



2013 Minerals Yearbook

NIOBIUM AND TANTALUM [ADVANCE RELEASE]

NIObIUM (COlUMBIUM) AND TANTALUM

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In 2013, U.S. niobium apparent consumption (measured in contained niobium) was 8,140 metric tons (t), 16% less than that of 2012; U.S. tantalum apparent consumption (measured in contained tantalum) was 260 t, 40% less than that of 2012. No domestic mine production of niobium or tantalum ore was reported. Compared to that of the previous year, the niobium content of world production of niobium and tantalum mineral concentrates decreased by 8.5%, whereas tantalum content increased by 9%. Measured in gross quantity, U.S. exports of niobium materials increased 29%, whereas imports decreased 16%; U.S. exports of tantalum materials increased 16%, and imports increased 31%. The leading use of niobium was as an alloying element in steel. The leading use of tantalum was in the manufacture of capacitors.

Because the United States has no niobium or tantalum reserves, domestic supply has been a concern during every national military emergency since World War I. World niobium and tantalum production are geographically concentrated in Brazil (niobium and tantalum) and Canada (niobium) in the Western Hemisphere and in Congo (Kinshasa) (tantalum) and Rwanda (tantalum) in the Eastern Hemisphere. Materials from recycling and stocks are the only domestic supply sources of niobium and tantalum. Synthetic concentrate, a product of tin slag, substitutes for ore concentrate.

About 74% of tantalum world supply was from the mine production of tantalum-containing minerals with an additional 8% from slags and synthetic concentrates and the remaining 18% from recycling in 2011, the most recent year for which data were available (Roskill Information Services Ltd., 2012, p. 17).

Legislation and Government Programs

The Defense Logistics Agency Strategic Materials (DLA Strategic Materials), U.S. Department of Defense, did not designate niobium or tantalum materials for disposal under its fiscal year 2013–14 Annual Materials Plans (Defense Logistics Agency Strategic Materials, 2013). The U.S. Department of Defense (2014) reported acquiring tantalum metal scrap for the National Defense Stockpile that another Federal agency determined to be in excess of that agency's needs.

Tantalum was identified as a "conflict mineral" by the Dodd-Frank Wall Street Reform and Consumer Protection Act. The U.S. Securities and Exchange Commission (SEC) (2012) ruled that United States-listed companies that use conflict minerals must report annually whether any of those minerals originated in Congo (Kinshasa) or an adjoining country and whether it came from a source contributing to violence in the region. The first such reports, called Form SD—a new Securities and Exchange Commission Specialized Disclosure Report form, were to be filed in June 2014.

Production

The major marketable niobium materials are ferroniobium and niobium metal, ore, and oxide. The major marketable tantalum materials are tantalum metal (unwrought and wrought alloys, metal, and powder), ore, and scrap. In 2013, neither niobium nor tantalum domestic mine production was reported.

NioCorp Developments Ltd., formerly Quantum Rare Earth Developments Corp., reported 19.3 million metric tons (Mt) of indicated resources at 0.67% niobium pentoxide (Nb_2O_5) and 83.3 Mt of inferred resources at 0.63% Nb_2O_5 to a cutoff grade of 0.40% Nb_2O_5 at its Elk Creek, NE, property. Elk Creek was thought to be the only primary niobium deposit being developed in the United States (NioCorp Developments Ltd., 2014, p. 6).

Global Advanced Metals Pty. Ltd. (GAM) (Australia), a vertically integrated tantalum producer, produced capacitor-grade tantalum metal powder and metallurgical products of tantalum, niobium, and their alloys. GAM operated a plant at Boyerstown, PA (Global Advanced Metals Pty. Ltd., 2010).

Consumption

U.S. reported consumption of ferroniobium and nickel niobium in 2013 was about the same as that of 2012. Domestic consumption data for niobium and tantalum materials were developed by the U.S. Geological Survey (USGS) by means of the "Columbium (Niobium) and Tantalum," "Consolidated Consumers," and "Specialty Ferroalloys" surveys. For niobium and tantalum materials, 1 consumer responded to the "Columbium (Niobium) and Tantalum" canvass, about 70 responded to the "Consolidated Consumers" canvass, and 1 responded to the "Specialty Ferroalloys" canvass. The steel industry accounted for about 80% of U.S. reported niobium and tantalum consumption; other uses, predominantly the superalloy industry, accounted for the remaining 20%.

U.S. apparent consumption of niobium for 2013, as calculated from exports, imports, and changes in Government and industry stocks, was 16% less than that in 2012 (tables 1, 3). The decrease was primarily caused by a decrease in net imports in 2013 compared with those in 2012. U.S. apparent consumption of tantalum for 2013, as calculated from exports, imports, and changes in Government and industry stocks, was 40% less than that in 2012 (tables 2, 3). The decrease was primarily caused by an increase in net exports in 2013 compared to those in 2012.

Tantalum was used by the chemical processing, cutting tool, electronics, medical, and optical and x-ray equipment industries (Stratton and Henderson, undated). Worldwide, the electronics industry was the leading tantalum consumer, accounting for more than one-half of tantalum use, and electronic capacitors were the leading electronic use. Tantalum provides high

dielectric constant and oxide layer stability to tantalum capacitors, which results in high volumetric and thermally stable capacitance, which are desirable characteristics in some applications. Bioinertness makes tantalum useful in biomedical and surgical applications. Ductility and corrosion resistance make tantalum mill products useful in chemical processing. High-temperature strength and high melting points of tantalum and tantalum alloys make tantalum useful in superalloys. A wide variety of tantalum chemical uses take advantage of specific properties. For example, tantalum pentoxide increases the refractive index of glass used in camera lenses, tantalum carbide increases the toughness of cemented carbide cutting tools, and tantalum nitride contributes to the inertness of diffusion barriers in microelectronic circuits (Burt and Schwela, 2013, p. 4–13).

ATI Wah Chang Inc., GAM, and H.C. Starck Inc. consumed niobium and (or) tantalum feed materials to produce intermediate niobium and (or) tantalum materials used in industrial manufacturing processes and products.

Prices

Niobium and tantalum materials were not openly traded. Purchase contracts were confidential between buyer and seller; however, trade journals reported composite prices of tantalite based on interviews with buyers and sellers, and traders declared the value of niobium and tantalum materials that they imported or exported. In 2013, the annual average price of tantalite ore per pound of contained tantalum oxide (Ta_2O_5) was \$117.93. The tantalite ore price opened the year at \$120.00 but declined to \$116.50 in July, where it remained for the remainder of the year.

Tantalum ore and concentrate price is often described as opaque because there is no open market and the only source of price is spot price in trade journals. Industrial tantalum ore and concentrate producers make long-term contracts that specify confidential prices with processors, so the spot price does not necessarily apply (Burt and Schwela, 2013, p. 4–13; Humphreys, 2014, p. 24; Linnen and others, 2014, p. 380). This is a problem for the tantalum mining industry, because tantalum reserves are put into production when market conditions make mine development economic. When cost of production and price align, tantalum resources become reserves and may be profitably brought into production. There is a multiyear time lag between alignment and new mine development because investors must be convinced that higher consumption is sustainable as mine development takes several years. Owing to the lack of transparency of the tantalum mineral price, financial analysts do not have reliable prices upon which to base development decisions (Humphreys, 2014, p. 24–25).

Foreign Trade

Niobium and tantalum material exports from and imports to the United States included ferroniobium and niobium chemicals, metal, ore, and oxide, and tantalum metal and ore. In 2013, the values of foreign trade of these niobium and tantalum materials were \$201 million for exports (25% more than that of 2012) and \$690 million for imports (11% less than that of 2012).

The United States exported 435 t of niobium contained in niobium materials (13% greater than that of 2012) and imported

8,580 t of niobium contained in niobium materials (15% less than that of 2012) (table 1). The United States exported 844 t of tantalum contained in tantalum materials (46% more than that of 2012) and imported 1,100 t of tantalum contained in tantalum materials (9% more than that of 2012) (table 2).

