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Niobium (Columbium) and Tantalum

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In 2011, U.S. niobium apparent consumption (measured in contained niobium) was 9,160 metric tons (t), 12% more than that of 2010; U.S. tantalum apparent consumption (measured in contained tantalum) was 1,210 t, 4% more than that of 2010. No domestic mine production of niobium or tantalum ore was reported.

Legislation and Government Programs

The Defense Logistics Agency, Strategic Materials (DLA) did not dispose of niobium or tantalum materials under its fiscal year 2011 Annual Materials Plan (AMP). The DLA did not sell niobium or tantalum materials in calendar year 2011. The DLA's fiscal year 2012 AMP set maximum disposal goals for niobium and tantalum materials at zero (Defense Logistics Agency, Strategic Materials, 2011).

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 2011, neither niobium nor tantalum domestic mine production was reported. The Kougarok prospect, on the Seward Peninsula in Alaska, hosts significant tantalum resources in a lithium-fluorine granite (Hudson, 1998, p. 151–153; Navigator Exploration Corp., 2003, p. 2).

Global Advance Metals Pty. Ltd. purchased Cabot Corp.'s Supermetals business, which comprised tantalum manufacturing facilities in Pennsylvania and Japan (Cabot Corp., 2012, p. 4). Cabot retained Tantalum Mining Corp. of Canada (Cabot Corp., 2011a).

Quantum Rare Earth Developments Corp. (2012, p. 4, 85) reported niobium resources for its Elk Creek deposit in Nebraska (about 40°16' N, 96°11' W). Quantum estimated, at a cutoff grade of 0.4% niobium pentoxide (Nb_2O_5), an indicated resource of 19.3 million metric tons (Mt) at 0.67% Nb_2O_5 (129,000 t of Nb_2O_5), and an inferred resource of 83.3 Mt at 0.63% Nb_2O_5.

Rare Earth Industries (2011) explored for tantalum at two sites in Colorado—Turret District in Chaffee County and Phantom Pegmatites in Freemont County. Turret Mines produced tantalum in 1952; beryl was produced in the Phantom area. Tantalum and niobium were described as "interesting but almost valueless materials" in 1961 (Hanley and others, 1950, p. 23–27, 41; Eckel, 1961, p. 11, 111–12, 318–19; Meeves and others, 1966, p. 7–9, 26). Texas Rare Earth Resources Corp. explored for niobium and tantalum in streambed samples around Round Top Mountain, Hudspeth County, Texas (Texas Rare Earth Resources Corp., 2011).

Consumption

Domestic data for niobium and tantalum 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 and tantalum materials, there was 1 respondent to the "Columbium (Niobium) and Tantalum" canvass, about 70 respondents to "Consolidated Consumers" canvass, and 1 respondent to the "Specialty Ferroalloys" canvass. The steel industry accounted for 75% of niobium and tantalum reported consumption; the superalloy industry, 25%.

Schwela (2011) reported world niobium and tantalum consumption by material. Tantalum consumption, based on tantalum processors' shipments, was capacitor-grade tantalum powder (24%); metallurgical-grade powder, unwrought metal, scrap, and other (17%); mill products of tantalum (22%); tantalum carbide (7%); tantalum chemicals (18%); and tantalum ingot (12%). Niobium consumption, based on niobium processors' shipments, was niobium alloys (2.5%); niobium chemicals (5.2%); niobium metal (0.9%); steel-grade ferroniobium (87%); and vacuum-grade niobium (2.7%). Niobium masteralloys—ferroniobium and niobium-nickel alloy—were consumed to produce steel and superalloys. About 75% of world niobium consumption was for the production of microalloyed steel (Companhia Brasileira de Metalurgia e Mineração, undated c).

Prices

Tantalite ore annual average price per pound of contained tantalum pentoxide (Ta_2O_5) was $124.896.

Foreign Trade

The values of foreign trade of these niobium and tantalum materials (ferroniobium and niobium chemicals, metal, ore, and oxide, and tantalum metal and ore) were $181 million for exports (48% greater than that of 2010) and $643 million for imports (28% greater than that of 2010). The United States exported 363 t of niobium contained in niobium materials (29% greater than that of 2010) and imported 9,520 t of niobium contained in niobium materials (12% greater than that of 2010) (table 1). The United States exported 648 t of tantalum contained in tantalum materials (48% greater than that of 2010) and imported 1,860 t of tantalum contained in tantalum materials (16% greater than that of 2010) (table 2).

World Industry Structure

Brazil and Canada were the leading producers of niobium mineral concentrates; Brazil and Mozambique were the leading producers of tantalum mineral concentrates. Tantalum-bearing tin slags, which are byproducts from tin smelting, principally from Asia, Australia, and Brazil, are another source of tantalum. The leading niobium ore and concentrate producers were Companhia Brasileira de Metalurgia e Mineração (CBMM) in Brazil and IAMGOLD Corp. (Niobec Mine) in Canada. The leading tantalum ore and concentrate producers were Metalurg Group (Mibra Mine) and Mineração Taboca S/A (Pitinga Mine) in Brazil and Noventa Ltd. (Morropino Mine) in Mozambique.

Based on a survey of its members, the Tantalum-Niobium International Study Center (TIC) reported annual niobium and tantalum raw material production (raw material production by members plus producer and trader receipts of raw materials from nonmembers) to have been [in metric tons of contained tantalum (Ta)]: 2007, 1,100 t of Ta; 2008, 1,200 t of Ta; 2009, 490 t of Ta; and 2010, 720 t of Ta; and [in metric tons of contained niobium (Nb)]: 2007, 70,000 t of Nb; 2008, 68,000 t of Nb; 2009, 41,000 t of Nb; and 2010, 58,000 t of Nb (Tantalum-Niobium International Study Center, 2012, p. 6, 10).

