000 along with other materials.

Sources: U.S. Census Bureau and U.S. Geological Survey.

TABLE 4
NIOBIUM: WORLD PRODUCTION OF MINERAL CONCENTRATES, BY COUNTRY OR LOCALITY[1, 2]

(Kilograms, niobium content)

Country or locality[3]	2014	2015	2016	2017	2018
Brazil, mineral concentrate[4]	62,055,000	58,852,000	50,752,000	58,137,000 r	59,000,000 e
Burundi, ore and concentrate	21,000	10,000	6,200	15,000 r	23,000 e
Canada, pyrochlore concentrate	6,000,000 r	5,600,000 r	6,300,000 r	7,200,000 r	7,700,000 e
China, mineral concentrate[e]	19,600	30,100	35,000	37,000	40,000
Congo (Kinshasa):					
Cassiterite concentrate	74,000	84,000	120,000	190,000	160,000
Columbite-tantalite concentrate	200,000	370,000	420,000	380,000	400,000
Ethiopia, columbite-tantalite concentrate[e]	12,000	15,000	16,000	22,000 r	26,000
Mozambique, columbite-tantalite concentrate	4,837	2,735	4,005	3,700 e	4,000 e
Nigeria, columbite-tantalite concentrate[e]	52,000	53,000 r	73,000 r	75,000 r	70,000
Russia, loparite concentrate	405,935	439,140	439,209	452,771 r	480,000 e
Rwanda:					
Cassiterite concentrate	53,000	34,000	32,000	42,000	42,000
Columbite-tantalite concentrate	290,000	210,000	160,000	220,000	210,000
Uganda, ore and concentrate[e]	--	190 r	530 r	470 r	550
Total	69,200,000 r	65,700,000 r	58,400,000 r	66,800,000 r	68,200,000

[e]Estimated. [r]Revised. -- Zero.

[1]Table includes data available through July 16, 2019. 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]Figures for all countries and (or) localities represent marketable output.

[3]In addition to the countries and (or) localities listed, Australia, French Guiana, Malaysia, and Venezuela may have produced niobium mineral concentrates, but available information was inadequate to make reliable estimates of output.

[4]Includes columbite-tantalite and pyrochlore.

TABLE 5
FERRONIOBIUM (FERROCOLUMBIUM): WORLD PRODUCTION, BY COUNTRY OR LOCALITY[1]

(Metric tons, niobium content)

Country or locality[2]	2014	2015	2016	2017	2018[e]
Brazil	51,737	51,874 r	44,390 r	58,690 r	59,000
Canada	5,774	5,385	6,099 r	6,981	7,500
Russia[e]	100	160	80	240 r	250
Total	57,600	57,400 r	50,600 r	65,900 r	66,800

[e]Estimated. [r]Revised.

[1]Table includes data available through July 3, 2019. 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, Austria, China, and Germany may have produced ferroniobium (ferrocolumbium), but available information was inadequate to make reliable estimates of output.