World Industry Structure

Niobium ore was beneficiated to concentrates containing about 54% Nb_2O_5 . Nb_2O_5 was produced from the concentrate; ferroniobium or niobium metal, from Nb_2O_5 . Ferroniobium, the leading commercial niobium-containing material, was typically about 60% niobium, and was used in the production of high-strength low-alloy (HSLA) steels. Other uses included the production of niobium carbide and chemicals.

Brazil and Canada were the leading producers of niobium mineral concentrates; Rwanda, Congo (Kinshasa), and Brazil were the leading producers of tantalum mineral concentrates (table 6). Tantalum-bearing tin slags, which are byproducts from tin smelting, principally from Asia, Australia, and Brazil, were another source of tantalum. The leading niobium ore- and concentrate-producing companies were Companhia Brasileira de Metalurgia e Mineração (CBMM) and Anglo American Brazil Ltd. (a subsidiary of Anglo American plc) in Brazil and IAMGOLD Corp. (Niobec Mine) in Canada. The leading tantalum ore- and concentrate-producing companies were Metallurg Group (Mibra Mine) and Mineração Taboca S.A. (Pitinga Mine) in Brazil.

Most niobium mine production resulted from mining the mineral pyrochlore and was converted to ferroniobium at the mine site. Steelmaking, primarily HSLA and some stainless steels, and the superalloy industry accounted for about 90% of niobium use. Niobium-containing HSLA steel was used in automobiles, construction, and gas pipelines; stainless steel was used in automobiles. In its leading end use, HSLA steels, a small amount of niobium significantly increases steel strength. Niobium-containing steel was typically used more in developed countries, resulting in an uneven geographic distribution of use. Intensity of niobium use in developing countries with large steel industries is nearly one-half that of developed countries, suggesting that as steel production in developing countries moves to higher grades of steel, niobium use will increase (Roskill Information Services Ltd., 2013, p. 2).

The Tantalum-Niobium International Study Center reported annual niobium and tantalum primary production based on a survey of its members. Tantalum primary production from tantalum concentrates, tin slags, and other concentrates was estimated to have been 600 t of contained tantalum in 2012, the most recent year for which data were available. Niobium primary production from niobium concentrates and other concentrates containing more than 2% Nb_2O_5 was estimated to have been 70,000 t of contained niobium in 2012 (Tantalum-Niobium International Study Center, 2013).

Niobium

The world steel industry accounted for about 88% of world niobium consumption. Niobium is not used in all HSLA and stainless steels; however, in those grades in which it is used,

HSLA steels contain about 0.05% niobium by weight and stainless steels contain 0.04% to 0.08%. The leading use of ferroniobium was in HSLA steels—structural steel accounted for 45% of world ferroniobium consumption; automotive steel, 23%; and line pipe steel, 16%. Stainless steel accounted for 6% of ferroniobium consumption. Leading world ferroniobium producers were CBMM (Brazil), Mineração Catalão de Goiás (Brazil), and IAMGOLD (Canada), which collectively accounted for most of world niobium production and marketed their production as ferroniobium. World ferroniobium shipments, measured in contained niobium, were 53,500 t in 2012, an increase from 52,200 t in 2011 (Roskill Information Services Ltd., 2013, p. 23, 115, 116, 125, 127, 129, 134).

Tantalum

World tantalum resources were reported to have been distributed among (listed in descending order of quantity of resources) South America (41%), Australia (21%), China and Southeast Asia (10%), Russia and the Middle East (10%), Central Africa (9%), other Africa (7%), and North America (2%). The sources of tantalum are artisanal and industrial tantalum mines; tin mines; low-grade slag stockpiles, which supply processors with concentrates; and recycling, which supplies processors with scrap metal. Tantalum ore and concentrate were supplied by artisanal and industrial mines; tin slag, by tin smelters. Historically (before the late 1980s), most tantalum was produced from tin slags. Since then, tantalum mines have dominated supply. Australia was the leading industrial tantalum producer until 2008 when the Greenbushes and Wodgina Mines were put on care-and-maintenance status, leaving Brazil as the leading industrial tantalum producer. As tantalum consumption increased in the 1980s, two integrated processors emerged—Cabot Corp. in the United States and H.C. Starck in Germany. Both companies spawned subsidiary tantalum processors in countries other than Germany and the United States, taking over 90% of the world market in the 1990s. Following that, Ningxia Non-Ferrous Metals Smeltery and other Chinese businesses entered the tantalum processing industry. In 2013, there were also significant tantalum integrated processors in Estonia and Kazakhstan (Burt and Schwela, 2013, p. 4–13).

World Review

Australia.—The Government of Australia reported that, as of December 31, 2012, Joint Ore Reserves Committee (JORC)-compliant ore reserves (as stated in company annual reports and reports to the Australian Stock Exchange) were 115,000 t of contained niobium and 29,000 t of contained tantalum. Accessible economic demonstrated resources were 205,000 t of contained niobium and 60,000 t of contained tantalum (McKay and others, 2014, p. 6).

Alkane Resources Ltd. (2014, p. 5–10, 18) completed an updated definitive feasibility study in April for its Dubbo Zirconia Project with updated capital and operating costs for the production of 1 million metric tons per year (Mt/yr) of ore. The definitive feasibility study described a technically and financially robust project over an initial 20-year mine life.

At 1 Mt/yr, Alkane could produce 3,000 metric tons per year (t/yr) of ferroniobium and 10 t/yr of Ta₂O₅. Alkane reported 35.9 Mt of reserves at 0.46% Nb₂O₅ and 0.03% Ta₂O₅ as of November 2011 and 73.2 Mt of resources at the same grade at its Dubbo Zirconia Project, Toongi deposit, New South Wales.

GAM processed tantalum ore and concentrate. GAM processed tantalum ore from the Wodgina and Mt. Cattlin Mines into concentrate at Greenbushes. GAM's production capacity measured in contained Ta₂O₅ in concentrate was 635 t/yr, of which one-half was committed for contracts. GAM processed tantalum ore concentrate from Wodgina at Greenbushes, which had a production capacity of 454 t/yr of Ta₂O₅. Tantalum pentoxide was shipped to Japan and the United States where GAM produced tantalum products, including tantalum powder and tantalum metallurgical products. GAM also produced niobium metallurgical products (Global Advanced Metals Pty Ltd., undated a, b, c).

Galaxy Resources Ltd. suspended Mt. Cattlin Mine and processing plant operations in March 2013. Galaxy reported proven plus probable reserves of 10.737 Mt containing 0.0146% Ta₂O₅ as of 2010 and resources of 17.155 Mt containing 0.0155% Ta₂O₅ to a cutoff grade of 0.4% lithium oxide (Li₂O) as of 2011 (Galaxy Resources Ltd., 2014, p. 8, 57).

Capital Mining Ltd. (2013, p. 5) targeted niobium at its Narraburra (rare earths and zirconium) prospect and reported 73 Mt of inferred resources grading 0.0126% Nb₂O₅. Narraburra was located about 12 kilometers (km) northeast of Temora, New South Wales.

Hastings Rare Metals Ltd. reported 36.2 Mt of resources containing 0.35% Nb₂O₅ at its Hastings (rare earths, niobium, and zirconium) project (Hastings Rare Metals Ltd., 2013, p. 7–11). The project was located about 18 km southeast of Halls Creek Township in Western Australia. Hastings completed a scoping study that indicated conventional openpit mining with a 25-year mine life.

Brazil.—Brazil was the leading niobium-ore-producing country and a leading tantalum-ore-producing country. Niobium mine production in Brazil was 82,214 t of contained Nb₂O₅ from reserves of about 10.7 Mt of Nb₂O₅ in 2012. Final products were 82,214 t of Nb₂O₅ contained in concentrate; 50,562 t of niobium contained in ferroniobium; and 6,157 t of Nb₂O₅ (Pereira, 2014). Brazilian tantalum mine production was 185 t of Ta₂O₅ contained in concentrate from reserves of 36,190 t of tantalum in 2013 (Pontes, 2014).