Niobium

Niobium is a transition metal with physical and chemical properties very similar to those of tantalum. The crustal abundance of niobium is 8 grams per ton (g/t) (0.0008%). Niobium does not occur naturally as a free metal; however, niobium occurs in a range of oxide mineral species that are economically important, including columbite (78.72% Nb_2O_5), euxenite (47.43% Nb_2O_5), lueshite (81.09% Nb_2O_5), and pyrochlore (75.12% Nb_2O_5). Niobium ore grade at deposits mined in 2011 ranged from 0.59% Nb_2O_5 in Canada to 3% Nb_2O_5 in Brazil, Congo (Kinshasa), and Russia. Niobium ore was beneficiated to concentrate containing about 54% Nb_2O_5. Nb_2O_5 was produced from the concentrate; ferroniobium or niobium metal, from the Nb_2O_5. Ferroniobium, the leading commercial niobium-containing material, was typically about 60% niobium, and was consumed in the production of HSLA steel. Other uses included the production of niobium carbide and chemicals. Brazil has been the leading niobium producer; Canada, the second-ranked producer (British Geological Survey, 2011a, p. 1, 3, 10–12).

Tantalum

Tantalum is a transition metal with physical and chemical properties very similar to those of niobium. The crustal abundance of tantalum is 0.7 g/t (0.00007%). Tantalum does not occur naturally as a free metal; however, tantalum occurs in a range of oxide mineral species that are economically important, including ixiolite (68.96% Ta_2O_5), microlite (83.53% Ta_2O_5), tantalite (86.17% Ta_2O_5), tapiolite (83.96% Ta_2O_5), and wodginite (69.58% Ta_2O_5). In 2011, tantalum ore grade at deposits mined was less than 0.05% Ta_2O_5 in Australia, Brazil, Canada, Ethiopia, and Mozambique. Tantalum ore was beneficiated to concentrate containing about 30% Ta_2O_5. Potassium tantalum fluoride (K_2TaF_7) was produced from the concentrate; tantalum metal, from the K_2TaF_7. Tantalum metal was the leading commercial tantalum material and was consumed in the production of tantalum capacitors. Other uses included the production of tantalum chemicals and metal. Australia has been the leading tantalum producer (British Geological Survey, 2011a, p. 1, 3, 10–12).

World Review

Burt (2012, p. 13–14) reported that the ITRI Tin Supply Chain Initiative (iTSCi) was implemented in Rwanda and Katanga Province of Congo (Kinshasa) in 2011. Eleven tantalum smelters were designated conflict of free smelters. The supply chain initiative was similar to the sustainability methodology a successfully implemented framework to improve worker health and safety conditions through business contracts with leading international companies in countries that lack governance and were part of the global supply chain (Fair Labor Association, 2012).

European Union.—The European Union (EU) found niobium to be one of 14 metals necessary for implementing six low-carbon energy technologies [bioenergy, carbon capture and storage (CCS), electricity grids, nuclear, solar, and wind] in Europe between 2020 and 2030. The metals were characterized by rapid demand growth and geographical concentration of supply, in addition to being necessary for the six technologies. Moss and others (2011, p. 5, 15, 37, 95, 136–139) summarized the risk niobium supply-chain bottleneck as medium, with market factors of high likelihood of rapid demand growth and low limitation to expanding production capacity, and political factors as high concentration of supply and medium political risk. Niobium was found to be important to capture and storage of carbon and nuclear technologies. For carbon capture and storage the major use would be in pipelines; for nuclear, stainless steels, and superalloys.

Australia.—Australia reported that, as of December 31, 2010, Joint Ore Reserves Committee (JORC)-compliant proven and probable ore reserves (as stated in company annual reports and reports to the Australian Stock Exchange) were not available for niobium and were 19,000 t of Ta for tantalum, and accessible economic demonstrated resources were 134,000 t of Nb for niobium and 53,000 t of Ta for tantalum (Geoscience Australia, 2011, p. 5–6).

Global Advanced Metals (GAM) reopened the Wodgina Mine and Greenbushes Mine processing plant, which had been on care-and-maintenance status since December 2008. GAM produced tantalum ore at Wodgina Mine, which it processed along with tantalum ore from Mt. Cattlin into concentrate at Greenbushes. Wodgina's production capacity of Ta_2O_5 contained in concentrate was 640 metric tons per year (t/yr) of which one-half was committed for contracts (Global Advanced Metals, 2011).

Galaxy Resources Limited produced 464 t of tantalum concentrate grading 3.3% Ta_2O_5 at Mount Cattlin, Western Australia State, of which it shipped 234 t to GAM Greenbushes Mine processing plant. Galaxy planned to produce 25 t/yr of tantalum in concentrate. Galaxy reported proved plus probable reserves of 10.737 Mt containing 146 g/t Ta_2O_5 and resources of 17.155 Mt containing 155 g/t Ta_2O_5 to a

cutoff grade of 0.4% lithium oxide (Li_2O) as of 2011 (Galaxy Resources Limited, 2012, p. 2, 15–16).

Alkane Resources Ltd. (2012, p. 3–5) conducted a feasibility study for the production of 1,200 t/yr Nb_2O_5 and worked on a study to increase production to 3,000 t/yr Nb_2O_5. Alkane reported 35.9 Mt of proved plus probable reserves at 0.46% Nb_2O_5 and 0.03% Ta_2O_5 as of November 2011 and 73.3 Mt of measured plus inferred resources at the same grade as of December 2011at its Dubbo Zirconia Project, Toongi deposit, New South Wales.

Altura Minerals Ltd. (2011, p. 17) (formerly Australian Tantalum Pty. Ltd.) reported tantalum at its Finniss Range (Northern Territory) and Smithfield (Western Australia) projects based on rock chip sampling.

Artemis Resources Ltd. (2011, p. 9) was granted exploration permits for an additional 93 square kilometers (km^2) at Buchanan's Creek/Grant's Gully tenements south of Georgetown, Queensland. Capital Mining Ltd. (2011, p. 15–16) reported 55 Mt of inferred resources grading 80 g/t Nb_2O_5 at Narraburra prospect about 12 kilometers (km) northeast of Temora, New South Wales.