Anglo American Brazil Ltd. mined pyrochlore from a carbonatite deposit. The Catalao Mine consists of three open pit mines and a processing facility near the city of Catalao, Goiás State. Anglo reported production of 4,500 t of niobium contained in ore in 2013 compared with 4,400 t in 2012. Anglo mined 1,228,809 t of ore and processed 963,118 t of ore at 1.16% niobium. JORC-compliant (operation plus project) reserves in 2013 were 40.2 Mt at 0.86% Nb₂O₅ and resources were 58.5 Mt at 1.11% Nb₂O₅ (Anglo American plc, 2014, p. 238, 253). Anglo planned to increase the Boa Vista Fresh Rock project into production in 2014, which would increase their niobium production capacity to 6,500 t/yr of niobium in 2015 from 4,400 t/yr in 2012.

CBMM mined niobium ore from the Barreiro carbonatite complex near Araxa, Minas Gerais State, and beneficiated the ore at the mine site by selectively extracting the pyrochlore minerals from which niobium oxide was produced. CBMM produced ferroniobium, nickel-niobium, niobium metal, niobium oxide, and high-purity ferroniobium, with a production capacity of 90,000 t of ferroniobium equivalent. CBMM planned to increase production capacity to 150,000 t in 2016 (Companhia Brasileira de Metalurgia e Mineração, undated).

Mineração Taboca S.A. mined columbite at the Pitinga Mine in Presidente Figueiredo Municipality, Amazon State. Taboca produced a ferroniobium-tantalum alloy containing 45.00% niobium, 4.20% tantalum, and 25.00% iron that was sold for the production of niobium and tantalum oxides (Mineração Taboca S.A., 2013).

MBAC Fertilizer Corp. (2014, p. 11–12) reported Araxa Project resources of 28.28 Mt at 0.73% Nb₂O₅. MBAC produced high-purity niobium and tantalum oxides at the bench scale from the Nb₂O₅ concentrate stream produced in its pilot plant. MBAC planned to start mine production in 2015 followed by full-scale production in 2016. At full production, MBAC planned to produce 742 t/yr of Nb₂O₅ as a byproduct, increasing to 1,832 t/yr in 2023. Mine life was expected to be 40 years.

Companhia Industrial Fluminense Mineracao S.A. (CIF) (owned by AMG Advanced Metallurgical Group N.V.) produced niobium and tantalum concentrate at Mibra (Volta Grande) Mine near Nazareno, Minas Gerais State. AMG completed an NI 43–101-compliant resource evaluation in 2013. AMG reported (measured plus indicated plus inferred) resources of 8.88 Mt at 310 parts per million (ppm) tantalum and 58.8 ppm niobium. AMG estimated the mine life at 20 years (AMG Advanced Metallurgical Group N.V., 2013; 2014, p. 5, 24–26).

Canada.—Canada was a leading niobium-ore-producing country. Canada reported niobium mine production of 4,910 t of contained Nb₂O₅ in 2013 compared with 4,705 t of contained Nb₂O₅ in 2012. Niobium ore was mined in Quebec (Natural Resources Canada, undated a, b).

Avalon Rare Metals Inc. (Toronto, Ontario) prospected for niobium and tantalum at its Nechalacho (rare earths) deposit at Thor Lake and for tantalum at its Separation Rapids and Lilypad Lakes properties. For Nechalacho, Avalon reported (proven plus probable) reserves of 10.41 Mt at 0.416% Nb₂O₅ and 0.045% Ta₂O₅ (Avalon Rare Metals Inc., 2013, p. 8, 10). At the Separation Rapids (lithium and tantalum) project, Avalon reported petalite resources of 11.6 Mt at 0.007% Ta₂O₅. At Lilypad Lakes, Avalon explored for lithium and tantalum (Avalon Rare Metals Inc., undated a, b).

Cache Exploration Inc. (undated) explored for niobium at its Cross Hills property in Newfoundland. Commerce Resources Corp. (Vancouver, British Columbia) prospected for niobium and tantalum at its Blue River (east of Quesnel, British Columbia) property, which hosts a carbonatite deposit. Commerce updated its NI 43–101-compliant resources for the Blue River property. Commerce estimated (indicated plus inferred) resources of 53.81 Mt containing an average 0.02% Ta₂O₅ and 0.16% of Nb₂O₅ (Commerce Resources Corp., 2013b, p. 1–1, 14–1—14–28). Commerce Resources Corp. (2013a)

planned to do a prefeasibility study of its Upper Fir Blue River property.

Critical Elements Corp. (Montreal, Quebec) developed the Rose lithium-tantalum property in the James Bay area of Quebec and explored British Columbia rare earths properties for rare earths and niobium. For the Rose property, Critical Elements reported 37.2 Mt of resource at 0.016% Ta₂O₅. Critical Elements conducted bench-scale tantalum recovery tests and planned to optimize the purity of the lithium carbonate produced by bicarbonation, create a final flow sheet, and improve the recovery of tantalum as a byproduct, currently at about 60%. Critical Elements planned to use the final flow sheet to advance the pilot plant for the feasibility study (Critical Elements Corp., 2013a, b).

Dios Exploration Inc. (Montreal) received a final report for drilling at the Shishshaw Carbonatite Complex near Chicoutimi, Quebec, in 2012. Dios conducted no further testing (Dios Exploration Inc., 2014, p. 3, 17). Endurance Gold Corp. (2013) explored for rare-earth elements and niobium at its Bandito project in Yukon Territory.

IAMGOLD (Toronto) mined niobium contained in pyrochlore from the Saint-Honoré carbonatite deposit at the Niobec Mine 15 km northwest of Chicoutimi, Quebec. Niobec mill production capacity was 4,500 t/yr of niobium. The mill produced concentrate from which Niobec produced Nb₂O₅ that was then converted to standard-grade (66% niobium) ferroniobium by aluminothermic reduction. In 2013, the Niobec Mine produced 5,263 t of niobium compared with 4,707 t of niobium in 2012 from reserves of 416.42 Mt at 0.41% Nb₂O₅ and 702 Mt of resources at 0.41% Nb₂O₅ (IAMGOLD Corp., 2014, p. unnumbered, 15). IAMGOLD sought a partner with whom to expand Niobec Mine production.

Matamec Explorations Inc. (Montreal) explored for niobium and tantalum at its Zeus property in the Kipawa Alkalic Complex in Quebec (Matamec Explorations Inc., 2013, p. 2, 15). The niobium and tantalum were found associated with heavy rare-earth elements, yttrium, and zirconium on the Kipawa joint-venture property, located in Temiscaming, southwestern Quebec.

GéoMégA Resources Inc. (2013, p. 2–3) explored the Montviel rare-earth-niobium project located approximately 100 km north of Lebel-sur-Quevillon and 45 km west of the Cree First Nation of Waswanipi in the urbanized southern part of northern Quebec. At a cutoff grade of 1% total rare-earth oxides, GéoMégA estimated 183.9 Mt of indicated resources at 0.126% Nb₂O₅ and 66.7 Mt of inferred resources at 0.140% Nb₂O₅.

Houston Lake Mining Inc. (HLM) explored for tantalum at its PAK Rare Metals Project (Pakeagama Lake pegmatite deposit) located about 160 km north of Red Lake in northwestern Ontario. To a cutoff grade of 0.4% lithium oxide equivalent, HLM estimated 6.886 Mt of inferred mineral resources containing 105 ppm Ta₂O₅ (Houston Lake Mining Inc., 2013).

MDN Inc. developed the Crevier niobium project north of Lac Saint-Jean, Quebec. MDN used flotation (to produce pyrochlore concentrate from ore) and leaching (to produce niobium and tantalum oxide from concentrate) and continued

to seek a strategic partner. Flotation recovery was 62.8% yielding a 9.6%-niobium-and-tantalum concentrate (MDN Inc., 2014, p. 6–8).

Niocan Inc. (Montreal) explored for niobium minerals at its Oka property located in the Parishes of l'Annonciation and St-Joseph-du-Lac, about 50 km northwest of Montreal and 10 km from Highway 640 near Oka, Quebec. Niocan Inc. (2014) reported 13.85 Mt of resources at 0.66% Nb₂O₅ as of December 2009.