Lithex Resources Ltd. (2012) reported 1.9 Mt of inferred resources containing 20 g/t tantalum in tin mine tailings stockpiles at its Moolyella project. The project includes tailings from tin mining from 1898 to 1986.

Brazil.—The National Department of Mineral Production (DNPM) reported that CBMM and Anglo American Brazil produced niobium, and Mineração Taboca produced tantalum. Pereira (2011) reported Brazilian niobium mine production of 165,723 t of Nb_2O_5 from reserves of 4,499,106 t of Nb_2O_5 in 2009, from which Brazil produced 88,920 t of Nb_2O_5 contained in concentrate, 34,746 t of Nb contained in ferroniobium, and 2,333 t of Nb_2O_5. Pontes (2011) reported Brazilian tantalum mine production of 218 t of Ta_2O_5 contained in concentrate from reserves of 87,782 t of Ta_2O_5 in 2009.

Anglo American Brazil Ltd. (a subsidiary of Anglo American plc) mined pyrochlore from a carbonatite deposit. Catalão Mine (47°48' W, 18°08' S) is comprised of three open pit mines and a processing facility. Anglo reported that Catalão produced 3,900 t of niobium contained in ore in 2011 compared with 4,000 t in 2010. Anglo mined 867,000 t of ore and processed 903,000 t of ore with a niobium content of 8.1 kilograms per ton (kg/t). JORC-compliant proved and probable reserves in 2011 were 4.3 Mt at 1.03% Nb_2O_5 containing 31,000 t of niobium and measured plus indicated resources of 2.8 Mt at 1.22% Nb_2O_5 containing 23,900 Mt of niobium (Anglo American plc, 2012, p. 19, 86, 198, 204). In addition, Anglo reported measured plus indicated resources of 33.2 Mt at 1.24% Nb_2O_5 containing 288,000 t of niobium at its Fresh Rock project where it planned to start production in 2013, which would bring its production capacity to 6,500 t/yr of niobium from the current 3,800 t/yr.

CBMM mined niobium ore from the Barreiro carbonatite complex (19°40' S, 46°56' W) and beneficiated the ore at the mine site by selectively extracting the pyrochlore minerals from which niobium oxide is produced. The deposit contained 440 Mt of ore reserves at an average grade of 2.5% to 3% Nb_2O_5 that could be mined by open pit methods (Riffel, undated). CBMM produced ferroniobium, nickel-niobium, niobium metal, niobium oxide, and high-purity ferroniobium, and had production capacities of 70,000 t/yr of ferroniobium, 3,000 t/yr of high-purity ferroniobium and nickel-niobium, and 210 t/yr of niobium metal (Companhia Brasileira de Metalurgia e Mineração, undated a, b).

Companhia Industrial Fluminense Mineracao S.A. (CIF), owned by AMG Advanced Metallurgical Group N.V., produced niobium and tantalum concentrate at Volta Grande Mine (21° 05' S, 44° 35' W). CIF produced from an annual production capacity of 136 t of Ta_2O_5 contained in concentrate and planned to increase production capacity to 227 t/yr of Ta_2O_5 contained in concentrate. CIF reported NI 43–101 compliant 2008 ore reserves sufficient to support production of 136 t/yr of Ta_2O_5 for 30 years. Ore grade was 375 g/t Ta_2O_5 (Schwela, 2010, p. 2–6; AMG Advanced Metallurgical Group N.V., 2012, p. 7, 21, 25, 76; Companhia Industrial Fluminense Mineracao S.A., undated). CIF planned to increase production to 227 t/yr of concentrate in 2013 (Resende, 2011).

Mineração Taboca S.A. mined columbite at the Pitinga Mine. Taboca produced a ferroniobiumtantalum alloy containing 45.00% niobium, 4.20% tantalum, and 25.00% iron that was sold for the production of niobium and tantalum oxide (Mineração Taboca S.A., 2012a, b).

Arqueana de Minérios e Metais Ltda. conducted small-scale artisanal mining of niobium and tantalum in the Itinga pegmatites, Minas Gerais (Kokomo Enterprises Inc., 2011).

MBAC Fertilizer Corp. acquired the Araxá Project (about 19°39' S, 46°56' W), a niobium, rare-earth oxide, and phosphate deposit in the Barreiro Cretaceous carbonatite. MBAC reported inferred minerals resource of 2.7 Mt with an average 1.41% Nb_2O_5 grade (MBAC Fertilizer Corp., 2011, p. 7–8; 2012, p. 53; undated).

Canada.—Canada reported niobium mine production of 4,532 t of contained Nb in 2011 compared with 4,419 t of contained Nb in 2010. No production of tantalum was reported for 2010 or 2011. Niobium ore was mined in Quebec (Natural Resources Canada, 2012a, b).

IAMGOLD (Toronto, Ontario) mined niobium contained in pyrochlore from the Saint-Honoré carbonatite deposit at the Niobec Mine (about 48°32' N, 71°09' W). Niobec mill production capacity was 4,500 t/yr of niobium. The mill produced concentrate from which Niobec produced Nb_2O_5 that was then converted to standard grade (66% niobium) ferroniobium by an aluminothermic reduction. In 2011, the Niobec Mine produced 4,632 t of niobium compared with 4,343 t of niobium in 2010 (IAMGOLD Corp., 2012, p. 26).

Tantalum Mining Corp. of Canada (Lac Du Bonnet, Manitoba) (Tanco) restarted tantalum production in May citing rising global demand for tantalum. Tanco suspended production in 2009 following the world financial crisis (Cabot Corp., 2011b).

Avalon Rare Metals Inc. (Toronto, Ontario) prospected for niobium and tantalum at its Thor Lake property (about 62°06'30" N, 112°35'30" W). Avalon updated a prefeasibility study and planned to complete a bankable feasibility study in 2012. The company reported probable reserves at the Nechalacho deposit at Thor Lake of 14.54 Mt at 3,800 g/t Nb_2O_5 (0.38%) and 404 g/t Ta_2O_5 (0.0404%). Avalon planned

to produce 1,700 t/yr of Nb_2O_5 and 100 t/yr of Ta_2O_5 (Cox and others, 2011, p. 4–1, 15–1—15–7, 16–4; Avalon Rare Metals Inc., 2012, p. 2, 9).