Nuinsco Resources Ltd. (2014) started processing a 30-t sample of carbonatite rock extracted from its Prairie Lake phosphorus-rare-earth-elements-niobium exploration target located about 45 km northwest of Marathon, Ontario.

PhosCan Chemical Corp. (2014, p. 2) maintained the Martison (phosphate product, niobium byproduct) project in good standing with all stakeholders. This good standing would enable them to resume the previously suspended feasibility study once financing was secure in order to develop the project to commercial production.

Canada Rare Earth Corp. (formerly Rare Earth Metals Inc.) (Thunder Bay, Ontario) reported niobium mineralization at its Clay-Howells rare earths deposit near Kapuskasing, Ontario, as well as a 40.635-Mt inferred resource at 0.26% Nb₂O₅ to a cutoff grade of 0.60% total rare-earth oxides for the Two Tom deposit near Letitia Lake, Newfoundland and Labrador (Canada Rare Earth Corp., 2014, p. 4–5).

Quest Rare Minerals Ltd. (Montreal) explored for niobium minerals, among other minerals, at the Strange Lake rare-earth project on the Quebec-Labrador border. Quest's preliminary economic assessment reported estimated indicated mineral resources of 278.13 Mt at 0.93% total rare-earth oxides and inferred mineral resources of 214.35 Mt at 0.85% total rare-earth oxides (Quest Rare Minerals Ltd., 2014, p. 3–5).

Search Minerals Inc. reported niobium resources as of September 30, 2012, to a cutoff grade of 130 ppm dysprosium. Search Minerals Inc. reported indicated resources of 9.229 Mt containing 1,687 ppm Nb₂O₅ and inferred resources of 5.165 Mt containing 1,442 ppm Nb₂O₅ at its Foxtrot rare-earth project (Search Minerals Inc., 2013, p. 14–1).

Taseko Mines Ltd. (Vancouver) explored for niobium minerals at its Aley prospect in northern British Columbia. Taseko continued working on metallurgical flow sheets, engineering, and environmental studies. Taseko reported measured and indicated resources of 285 Mt at 0.37% Nb₂O₅ to a cutoff grade of 0.20% Nb₂O₅ effective December 31, 2013 (Taseko Mines Ltd., 2013, p. 6, 10).

Cabot Corp. (Boston, MA) agreed to sell tantalum ore from Tantalum Mining Corp. of Canada (Lac Du Bonnet, Manitoba) (Tanco) to GAM. Cabot and GAM terminated their agreement, and Cabot expected to complete shipments of stocks to GAM in calendar year 2013 (Cabot Corp., 2013, p. 74). Tanco downsized in March (Zienkiewicz, 2013) and was expected to stop tantalum production in 2014.

China.—Tantalum was mined by Guangxi Limu Mining Co., Ltd.; Inner Mongolia Baotou; Jiangxi Yinchun; and Xinjiang Keketuohai. Ore and concentrate from those operations supported the tantalum-processing industry, which consisted of Conghua Tantalum & Niobium Smeltery Ltd., Guangxi Limu

Nonferrous Metal Co., Hunan Zhuzhou Hard Alloy Factory, Jiangxi Jiulong Nonferrous Metal Smeltery Ltd., and Ningxia Orient Tantalum Industry Co., Ltd., among others. Huidian Research (2013, p. 16–17, 20–21, 24–25, 34–41, 44) reported that more than 92 mines produced tantalum ore from China's reserves of 540,000 t of Ta₂O₅. More than 70% of tantalum reserves were in Guangdong and Jiangxi Provinces and Nei Mongol Autonomous Region. The leading tantalum mines were Jiangxi Yichun Tantalum Mine, Fujian Nanping Tantalum Mine, Guangxi Limu Mine, Hunan Chaling Tantalum Mine, and Sinkiang Koktokay Mine. These mines and imported tantalum materials supplied China's major tantalum processing industries, which were Ningxia Orient Tantalum Industry Co. Ltd.; Sinkiang Nonferrous Metals Industry Group Rare Metals Co., Ltd.; Conghua Tantalum & Niobium Smeltery; Jiujiang Tanbre Co., Ltd. (formerly named as Jiujiang Tanbre's Smeltery); and Changsha South Tantalum Niobium Co., Ltd. Huidian Research (2013) forecast 12% annual growth for China's tantalum industry from 2017 through 2022 based on China's projected economic transformation, which is expected to increase domestic tantalum demand driven by urbanization and industrial transformation to high-technology products that are tantalum-use intensive.

Colombia.—The South Korean Institute of Geoscience and Minerals Resources continued to explore for tantalum in Guainia and Vichada Departments, which started in 2012. Columbite-tantalite (known as coltan) production from tributaries of the Amazon River reached \$20.4 million in 2012 (Kurmanav and Smith, 2013; Korea Institute of Geoscience and Mineral Resources, 2013, p. 37).

Congo (Kinshasa).—Congo was a leading tantalum ore producer. Katanga, Kivu, Maniema, and Orientale Provinces in the eastern part of Congo (Kinshasa) host coltan deposits (Fetherston, 2004, p. 71).

Tantale et Niobium du Tanganika Sprl, a 75% subsidiary of African Specialty Metals Sprl and Cominière, a Congo (Kinshasa) state-owned company, started tantalite production in the fourth quarter of 2013 (Paragon Resources PLC, 2013, p. 6, 35).

Mining Minerals Resources Sprl (MMR) mined tantalite at Kisengo Mine, Katanga Province, for Kemet Corp. MMR's tantalite ore was converted to concentrate by Tantalite Resources Pty. Ltd. (South Africa), which was converted to potassium salt (K-salt) by KEMET de Mexico, S.A. de C.V. (Matamoros, Mexico), and then by KEMET Blue Powder Corp. (Mound House, NV) to tantalum powder, from which KEMET manufactured capacitors (Kemet Corp., 2014, p. 7, 30; undated, p. 6, 12, 20).

Egypt.—Tantalum Egypt JSC [Gippsland Ltd. (Claremont, Western Australia, Australia) and the Government of Egypt] planned to mine tantalite from the Abu Dabbab tantalum-tin-feldspar deposit and the Nuweibi deposit. Tantalum Egypt mined tin until September, when it stopped. Gippsland reported 33.18 Mt of reserves at 252 g/t Ta₂O₅ at Abu Dabbab and 142.5 Mt of resources at 176 g/t Ta₂O₅ at Abu Dabbab and Nuweibi. Gippsland planned to complete a definitive feasibility study in 2015 for open pit mining of 2 Mt/yr of ore, which would yield 2,750 t/yr of concentrate grading 10% Ta₂O₅ and 50% tin. Tin smelting would

produce tantalum glass grading 20% to 30% Ta₂O₅ for which Gippsland has an offtake agreement with H.C. Starck GmbH. Annual production would be about 270 t of tantalum (as Ta₂O₅ contained in glass) (Gippsland Ltd., 2014, p. 2–3, 8).

Estonia.—Molycorp Silmet (Sillamae) produced ferroniobium-tantalum and other niobium and tantalum products from raw materials (Molycorp Inc., 2014, p. 11, 44).

Ethiopia.—The Ethiopian Mineral Development Share Co. (EMDSC; undated) (Addis Ababa) owned and managed the Kenticha tantalum mine, which produced tantalite concentrate from the tantalite ore from a production capacity of about 200 t/yr; however, EMDSC suspended production in April 2012 (Bekele, 2013). EMDSC sought investors to develop a tantalite concentrate processing plant to produce downstream tantalum products. EMDSC negotiated with CVMR Ltd. (Canada) for first right of refusal to purchase tantalite concentrate (Canadian Council on Africa, 2014).

Finland.—Tertiary Minerals plc (Macclesfield, United Kingdom) was granted an exploration license for the Rosendal tantalum prospect (Kemio Island), which had a 1-Mt mineral resource grading 255 g/t (0.0255%) Ta₂O₅. Tertiary put the project on hold in 2002 when the price of tantalite was \$35 to \$40 per pound; however, since then the price has risen to \$80 to \$90 per pound and consumers are seeking material. These factors led the company to evaluate production opportunities (Tertiary Minerals plc, 2013, p. 9).

Gabon.—Eramet S.A. (Paris, France) planned to build a pilot plant to test and prove a recovery process for the Mabounie polymetallic pyrochlore deposit. The Mabounie project is located by the Ngounie River in Moyen-Ogooue Province, about 50 km from the town of Lambarene. Eramet planned to recover niobium, rare earths, and uranium (Eramet S.A., 2014a, p. 27; 2014b; undated).

Kazakhstan.—Elba Metallurgical Plant JSC, a subsidiary of Kazatomprom National Atomic Co., produced niobium and tantalum products from raw materials (Kazatomprom National Atomic Co., 2015).

Kenya.—Pacific Wildcat Resources Corp. (Vancouver) explored for niobium and rare earths at Mrima Hill, where it reported a niobium inferred resource (to a cutoff grade of 0.2% Nb₂O₅) of 94.4 Mt at 0.73% Nb₂O₅ (Pacific Wildcat Resources Corp., 2015). Pacific Wildcat planned to complete additional metallurgical work to support a preliminary economic assessment study for Mrima Hill.

Malawi.—Globe Metals & Mining Ltd. (West Perth, Western Australia, Australia), through its Kanyika project, sent niobium ore samples to Guangzhou Research Institute of Non-Ferrous Metals (China) to develop a recovery process (Mining In Malawi, 2014).

Mozambique.—Paragon Resources PLC (2013) (formerly Noventa Ltd.) (St. Helier, Jersey [United Kingdom]) commissioned its new plant in Mozambique in May; however, production did not meet expectations. Paragon stopped production and decided to sell the mine and plant.

Rwanda.—Rwanda was the leading tantalum-ore-producing country. Solomon Resources Ltd. explored for niobium, tantalum, and tin minerals at its Rurembo license prospecting area located in Muhanga district, Southern Province. Solomon

targeted Gipfizi Ridge near the town of Gitarama for further exploration (Solomon Resources Ltd., 2013).

Tanzania.—Cradle Resources Ltd. (2014) started a scoping study of its Panda Hill Niobium Project in the Mbeya region, after which it planned to conduct a prefeasibility study. Cradle held 81.8 Mt of (JORC-compliant) resources at 0.52% Nb₂O₅, of which 76.4 Mt at 0.51% Nb₂O₅ were indicated and 5.4 Mt at 0.62% Nb₂O₅ were inferred. Cradle planned to develop a 2-Mt/yr mine and processing plant.

Outlook

Niobium.—Pyrochlore is the leading mineral mined for niobium. Currently operating niobium mines have abundant reserves. Potential new sources of niobium are typically associated with the production of other minerals with niobium as a byproduct. Niobium minerals are typically converted to ferroniobium and other products at the mine site. Most ferroniobium is used in HSLA steel. The intensity of niobium use in HSLA steel is greatest in developed countries, suggesting that there is potential for increased niobium use in steel produced in developing nations (Roskill Information Services Ltd., 2013, p. 197–213). A broad variety of niobium properties, production processes, and applications other than steelmaking were described by Wong (2011), especially those for niobium as a substitute for tantalum in capacitor applications.

The three main niobium producers have all announced brownfield expansion plans, though none were expected to be producing at full capacity in 2014. Consumption of niobium is expected to increase by around 5% in 2014, in line with the expected increase in production of crude steel and niobium-bearing alloys in the final product mix of steel (Anglo American plc, 2014, p. 79).

Tantalum.—Tantalum supply consists of ores from artisanal and conventional mining, slags and synthetic concentrates, recycled materials, and stocks. World primary production was expected to increase from about 1,100 t of tantalum in 2011 to about 1,600 t of tantalum in 2016. Conventional mining accounted for about one-half of supply in 2011. If conventional mining accounts for all of the expected growth, an additional 500 t of tantalum in mine expansions and new projects would be needed to account for that amount of material. Current producers collectively were expected to increase production by 600 t of tantalum, and projects currently being planned would increase production by more than 1,300 t of tantalum. Processing capacity would also need to increase to convert that ore and concentrate into intermediate and final chemical and metal products (Roskill Information Services Ltd., 2012, p. 2, 6, 21–23, 31–33).

Tantalum minerals are found with other minerals of tin, lithium, niobium, and rare-earth elements. Tantalum is or has been a primary product [for example, EMDSC (Kenticha tantalum mine) in Ethiopia and GAM (Wodgina Mine) in Australia], and a byproduct of tin [for example, Mineração Taboca (Pitinga Mine) in Brazil] and lithium [for example, AMG Mineração (Volta Grande Mine) in Brazil, Cabot (Tanco Mine) in Canada, and Galaxy Resources (Mt. Cattlin Mine) in Australia]. Identified tantalum resources have increased as a

result of exploration for lithium and rare-earth elements. The price of tantalum has been uncertain as a result of its byproduct status and opaque as a result of the industry practice of not revealing contract prices. Tantalum supply uncertainty has been increased by its dependence on other metal markets.

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TABLE 1
SALIENT NIOBIUM STATISTICS¹

		2009	2010	2011	2012	2013
United States:						
Exports, Nb content ²	metric tons	195	281	363	385	435
Imports for consumption:						
Mineral concentrates, Nb content	do.	41	5	23	32	75
Niobium metal, gross quantity ³	do.	699	1,380	1,460	1,440	1,360
Niobium oxide, Nb content ^e	do.	742	824	1,120	1,220	997
Ferroniobium, Nb content ^e	do.	2,920	6,280	6,910	7,430	6,140
Reported consumption, Nb content						
Raw materials	do.	W	W	W	W	W
Ferroniobium and nickel niobium	do.	4,350	5,590	9,060	7,460 ^r	7,500
Apparent consumption, Nb content	do.	4,210	8,210	9,160	9,730	8,140
Value: ⁴						
Niobium ores and concentrates (gross quantity)	dollars per kilogram	59.86	19.84	39.34	23.54	16.96
Niobium oxide (gross quantity)	do.	27.30	30.32	37.69	44.43	43.47
Ferroniobium (gross quantity)	do.	23.59	24.01	26.43	27.63	27.29
World, production of niobium-tantalum concentrates, Nb content	metric tons	67,000 ^r	49,100 ^r	50,300 ^r	62,700 ^r	57,300 ^e

^eEstimated. ^rRevised. do. Ditto. W Withheld to avoid disclosing company proprietary data.

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

²Includes natural and synthetic niobium ore and concentrates, niobium oxide, niobium ferroalloy, and unwrought niobium metal and alloys.

³Includes niobium and articles made of niobium.

⁴Weighted average value of imported plus exported materials.

TABLE 2
SALIENT TANTALUM STATISTICS¹

		2009	2010	2011	2012	2013
United States:						
Exports:						
Tantalum ores and concentrates, ² Ta content	metric tons	94	58	65	124	107
Tantalum metal, gross quantity	do.	138	246	443	341	591
Tantalum and tantalum alloy powder, gross quantity	do.	94	134	140	111	146
Imports for consumption:						
Mineral ores and concentrates, Ta content	do.	109	9	60	82	200
Tantalum metal and tantalum-bearing alloys, ³ gross quantity	do.	689	1,590	1,800	932	904
Reported consumption, raw materials Ta content	do.	W	W	W	W	W
Apparent consumption, Ta content	do.	473	1,160	1,210	437	260
Price, tantalite, ⁴ Ta ₂ O ₅ content	dollars per kilogram	89	120	275	239	260
Value, ⁵ tantalum ores and concentrates, gross quantity	do.	30	32	46	45	68
World, production of niobium-tantalum concentrates, Ta content	metric tons	1,140 ^r	923 ^r	1,005 ^r	1,107 ^r	1,208 ^e

^eEstimated. ^rRevised. do. Ditto. W Withheld to avoid disclosing company proprietary data.

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

²Includes natural and synthetic tantalum ore and concentrates.

³Includes unwrought powders, unwrought alloys and metals, waste and scrap, and wrought alloys and metal.