Commerce Resources Corp. (Vancouver, British Columbia) prospected for niobium and (or) tantalum at the Blue River (east of Quesnel, British Columbia), Eldor (south of Kuujjuaq, Quebec), and Carbo (northeast of Prince George, British Columbia) properties, which host carbonatite deposits. Commerce reported NI 43–101-compliant resources for the Blue River property (52°19' N, 119°10' W), comprising Fir, Upper Fir, and Verity deposits. Commerce estimated indicated resources of 36.35 Mt containing 7,090 t of Ta_2O_5 and 61,650 t of Nb_2O_5 (Commerce Resources Corp., 2012, p. 2–3).

Critical Elements Corp. (Montreal, Quebec) explored the Rose property (52°01'02''N, 76°09'34''W) in the James Bay area of Quebec. Critical Elements reported 37.2 Mt of indicated plus inferred resource at 158 g/t Ta_2O_5 (Critical Elements Corp., 2011, p. 1–3, 4–1—4–4, 14–14).

Dios Exploration Inc. (Montreal, Quebec) discovered the Shipshaw Carbonatite Complex near Chicoutimi, Quebec, in 2010. Dios continued drilling on the property to explore for niobium and tantalum (Dios Exploration Inc., 2011, p. 5–6).

Matamec Explorations Inc. (Montreal, Quebec) explored for niobium and tantalum at Zeus and Tansim properties in Quebec hosted by the Kipawa Alkalic Complex (Matamec Explorations Inc., 2012, p. 1, 14).

Geometa Resources Inc. (2011, p. 7) estimated 0.126% Nb_2O_5 contained in 183.9 Mt of indicated resources and 66.7 Mt of inferred resources at Montviel Core Zone in Quebec for the Montviel Core Zone at a cutoff grade of 1% total rare-earth oxides.

MDN Inc. (Montreal, Quebec) sought a strategic partner for its Crevier Niobium project (49°30′ N, 72°49′ W), which had measured plus indicated resources of 25.369 Mt containing 0.196% Nb_2O_5 and 234 g/t Ta_2O_5. MDN planned to start Crevier Mine construction in 2013, with possible production of 4,000 tons per day from an open pit mine (MDN Inc., 2012, p. 14).

Niocan Inc. (Montreal, Quebec) (2012, p. 2) explored for niobium minerals at its Oka property near Oka, Quebec. Niocan reported 10.63 Mt of measured plus indicated resources at 0.68% Nb_2O_5 as of December 2009.

PhosCan Chemical Corp. (Toronto, Ontario) (2012, p. 11) sought a process to recover niobium from ore processed for phosphate concentration from its Martison phosphate deposit near Hearst, Ontario.

Rare Earth Metals Inc. (Thunder Bay, Ontario) reported an 8.5 Mt inferred resource with 0.13% Nb_2O_5 at a cutoff grade of 0.6% total rare-earth oxides for the Clay-Howells deposit near Kapuskasing, Ontario, and a 41 Mt inferred resource at 0.26% Nb_2O_5 to a cutoff grade of 0.60% total rare-earth oxides for Two Tom deposit near Letitia Lake, Newfoundland and Labrador (Rare Earth Metals Inc., 2011, p. 2, 64, 66; Daigle, 2012, p. 73).

Quest Rare Minerals Ltd. (Montreal, Quebec) found niobium minerals, among other minerals, at its Misery Lake and Strange Lake rare-earth projects on the Quebec-Labrador border. Quest reported NI 43–101 compliant inferred resources of 114.8 Mt grading 0.208% Nb_2O_5 at Strange Lake and conducted prefeasibility study work. Quest also explored for Nb_2O_5 at Misery Lake (Quest Rare Minerals Ltd., 2012, p. 10, 17).

Taseko Mines Ltd. (Vancouver, British Columbia) explored for niobium minerals at its Aley prospect in northern British Columbia. Taseko started the construction of road access to the site (Taseko Mines Ltd., 2012, p. 3).

TNR Gold Corp. (Vancouver, British Columbia) explored the Great Slave Lake property in Northwest Territories (Moose project) for niobium and tantalum. Tantalum was mined at the property in 1947 and 1953–54. TNR also explored for niobium near Thunder Bay, Ontario (Big Beaverhouse property) (TNR Gold Corp., undated).

Egypt.—Tantalum Egypt JSC [Gippsland Ltd. (Claremont, Australia) and the Government of Egypt] planned to mine tantalite from the Abu Dabbab (about 25°20'11" N, 34°32'34" E) and Nuweibi (25°12'3.09" N, 34°29'56.15" E) deposits, starting with Abu Dabbab in 2013 at the rate of 400 t/yr Ta_2O_5 content. Gippsland reported Abu Dabbab proven plus probable reserves were 33.18 Mt at 0.0252% Ta_2O_5. At Nuweibi, indicated plus inferred resources were 98 Mt at 140 g/t Ta_2O_5. H.C. Stark Group GmbH (Goslar, Germany) committed to buy 300 t/yr of contained Ta_2O_5 for the first 10 years (Gippsland Ltd., 2012, p. 8–11, 17).

Estonia.—AS Silmet (Sillamäe) produced niobium and tantalum products from raw materials imported from Brazil (niobium-tantalum alloy) and Russia (niobium-tantalum ore) (Kerr, 2010). Molycorp Inc. (United States) acquired Silmet to become Molycorp Silmet.

Ethiopia.—The Ethiopian Mineral Development Share Company (EMDSC) (Addis Ababa) (undated) owned and managed the Kenticha Tantalum Mine (5°27'13.63" N, 39°1'2.51" E), and produced and exported tantalum concentrate from a capacity of 200 t/yr grading 45% to 60% Ta_2O_5. EMDSC estimated proved reserves of 16.4 Mt at 0.015% Ta_2O_5 and inferred reserves of 100 Mt at 0.017% Ta_2O_5.