⁴Average annual price per Ta₂O₅ content as reported in Ryan's Notes.

⁵Weighted average value of imported plus exported materials.

TABLE 3
REPORTED CONSUMPTION, BY END USE, INDUSTRY STOCKS OF FERRONIUM AND
NICKEL NIOBIUM, AND GOVERNMENT STOCKS BY MATERIAL IN THE UNITED STATES¹

(Metric tons of niobium and tantalum content)

	2012	2013
End use:		
Steel:		
Carbon	1,570	1,250
Stainless and heat-resisting	811	828
Full alloy	(2)	(2)
High-strength low-alloy	784	747
Electric	(2)	(2)
Tool	(2)	(2)
Unspecified	2,870	3,080
Total	6,030	5,900
Superalloys	1,420	1,580
Alloys (excluding steels and superalloys)	18	21
Grand total	7,460	7,500
Stocks, December 31:		
Consumer	393 ^r	388
Producer ³	W	W
Total	393 ^r	388
National Defense Stockpile, total uncommitted inventory by material:		
Niobium metal ingots	10.0	10.0
Tantalum carbide powder	1.71	1.80

^rRevised. W Withheld to avoid disclosing company proprietary data.

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

²Included with "Steel: Unspecified."

³Ferroniobium only.

TABLE 4
U.S. FOREIGN TRADE IN NIOBIUM AND TANTALUM METAL AND ALLOYS, BY CLASS¹

HTS code ²	Class	2012		2013		Principal destinations and sources in 2013 (gross quantity in kilograms and values in thousand dollars)
		Gross quantity (kilograms)	Value (thousands)	Gross quantity (kilograms)	Value (thousands)	
Exports:						
Niobium:						
2615.90.6030	Ores and concentrates	31,500	\$239	111,000	\$1,430	China 100,100, \$1,340; United Kingdom 2,600, \$18; India 2,400, \$17; France 2,010, \$14; Japan 1,470, \$10; Italy 1,360, \$22.
7202.93.0000	Ferromiobium	512,000	5,630	588,000	7,280	Canada 498,000, \$6,280; Mexico 65,700, \$730; India 11,600, \$128; Trinidad and Tobago 7,000, \$77; United Kingdom 1,680, \$18; Colombia 91, \$3.
Tantalum:						
2615.90.3000	Synthetic concentrates	209,000	2,840	61,300	744	China 40,500, \$706; Mexico 20,200, \$26; Hong Kong 398, \$4; Japan 72, \$6; Republic of Korea 50, \$3.
2615.90.6060	Ores and concentrates	202,000	7,830	204,000	3,990	Brazil 108,000, \$1,170; Hong Kong 37,200, \$739; China 18,800, \$574; Austria 13,000, \$1,130; Germany 8,360, \$184.
8103.20.0030	Unwrought, powders	111,000	45,900	146,000	75,700	Mexico 107,000, \$54,800; Sweden 13,400, \$5,070; Israel 7,040, \$5,320; Czech Republic 5,780, \$6,100; Kazakhstan 1,980, \$800; Germany 1,940, \$692; Portugal 498, \$438; El Salvador 7,060, \$1,500; Japan 775, \$607; Switzerland 280, \$139; Republic of Korea 176, \$145;
8103.20.0090	Unwrought, alloys and metal	25,200	9,000	15,000	8,000	Luxembourg 100, \$37; Peru 30, \$8; India 25, \$14; China 11, \$17; Chile 1, \$4. Germany 11,600, \$5,670; Israel 828, \$1,270; Republic of Korea 632, \$208; Switzerland 599, \$239; United Kingdom 396, \$148; Canada 327, \$107.
8103.30.0000	Waste and scrap	235,000	31,000	521,000	67,800	United Kingdom 109,000, \$10,400; China 90,500, \$8,470; Kazakhstan 65,300, \$16,200; Mexico 67,300, \$12,500; Germany 49,700, \$8,570; Hong Kong 40,100, \$2,720.
8103.90.0000	Wrought	81,200	59,000	54,200	36,400	Germany 24,440, \$15,800; Mexico 18,600, \$10,900.
Total		XX	161,000	XX	201,000	
Imports for consumption:						
Niobium:						
2615.90.6030	Ores and concentrates	11,000	761	8,470	600	China 8,000, \$595; France 247, \$3; Gabon 220, \$2.
2825.90.1500	Oxide	1,740,000	77,400	1,430,000	62,000	Brazil 1,180,000, \$51,300; Russia 229,000, \$9,680; China 11,000, \$460; Germany 6,740, \$503; Thailand 2,000, \$82.
Ferromiobium:						
7202.93.4000	Silicon < 0.4%	830,000	37,000	390,000	18,500	Brazil 285,000, \$13,600; United Kingdom 105,000, \$4,930.
7202.93.8000	Other	10,600,000	287,000	9,060,000	248,000	Brazil 7,060,000, \$191,000; Canada 1,990,000, \$56,600; United Kingdom 2,270, \$141; China 1,250, \$24.
Total		11,400,000	324,000	9,450,000	267,000	
Unwrought, powders ³						
8112.92.4000	Unwrought, powders ³	1,440,000	84,400	1,360,000	77,600	Brazil 1,270,000, \$69,800; Germany 50,200, \$3,720; Estonia 28,800, \$2,450; Canada 10,400, \$410; China 4,770, \$630; Japan 1,720, \$64; Thailand 1,020, \$426; Kazakhstan 26, \$7; United Kingdom 12, \$5; Belgium 1, \$3.
Tantalum:						
2615.90.6060	Ores and concentrates	261,000	13,000	653,000	54,000	Brazil 324,000, \$28,600; Canada 159,000, \$14,200; Rwanda 37,000, \$2,520; Mozambique 30,200, \$1,110; South Africa 26,300, \$1,680; Congo 25,400, \$1,690; Australia 25,100, \$2,090; Sierra Leone 12,600, \$468; Bolivia 9,380, \$602; Tanzania 4,080, \$999; Mexico 120, \$19; China 20, \$7; Germany 20, \$5.

See footnotes at end of table.

TABLE 4—Continued
U.S. FOREIGN TRADE IN NIOBIUM AND TANTALUM METAL AND ALLOYS, BY CLASS¹

HTS code ²	Class	2012		2013		Principal destinations and sources in 2013 (gross quantity in kilograms and values in thousand dollars)
		Gross quantity (kilograms)	Value (thousands)	Gross quantity (kilograms)	Value (thousands)	
<u>Imports for consumption—Continued</u>						
<u>Tantalum—Continued</u>						
8103.20.0030	Unwrought powders	138,000	57,400	113,000	51,900	Thailand 48,300, \$23,200; Germany 18,900, \$11,700; Japan 14,800, \$4,360; China 14,600, \$7,630; Kazakhstan 7,610, \$3,770; Czech Republic 7,250, \$855; El Salvador 675, \$80; Portugal 338, \$33; Israel 257, \$198; Canada 112, \$24; Hong Kong 8, \$4; United Kingdom 4, \$9.
8103.20.0090	Unwrought, alloys and metal	205,000	78,000	197,000	73,000	China 93,400, \$38,500; Kazakhstan 76,300, \$26,500; United Kingdom 11,100, \$2,310; Hong Kong 5,420, \$1,680; Congo 3,910, \$1,020; Estonia 2,530, \$1,310; Switzerland 2,470, \$718; Germany 1,930, \$969; France 22, \$19.
8103.30.0000	Waste and scrap	519,000	99,800	527,000	63,000	Indonesia 137,000, \$7,160; Austria 85,500, \$3,510; China 77,600, \$15,600; Germany 45,900, \$15,500; Czech Republic 45,700, \$2,180; Mexico 39,600, \$592.
8103.90.0000	Wrought	70,200	36,700	67,700	41,100	China 32,200, \$19,200; Kazakhstan 20,800, \$14,700; France 5,350, \$2,210.
	Total	XX	772,000	XX	690,000	

XX Not applicable.

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

²Harmonized Tariff Schedule of the United States.

³Niobium waste and scrap is included in 8112.92.0600 along with other materials. Niobium other than unwrought; waste and scrap; and powders is included in 8112.99.9000 along with other materials.