Finland.—Tertiary Minerals plc (Macclesfield, United Kingdom) awaited an exploration license for the Rosendal tantalum prospect (Kemiö Island), which had 1.05 Mt of inferred mineral resource grading 255 g/t Ta_2O_5 (0.0255%) (Tertiary Minerals plc, 2011, p. 10).

Gabon.—Eramet S.A. (Paris, France) (2012, p. 5) planned to produce niobium and tantalum at its Mabounie project starting between 2018 and 2020, following the operation of a commercial scale demonstration plant in 2014.

Kenya.—Pacific Wildcat Resources Corp. (Vancouver, British Columbia, Canada) explored for niobium at Mrima Hill (about 4°21' S, 39°11' E), where it reported a niobium inferred resource of 105.3 Mt at 0.65% Nb_2O_5 (Pacific Wildcat Resources Corp., 2011a; c, p. 14, 18). Cortec Mining Kenya Ltd. (Nairobi) also explored for niobium in the Mrima Hill area (Cortec Mining Kenya Ltd., 2011).

Malawi.—Globe Metals & Mining Limited (West Perth, Australia), through its Kanyika project, planned to bring niobium mining into production in 2014 followed by ferroniobium production in 2015. Globe (2011, p. 7–9) reported measured plus indicated plus inferred resources for the Kanyika Niobium project (about 12°38' S, 33°38' E) of 60 Mt containing 174,000 t of Nb_2O_5 (0.29% average grade) and 8,400 t of Ta_2O_5

(0.014% average grade). Globe planned to complete a definitive feasibility study in 2012. Mkango Resources Ltd. explored for niobium at the Songwe Hill rare-earth project in southern Malawi.

Mozambique.—Highland African Mining Company Limitada [a subsidiary of Noventa Ltd. (St. Helier, United Kingdom)], operated the Marropino Mine, held concessions for the Morrua and Mutala deposits, and held exploration licenses for adjacent areas. Noventa reported indicated resources of 7.40 Mt at 223 g/t Ta_2O_5 (0.022% Ta_2O_5) at Marropinno (16°30' 40" S, 37°54' 10" E) and 4.65 Mt at 510 g/t Ta_2O_5 (0.051% Ta_2O_5) at Morrua (about 16°16' S, 37°52' E) (Noventa Ltd., 2011, p. 6, 9, 21). Noventa planned to upgrade its processing capacity to about 250 t/yr of contained Ta_2O_5. The company reported 2011 production of 38.4 t of contained Ta_2O_5 compared with 12.5 t in 2010.

Pacific Wildcat Resources Corp. (Vancouver, British Colombia, Canada) started tantalum ore production at the former Muiane Mine (15°44'10" S, 38°15'15" E). Pacific planned to produce 16 t/yr Ta_2O_5 to 34 t/yr Ta_2O_5 upon completion of its secondary processing plant at the mine site in 2012, from an indicated resource of 1.375 Mt with average grade of 250 g/t Ta_2O_5 (0.025% Ta_2O_5) to a cutoff grade of 50 g/t (Pacific Wildcat Resources Corp., 2009, p. 4; 2011b, p. 3).

Namibia.—Procomex Namibia Pty. Ltd. (Uis) planned to reopen the Uis Mine, which formerly produced tin and tantalite. Procomex planned to start tantalum ore production after construction of a new processing plant, rehabilitation of the water infrastructure, and modernization of electrical connections by NamPower, Namibia's national electrical power utility (Namibian, The, 2011).

Namibia Rare Earths Inc. (Halifax, Nova Scotia, Canada) (2012, p. 5) explored for niobium at the Lofdal carbonatite complex (20°21' S, 14°45' E) (Woolley, 2001, p. 209). Namibia Rare Earths planned to complete a resource estimate in 2012.

Norway.—EMC Metals Corp. (Vancouver, British Columbia, Canada) (2012, p. 28–29) explored for niobium and tantalum at Tørdal and Evje properties in southern Norway.

Russia.—OAO Severstal (Moscow) reported producing ferroniobium via its subsidiary OAO StalMag. StalMag was located in Krasnoyarsk Kray, where it had reserves sufficient to support production for 11 years. Ferroniobium production was reported to have been 129,000 t in 2010 compared with 296,000 t in 2009 and 146,000 t in 2008 (OAO Severstal, 2010, p. 31–32; SteelGuru, 2011).

Spain.—Solid Resources Ltd. (Vancouver, British Columbia, Canada) (2011, p. 33, 41) estimated mineral reserves for Presqueiras and Taboazas areas in the Galicia Region of Spain. Presqueiras area reserves were 0.2 Mt measured at 79.7 g/t Ta_2O_5, 79.8 g/t Nb_2O_5; 1.4 Mt indicated at 86.1 g/t Ta_2O_5, 80.2 g/t Nb_2O_5; and 4 Mt inferred at 93.0 g/t Ta_2O_5, 84.9 g/t Nb_2O_5. Taboazas area reserves were 0.2 Mt indicated at 150.8 g/t Ta_2O_5, 115.3 g/t Nb_2O_5; and 4 Mt inferred at 14.7 g/t Ta_2O_5, 109.2 g/t Nb_2O_5.

Tanzania.—Peak Resources Inc. (Perth, Australia) (2011) explored for niobium and tantalum in the Ngualla Carbonatite near Mount Ngualla (7°42' S, 32°50' E) (Woolley, 2001, p. 328).

United Kingdom.—The British Geological Survey (2011b) determined the niobium and tantalum relative supply risk index to be 8.0 and 6.0, respectively, based on those elements' abundance in the Earth's crust, the locations of production and reserves, and the political stability of those locations. The index ranged from very low risk, 1, to very high risk, 10.

Zambia.—African Consolidated Resources plc (Kent, United Kingdom) (ACR) explored its Nkombwa Hill project for niobium in Northern Province (10°10' S, 32°51' E) (Woolley, 2001, p. 355). ACR took chip samples and planned to take trench samples (African Consolidated Resources plc, 2011).

Outlook

Niobium.—The principal use for niobium (as much as 90% of global use) was as an additive in steelmaking, mostly in the manufacture of microalloyed or HSLA steels (Roskill Information Services Ltd., 2009a, p. 1–3). Niobium mainly is used in HSLA steels consumed by automobile, construction, and pipeline industries. The sharp fall in demand for automobiles and in construction that started in 2008 was expected to decrease demand for niobium-containing steel. The long-term growth of niobium use was interrupted by the economic downturn of 2008–09. Greater demand for natural gas was expected to result in increased demand for pipeline steel. Recovery of these markets was expected to revive demand for niobium. It was reported that the global unit consumption of niobium per ton of steel produced was 55 to 60 g/t, while that of highly economically developed countries was 100 g/t and that of China was 40 g/t, suggesting significant potential for niobium consumption growth as the Chinese economy develops (Roskill Information Services Ltd., 2009a, p. 124–125).

Tantalum.—Consumers heavily relied on tantalum inventories and huge quantities of highly contentious and politically sensitive, low-cost columbite-tantalite from Congo (Kinshasa) that appeared to have displaced producers in the conventional supply chain. In 2008 and 2009, an estimated near 40% of tantalum mine production was put on care-and-maintenance status, including mines in Australia, Canada, and Mozambique. Industry sought a way to exclude illegal columbite-tantalite from the supply chain. It was thought that a ban on such material by the United States and the European Union was possible. New production projects in Canada, Egypt, and Saudi Arabia offered the possibility that new mines could be brought into production between 2011 and 2013. It was anticipated that as the global economy recovered, so too would demand for tantalum (Roskill Information Services Ltd., 2009b, p. 21–23). Tantalum demand was expected to increase 6% per year and might exceed 7% in 2011 (Smith, 2011).

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TABLE 1
SALIENT NIOBIUM STATISTICS[1]

		2007	2008	2009	2010	2011
United States:						
Exports, Nb content[2]	metric tons	1,100 r	781	195	281	363
Imports for consumption:						
Mineral concentrates, Nb content	do.	109	134	41	5	23
Niobium metal, gross weight[3]	do.	864	1,130	699	1,380	1,460
Niobium oxide, Nb content[e]	do.	744	852	742	824	1,120
Ferroniobium, Nb content[e]	do.	8,400	7,120	2,920	6,280	6,910
Reported consumption, Nb content						
Raw materials	do.	W	W	W	W	W
Ferroniobium and nickel niobium	do.	6,510	5,380	4,350	5,590	7,210
Apparent consumption, Nb content	do.	9,020	8,450	4,210	8,210	9,160
Value:[4]						
Niobium ores and concentrates (gross weight)	dollars per kilogram	22.55	26.70	59.86	19.84	39.34
Niobium oxide (gross weight)	do.	17.64	25.65	27.30	30.32	37.69
Ferroniobium (gross weight)	do.	13.88	21.29	23.59	24.01	26.43
World, production of niobium-tantalum concentrates, Nb conten	metric tons	62,200 r	63,000	63,000 r	63,200 r	63,400 e

[e]Estimated. [r]Revised. do. Ditto. W Withheld to avoid disclosing company proprietary data.
[1]Data are rounded to no more than three significant digits, except values.
[2]Includes natural and synthetic niobium ore and concentrates, niobium oxide, niobium ferroalloy, and unwrought niobium metal and alloys.
[3]Includes niobium and articles made of niobium.
[4]Mass-weighted average value of imported plus exported materials.

TABLE 2
SALIENT TANTALUM STATISTICS[1]

		2007	2008	2009	2010	2011 [e]
United States:						
Exports:						
Tantalum ores and concentrates,[2] Ta content	metric tons	146	96	94	58	65
Tantalum metal, gross weight	do.	207	390	138	246	443
Tantalum and tantalum alloy powder, gross weight	do.	158	176	94	134	140
Imports for consumption:						
Mineral ores and concentrates, Ta content	do.	294	357	109	9	60
Tantalum metal and tantalum-bearing alloys,[3] gross weight	do.	861	934	689	1,590	1,800
Reported consumption, raw materials Ta content	do.	W	W	W	W	W
Apparent consumption, Ta content	do.	644	629	473	1,160	1,210
Price, tantalite,[4] Ta_2O_5 content	dollars per kilogram	82	96	89	120	275
Value,[5] tantalum ores and concentrates, gross weight	do.	43	49	30	32	46
World, production of niobium-tantalum concentrates, Ta content	metric tons	1,060 [r]	1,300 [r]	770 [r]	640 [r]	770

[e]Estimated. [r]Revised. do. Ditto. W Withheld to avoid disclosing company proprietary data.
[1]Data are rounded to no more than three significant digits.
[2]Includes natural and synthetic tantalum ore and concentrates.
[3]Includes unwrought powders, unwrought alloys and metals, waste and scrap, and wrought alloys and metal.
[4]Average annual price per Ta_2O_5 content as reported in Ryan's Notes.
[5]Mass-weighted average value of imported plus exported materials.