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

TABLE 5
U.S IMPORTS FOR CONSUMPTION OF TANTALUM ORES AND CONCENTRATES, BY COUNTRY¹

Country	2012		2013	
	Gross quantity (kilograms)	Value (thousands)	Gross quantity (kilograms)	Value (thousands)
Australia	--	--	25,100	\$2,090
Bolivia	23,400	\$423	9,380	602
Brazil	--	--	324,000	28,600
Canada	35,100	481	159,000	14,200
China	3,740	283	20	7
Colombia	4,160	221	--	--
Congo	--	--	25,400	1,690
Ethiopia	69,000	4,510	--	--
Germany	--	--	20	5
Indonesia	37,600	1,760	--	--
Mexico	--	--	120	19
Mozambique	--	--	30,200	1,110
Nigeria	2,010	182	--	--
Rwanda	63,900	3,520	37,000	2,520
Sierra Leone	--	--	12,600	468
South Africa	9,060	620	26,300	1,680
Tanzania	13,200	962	4,080	999
United Kingdom	6	7	--	--
Total	261,000	13,000	653,000	54,000

-- Zero.

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

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

TABLE 6
 NIOBIUM AND TANTALUM: WORLD PRODUCTION OF MINERAL CONCENTRATES, BY COUNTRY^{1,2}
 (Metric tons)

Country ⁵	Gross weight ³					Niobium content ⁴					Tantalum content ⁴				
	2009	2010	2011	2012	2013 ^e	2009	2010	2011	2012	2013 ^e	2009	2010	2011	2012	2013 ^e
Australia, columbite-tantalite ⁶	318	--	--	--	--	--	--	--	--	--	86	50 ^r	50 ^r	50 ^r	50
Bolivia, tantalite	--	3	17	42	47 ⁷	--	--	--	--	--	--	1	4	9	10
Brazil:															
Nb minerals ^{8,9}	159,000 ^r	113,000 ^r	115,000 ^r	147,000 ^r	136,000	62,159 ⁷	44,270 ⁷	45,198 ⁷	57,471 ^{r,7}	51,497 ⁷	--	--	--	--	--
Ta minerals ^{6,10}	473 ^{r,e}	587 ^{r,e}	453 ^{r,e}	393 ^{r,e}	400	--	--	--	--	--	116 ^r	144 ^r	111 ^r	98 ^r	152
Burundi	44	67	159 ^r	259 ^r	74	9	13	31 ^{r,e}	51 ^{r,e}	14	9	13	31 ^{r,e}	50 ^{r,e}	14
Canada:															
Nb minerals ⁹	1,773,000	1,792,000	2,087,000	2,155,000	2,300,000	4,330	4,419	4,632	4,707	5,263 ⁷	--	--	--	--	--
Ta minerals ^{6,10}	110 ⁷	--	40 ^r	80 ^r	20	5	--	1 ^r	3 ^r	1	24 ^r	--	-- ^r	37 ^r	9
China ^e	NA	NA	NA	NA	NA	21	22	17	14	15	74	70	61	66 ^r	60
Congo (Kinshasa):															
Cassiterite concentrate	15,512	13,415	9,267	8,018	6,231	150	130	90	80	60	220	190	140	120	90
Columbite-tantalite ¹¹	464 ^r	440 ^r	536 ^r	586 ^r	500	80 ^r	80 ^{r,e}	90 ^{r,e}	100 ^{r,e}	90	100 ^{r,e}	100 ^{r,e}	120 ^{r,e}	130 ^{r,e}	110
Nb minerals ^e	80	--	--	-- ⁷	--	40	--	--	-- ⁷	--	--	--	--	-- ⁷	--
Ethiopia, tantalite ¹²	398	252	285	380 ^{r,e}	50	28	22	25	26 ^{r,e}	4	99	82 ⁸	95 ⁸	91 ^{r,e}	10
French Guiana, columbite-tantalite ^e	2	2	2	2	2	--	--	--	--	--	(13)	(13)	(13)	(13)	(13)
Kazakhstan, niobium	NA	NA	NA	43	44	NA	NA	NA	--	--	NA	NA	NA	(13)	(13)
Mozambique ^e	405 ⁷	55 ⁷	139 ⁷	408 ^{r,7}	211	29	4	10	29 ^r	15	83 ^r	15	39	83 ^r	43
Nigeria, columbite-tantalite ^e	331	281	311	310	300	23	20	22	22	21	68	58	64	63	60
Rwanda ^e															
Cassiterite concentrate	4,210	5,290	6,950	4,640	4,900	40	50	70	50	50	60	80	100	70	70
Columbite-tantalite	952	560	890 ⁷	1,145	2,466	120	70	110	140	310	200	120	190	240	530
Somalia ^{6,14}	7	--	--	--	--	2	--	--	--	--	2	--	--	--	--
Uganda ^e	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)
Total	1,960,000 ^r	1,930,000 ^r	2,220,000 ^r	2,320,000 ^r	2,450,000	67,000 ^r	49,100 ^r	50,300 ^r	62,700 ^r	57,300	1,140 ^r	923 ^r	1,005 ^r	1,107 ^r	1,208

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

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

²Except for Congo (Kinshasa) and Rwanda, excludes production of niobium and tantalum contained in tin ores. Includes data available through August 25, 2015.

³Gross weight is weight of concentrate before metal is extracted.

⁴Content is weight of metal produced. Nb₂O₅ is 69.904% niobium; Ta₂O₅ is 81.897% tantalum.

⁵In addition to the countries listed, Russia was thought to have produced niobium and tantalum mineral concentrates, but available information is inadequate to make reliable estimates of output levels.

⁶Tantalum production reported in Ta₂O₅ converted to tantalum content. Gross weight is concentrate assumed to be one-third Ta₂O₅.

⁷Reported figure.

⁸Niobium concentrate production reported in Nb₂O₅ content converted to niobium content. Gross weight is concentrate assumed to be one-third Nb₂O₅.

⁹Includes columbite and pyrochlore.

¹⁰Includes djajmalite and tantalite.

TABLE 6—Continued
 NIOBIUM AND TANTALUM: WORLD PRODUCTION OF MINERAL CONCENTRATES, BY COUNTRY^{1,2}

¹¹Reported data includes the North Kivu and South Kivu Provinces.
¹²Data are for fiscal year beginning July 1 of that stated.
¹³Less than ½ unit.
¹⁴From August 2008 to April 2009, 18 metric tons of columbite-tantalite were reportedly produced in Somalia. It is unclear if production continued after early April 2009.

TABLE 7
 FERRONIUM (FERROCOLUMBIUM): WORLD PRODUCTION, BY COUNTRY^{1,2}

(Metric tons, Nb content)

Country ³	2009	2010	2011	2012	2013 ^e
Brazil	34,700 ^r	52,600 ^r	53,700	50,600 ^r	46,600 ⁴
Canada	4,110 ^r	4,310 ^r	4,630 ^r	4,710 ^r	5,260 ⁴
Russia	300 ^r	420 ^r	420 ^{r,e}	420 ^{r,e}	360
Total	39,200 ^r	57,300 ^r	58,700 ^r	55,700 ^r	52,200

^eEstimated. ^rRevised.
¹World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.
²Includes data available through May 21, 2015.
³In addition to the countries listed, Austria, China, and Germany are believed to have produced ferroniobium (ferrocolumbium), but production information is inadequate for the formulation of estimates of output levels.
⁴Reported figure.