TABLE 3
REPORTED CONSUMPTION, BY END USE, INDUSTRY STOCKS OF FERRONIOBIUM AND NICKEL NIOBIUM, AND GOVERNMENT STOCKS BY MATERIAL IN THE UNITED STATES[1]

(Metric tons of niobium and tantalum content)

	2010	2011
End use:		
Steel:		
Carbon	1,630	1,630
Stainless and heat-resisting	727	684
Full alloy	360	331
High-strength low-alloy	(2)	(2)
Electric	(2)	(2)
Tool	19	17
Unspecified	1,430 [r]	1,510
Total	4,160	4,160
Superalloys	1,400	3,020
Alloys (excluding steels and superalloys)	24	21
Grand total	5,590	7,200 [e]
Stocks, December 31:		
Consumer	462 [r]	406
Producer[3]	W	W
Total	462 [r]	406
National Defense Stockpile, total uncommitted inventory by material:		
Niobium metal ingots	10.0	10.0
Tantalum carbide powder	1.72	1.72

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]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 4
U.S. FOREIGN TRADE IN NIOBIUM AND TANTALUM METAL AND ALLOYS, BY CLASS[1]

HTS code[2]	Class	2010 Gross mass (kilograms)	2010 Value (thousands)	2011 Gross mass (kilograms)	2011 Value (thousands)	Principal destinations and sources in 2011 (gross mass in kilograms and values in thousand dollars)
	Exports:					
	Niobium:					
2615.90.6030	Ores and concentrates	24,900	$228	12,300	$129	India 7,340, $51; Peru 2,710, $19; France 1,750, $12; Italy 453, $47.
7202.93.0000	Ferroniobium	395,000	4,190	519,000	5,640	Canada 468,000, $5,070; Mexico 32,900, $360; Peru 10,900, $126; United Kingdom 5,840, $64; Belgium 953, $10; Argentina 275, $9.
	Tantalum:					
2615.90.3000	Synthetic concentrates	22,800	214	20,400	1,610	United Kingdom 5,350, $49; China 4,660, $526; Hong Kong 4,090, $429; Austria 2,160, $569; Japan 1,560, $14; Trinidad and Tobago 1,330, $11; Ireland 935, $9; South Africa 298, $3; Spain 8, $4.
2615.90.6060	Ores and concentrates	149,000	2,880	186,000	1,680	Brazil 185,000, $1,660; Korea, Republic of 959, $21; Germany 127, $3.
8103.20.0030	Unwrought, powders	134,000	57,400	140,000	66,500	Mexico 48,900, $22,000; Germany 36,700, $20,800; Israel 17,100, $9,710; Japan 12,600, $4,140; El Salvador 9,210, $4,090; Sweden 8,210, $3,100; China 1,960, $699; Netherlands 1,570, $211.
8103.20.0090	Unwrought, alloys and metal	15,400	2,730	58,800	18,000	Germany 40,700, $10,800; United Kingdom 5,450, $2,870; Netherlands 4,620, $345; Estonia 4,450, $2,230; Canada 1,490, $491; Mexico 595, $34; Israel 459, $455; Korea, Republic of 344, $32.
8103.30.0000	Waste and scrap	165,000	18,800	303,000	39,400	Hong Kong 80,800, $6,000; China 65,800, $7,450; Kazakhstan 48,100, $3,580; United Kingdom 43,500, $11,000; Germany 41,100, $7,750; France 6,430, $563.
8103.90.0000	Wrought	65,200	35,900	81,800	47,800	Germany 36,600, $17,900; Mexico 15,100, $9,230; France 11,800, $6,870; Japan 5,550, $3,500.
	Total	XX	122,000	XX	181,000	
	Imports for consumption:					
	Niobium:					
2615.90.6030	Ores and concentrates	11,600	494	9,090	710	China 6,070, $402; Germany 3,000, $305; United Kingdom 26, $3.
2825.90.1500	Oxide	1,180,000	35,800	1,610,000	60,600	Brazil 1,340,000, $45,100; China 148,000, $9,110; Germany 67,500, $3,650; Russia 30,800, $1,640; Hong Kong 14,900, $906; Taiwan 2,000, $125; Liechtenstein 10, $13.
	Ferroniobium:					
7202.93.4000	Silicon < 0.4%	444,000	14,900	1,020,000	34,600	Brazil 878,000, $28,100; United Kingdom 134,000, $5,710; Germany 9,540, $704.
7202.93.8000	Other	9,210,000	222,000	9,610,000	254,000	Brazil 8,190,000, $216,000; Canada 1,400,000, $37,700; Belgium 17,000, $499; Germany 1,750, $53;United Kingdom 908, $57.
	Total	9,660,000	237,000	10,600,000	289,000	
8112.92.4000	Unwrought, powders[3]	1,380,000	56,900	1,460,000	74,100	Brazil 1,250,000, $57,900; Germany 108,000, $6,640; Estonia 60,600, $6,290; China 41,000, $2,890; Austria 841, $42; United Kingdom 819, $24; Thailand 815, $217; Korea, Republic of 424, $44.
	Tantalum:					
2615.90.3000	Synthetic concentrates	--	--	10,700	56	Hong Kong 10,700, $54; Thailand 3, $2.
2615.90.6060	Ores and concentrates	19,800	2,520	179,000	15,200	Australia 111,000, $11,000; Mozambique 26,000, $796; Canada 20,000, $325; Brazil 20,000, $2,740; Bolivia 1,300, $45; China 773, $21; Kazakhstan 65, $18; Portugal 3, $3.
8103.20.0030	Unwrought powders	207,000	60,900	101,000	31,400	Thailand 32,700, $12,300; Germany 28,800, $7,830; China 13,000, $6,920; Japan 12,600, $2,070; Czech Republic 11,400, $1,150; Mexico 1,660, $1,130; France 122, $33; Italy 5, $2; Canada 5, $3.
8103.20.0090	Unwrought, alloys and metal	193,000	36,800	204,000	57,800	Kazakhstan 107,000, $31,800; Germany 47,700, $12,800; China 21,300, $9,900; United Kingdom 11,800, $2,210; France 7,800, $570; Czech Republic 6,360, $127.

See footnotes at end of table.

TABLE 4—Continued
U.S. FOREIGN TRADE IN NIOBIUM AND TANTALUM METAL AND ALLOYS, BY CLASS[1]

		2010		2011		
HTS code[2]	Class	Gross mass (kilograms)	Value (thousands)	Gross mass (kilograms)	Value (thousands)	Principal destinations and sources in 2011 (gross mass in kilograms and values in thousand dollars)
8103.30.0000	Waste and scrap	1,070,000	42,000	1,370,000	60,900	Estonia 559,000, $22,000; China 148,000, $9,570; Russia 127,000, $976; Mexico 125,000, $5,950; Japan 101,000, $5,860; Indonesia 90,200, $2,390; Germany 44,700, $2,900; United Kingdom 11,800, $2,210.
8103.90.0000	Wrought	114,000	31,500	124,000	53,600	China 44,800, $30,300; Kazakhstan 22,900, $12,300; Israel 21,300, $1,290; France 11,800, $1,800.
	Total	XX	504,000	XX	643,000	

XX Not applicable. -- Zero.
[1]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]Niobium 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 COUNTRY[1]

Country	2010		2011	
	Gross mass (kilograms)	Value (thousands)	Gross mass (kilograms)	Value (thousands)
Australia	--	--	111,000	$11,200
Bolivia	--	--	1,300	45
Brazil	11,000	$2,150	20,000	2,740
Canada	255	5	20,200	325
China	255	88	773	21
Kazakhstan	--	--	65	18
Mozambique	8,350	270	26,000	796
Portugal	--	--	3	3
Total	19,800	2,520	179,000	15,200

-- Zero.
[1]Data 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 mass[3]					Niobium content[4]					Tantalum content[4]				
	2007	2008	2009	2010	2011[e]	2007	2008	2009	2010	2011[e]	2007	2008	2009	2010	2011[e]
Australia, columbite-tantalite[6]	1,630 [e]	2,060 [e]	318	--	--	--	--	--	--	--	441	557	81	--	--
Brazil:[e]															
Nb minerals[7, 8]	245,766 [9]	246,000	247,000	245,000	250,000	57,267 [9]	58,000	58,000	58,000	58,000	--	--	--	--	--
Ta minerals[6, 10]	650	650	650	650	650	--	--	--	--	--	180	180	180	180	180
Burundi	52	91 [r]	24 [r]	67 [r]	68	10	18 [r]	5 [r]	13 [r]	13	9	18 [r]	5 [r]	13 [r]	13
Canada:															
Nb minerals[8]	161,800 [r]	178,800 [r]	175,500 [r]	186,400 [r]	211,300 [9]	4,337	4,383	4,330	4,419	4,632 [p, 9]	--	--	--	--	--
Ta minerals[6, 10]	201	150	110	--	--	--	--	--	--	--	45	40	25	--	--
Congo (Kinshasa):															
Columbite-tantalite[e, 11]	428 [r, 9]	527 [r, 9]	468 [r, 9]	397 [r, 9]	350	98 [r]	120 [r]	110 [r]	93 [r]	80	120 [r]	140	130	110 [r]	95
Nb minerals	--	119	80 [r, e]	--	--	--	59 [e]	40 [r, e]	--	--	--	--	--	--	--
Ethiopia, tantalite	117	206 [r]	202 [r]	167 [r]	207 [9]	12 [r]	14 [r]	14 [r]	17 [r]	14	52 [r]	76 [r]	74 [r]	74 [r]	76
Mozambique[e]	196 [9]	396 [9]	405 [9]	430	900	14	28	29	30	65	56	110	113	120	260
Nigeria, columbite-tantalite[e]	850 [r]	570 [r]	900 [r]	1,200 [r]	1,100	340 [r]	230 [r]	360 [r]	480 [r]	440	40 [r]	26 [r]	40 [r]	54 [r]	50
Rwanda	490	600 [r]	480 [r]	380 [r]	380	150 [r]	190 [r]	150 [r]	120 [r]	120	120	150 [r]	120 [r]	93 [r]	93
Somalia[e, 12]	--	11	7	--	--	--	2	2	--	--	--	3	2	--	--
Uganda[e]	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)	(13)
Total	412,000 [r]	430,000 [r]	426,000 [r]	435,000 [r]	465,000	62,200 [r]	63,000	63,000 [r]	63,200 [r]	63,400	1,060 [r]	1,300 [r]	770 [r]	640 [r]	770

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

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

[2]Excludes production of columbium and tantalum contained in tin ores and slags. Table includes data available through June 11, 2012.

[3]Gross mass is mass of concentrate before metal is extracted.

[4]Content is mass of metal produced. Nb_2O_5 is 69.904% niobium; Ta_2O_5 is 81.897% tantalum.

[5]In addition to the countries listed, Bolivia, China, French Guiana, Kazakhstan, and Russia also produce, or are thought to produce, niobium and tantalum mineral concentrates, but available information is inadequate to make reliable estimates of output levels.

[6]Tantalum production reported in Ta_2O_5 converted to tantalum content. Gross mass is concentrate assumed to be one-third Ta_2O_5.

[7]Niobium concentrate production reported in Nb_2O_5 content converted to niobium content. Gross mass is concentrate assumed to be one-third Nb_2O_5.

[8]Includes columbite and pyrochlore.

[9]Reported figure.

[10]Includes djalmaite and tantalite.

[11]Reported data includes the North and South Kivu Provinces.

[12]From August 2008 to April 2009, 18 metric tons of columbite-tantalite was reportedly produced in Somalia. It is unclear if production continued after early April 2009.

[13]Less than ½ unit.

TABLE 7
FERRONIOBIUM (FERROCOLUMBIUM): WORLD PRODUCTION, BY COUNTRY[1]

(Metric tons, Nb content)

Country[2]	2007	2008	2009	2010	2011
Brazil	34,612 [3]	35,534 [3]	22,932 [3]	34,708 [r, 3]	34,700 [p, e]
Canada[e]	4,337 [3]	4,384 [r, 3]	4,620	4,620	4,620
Russia[e]	80 [r]	80	79	80	80
United States	NA	NA	NA	NA	NA
Total	39,000	40,000	27,600	39,400 [r]	39,400

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.

[1]Estimated data are rounded to no more than three significant digits; may not add to totals shown. Table includes data available through July 13, 2012.

[2]In addition to the countries listed, Austria, China, and Germany are thought to have produced ferroniobium (ferrocolumbium), but production information is inadequate for the formulation of estimates of output levels.

[3]Reported figure.