TABLE 8
SELECTED TANTALUM PROCESSING PLANTS THAT CONSUMED
TANTALUM CONCENTRATE TO PRODUCE INDUSTRIAL TANTALUM PRODUCTS IN 2013¹

Country	Product(s) produced	Location	Operator/owner
Austria	Ta ₂ O ₅ , TaC	Multiple; Althofen, Carinthia (HQ)	Treibacher Industrie AG.
Do.	Ta ₂ O ₅ , TaPwdr, TaMtl	Multiple; Liezen, Reutte (HQ)	PLANSEE Group.
Brazil	Ta ₂ O ₅	Sao Joao Del Rei, Minas Gerais State	LSM Brazil SA (formerly Companhia Industrial Fluminense)[AMG Advanced Metallurgical Group N.V. (Netherlands)] (formerly London & Scandinavian Metallurgical Co., Ltd.).
Do.	FeNbTa	Sao Paulo State	Mineração Taboca SA (Minsur SA).
China	TaPwdr, Ta ₂ O ₅ , K ₂ TaF ₇ , TaMtl	Conghua, Guangdong Province	Conghua Tantalum and Niobium Smeltery (CTNS).
Do.	TaPwdr, Ta ₂ O ₅ , TaMtl	Sihui, Guangdong Province	Duo Luo Shan Sapphire Rare Metal Co Ltd of Zhaoqing.
Do.	K ₂ TaF ₇ , Ta ₂ O ₅ , TaC	Chengnan Industrial Zone, Qingyuan, Guangdong Province	Fogang Jiata Metals Co., Ltd. (Jiayuan Cobalt Holdings).
Do.	Ta ₂ O ₅ , K ₂ TaF ₇	Yingde, Guangdong Province	Guangdong Zhiyuan New Material Co., Ltd. (Jiayuan Cobalt Holdings).
Do.	do.	Hengyang City, Hunan Province	Hengyang King Xing Lifeng New Materials Co., Ltd.
Do.	Ta ₂ O ₅ , K ₂ TaF ₇ , TaPwdr, TaMtl	Yaxi Industrial Development Zone, Xinhui, Jiangmen, Guangdong Province	Jiangmen Fuxiang Electro-materials Ltd. (F&X Electro-Materials Ltd.).
Do.	Ta ₂ O ₅ , K ₂ TaF ₇	Fengxin County, Jiangxi Province	Jiangxi Province Ding Hai Tantalum & Niobium Co., Ltd.
Do.	Ta ₂ O ₅ , K ₂ TaF ₇ , TaC	Jiujiang, Jiangxi Province	JiuJiang JinXin Nonferrous Metals Co., Ltd.
Do.	Ta ₂ O ₅ , TaMtl	do.	Jiujiang Tanbre Co., Ltd. (JJTC) (formerly Jiujiang Tanbre smelter) (Jiangxi Tungsten Group Ltd Corp. [JWYX]).
Do.	Ta ₂ O ₅ , K ₂ TaF ₇ , TaC, TaMtl	do.	Jiujiang Zhongao Tantalum & Niobium Co., Ltd. (joint venture Jiangxi Jiujiang Yizhong Nonferrous Metals Co., Ltd., and others).
Do.	Ta ₂ O ₅ , K ₂ TaF ₇ , TaC, TaPwdr, TaMtl	Shishi Industrial Zone, Yifeng County Industrial Park, Fengcheng, Jiangxi Province	King-Tan Tantalum Industry, Ltd.
Do.	TaAlloys, TaC, Ta ₂ O ₅ , TaN, TaSi ₂ , TaSe ₂	Many (Shanghai, Suzhou in China and others in England, Ireland, Philippines, Singapore, Taiwan, and United States)	Materion Advanced Materials Thin Film Products.
Do.	Ta ₂ O ₅ , TaMtl, TaPwdr	Jiangning Economic Development Zone, Nanjing, Jiangsu Province	Metalink International Co., Ltd. (affiliates: Nanjing Metalink International Co., Ltd., and Metalink Special Alloys Corp.).
Do.	Ta ₂ O ₅ , TaCl ₅ , TaNbC, Ta ethoxide, TaMtl, TaAlloys	Shizuishan, Ningxia Province	Ningxia Orient Tantalum Industry Co., Ltd. (OTIC).
Do.	Ta ₂ O ₅	Buxia Cun, Rencun Town, Xinxing, Yunfu, Guangdong Province	XinXing Haorong Electronic Material Co., Ltd.

See footnotes at end of table.

TABLE 8—Continued
 SELECTED TANTALUM PROCESSING PLANTS THAT CONSUMED
 TANTALUM CONCENTRATE TO PRODUCE INDUSTRIAL TANTALUM PRODUCTS IN 2013¹

Country	Product(s) produced	Location	Operator/owner
China—Continued			
Do.	Ta ₂ O ₅ , TaC, TaPwdr	Liangang Industrial Park, Yifeng County, Yichun, Jiangxi Province	Yichun Jinyang Rare Metal Co., Ltd.
Do.	K ₂ TaF ₇ , Ta ₂ O ₅ , Ta ethoxide, TaPwdr, TaMtl, TaAlloys, TaC	Zhuzhou, Hunan Province	Zhuzhou Cemented Carbide Works Import & Export Co. (Zhuzhou Cemented Carbide Group Corporation, Ltd.)
Estonia	Ta ₂ O ₅ , TaH ₅ , TaMtl (ingots, chips)	Sillamae, Ida-Virumaa	Molycorp Silmet AS (Molycorp, Inc.)
Germany	TaMtl, Ta ₂ O ₅ , TaAl	Freiberg, Saxony	Freiberger NE-Metal GmbH & Co. Produktions KG (GfE Gesellschaft für Elektrometallurgie mbH, AMG Advanced Metallurgical Group N.V.)
Do.	do.	Nuremberg, Middle Franconia	GfE - Metalle und Materialien GmbH (GfE Gesellschaft für Elektrometallurgie mbH, AMG Advanced Metallurgical Group N.V.)
Do.	TaPwdr, TaNbC, Ta ₂ O ₅ , TaCl ₅ , TaMtl, TaRecyc	Many (Munich [HQ]; Im Schleeke, Goslar, Lower Saxony; Hermsdorf, Thuringia; two plants in Laufenberg, Baden-Württemberg in Germany; others in China, Japan, Thailand, and United States)	H.C. Starck, GmbH
Do.	do.	Hanau, Hesse	Heracus Materials Tecnology, GmbH & Co. KG (formerly W.C. Heraeus) (Heracus Holding, GmbH)
India	K ₂ TaF ₇ , Ta ₂ O ₅	Taloja, District Raigad, Maharashtra	Metallurgical Products India Pvt Ltd. (MPIL)
Japan	Ta ₂ O ₅ , TaC, TaNbC	Omuta, Fukuoka Prefecture	Engineered Powders Div. Mitke Rare Metal Plant (Mitsui Mining and Smelting Co., Ltd.)
Do.	TaPwdr	Aizuwakamatsu, Fukushima Prefecture	Global Advanced Metals, Pty, Ltd.
Do.	TaPwdr, TaNbC, Ta ₂ O ₅ , TaCl ₅ , TaMtl, TaRecyc	Hitachiomiya, Ibaraki Prefecture	H.C. Starck, Ltd., H.C. Starck, GmbH
Do.	Ta ₂ O ₅	Kako, Hyogo Prefecture	Taki Chemicals Co., Ltd.
Mexico	K ₂ TaF ₇	Matamoros, Tamaulipas	Kemet De Mexico, S.A. de C.V.
Russia	Ta ₂ O ₅ , TaMtl	Solikamsk, Perm Krai	(Kemet Blue Powder Corp. [Kemet Corp.]). Solikamsk Magnesium Works OAO (Solikamsk Magnesium Works [SMZ] JSC).
United States	TaMtl, TaAlloys	Boyetown, Montgomery County, Pennsylvania	Global Advanced Metals.
Do.	TaPwdr	Mound House, Nevada	Kemet Blue Powder (Kemet Corp.)

Do., do. Ditto. NA Not Available.

¹FeNbTa, ferriobium-tantalum; HQ, headquarters; K₂TaF₇, K-salt; Ta, tantalum; Ta₂O₅, tantalum pentoxide; TaAl, aluminum alloy; TaAlloys, tantalum alloys; TaC, tantalum carbide; TaCl₅, tantalum chloride; TaH₅, tantalum hydride; TaMtl, tantalum metal; TaN, tantalum nitride; TaNbC, tantalum niobium carbide; TaPwdr, tantalum powder; recycled tantalum; TaSe₂, tantalum diselenide; TaSi₂, tantalum silicide.