COLUMBIUM (NIOBIUM) AND TANTALUM

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Columbium [Niobium (Nb)] is vital as an alloying element in steels and superalloys for aircraft turbine engines and is in greatest demand in industrialized countries. It is critical to the United States because of its defense-related uses in the aerospace, energy, and transportation industries. Acceptable substitutes are available for some columbium applications, but, in most cases, they are less desirable.

Tantalum (Ta) is a refractory metal that is ductile, easily fabricated, highly resistant to corrosion by acids, and a good conductor of heat and electricity and has a high melting point. It is critical to the United States because of its defense-related applications in aircraft, missiles, and radio communications. Substitution for tantalum is made at either a performance or economic penalty in most applications.

Neither columbium nor tantalum was mined domestically because resources are of low grade. Some resources are mineralogically complex, and most are not currently (1999) commercially recoverable. The last significant mining of columbium and tantalum in the United States was during the Korean Conflict, when increased military demand resulted in columbium and tantalum ore shortages.

Pyrochlore was the principal columbium mineral mined worldwide. Brazil and Canada, which were the dominant pyrochlore producers, accounted for about 98% of total estimated columbium mine production in 1999. The two countries, however, no longer export pyrochlore—only columbium in upgraded valued-added forms produced from pyrochlore. Brazil exported mostly regular-grade ferrocolumbium and columbium oxide, and Canada exported regular-grade ferrocolumbium. The remaining columbium mineral supply came from the mining of columbite in Nigeria and tantalite-columbite, mostly in Australia, Brazil, and certain African countries. Tantalum mineral was produced mostly from tantalite-columbite mining operations in Australia and Brazil, which was almost 90% of total estimated tantalum mine production in 1999, and from other tantalum mine operations in Canada and certain African countries. The reliance on tantalum-containing tin slags as a source of tantalum supply remained down.

The United States remained dependent on imports of columbium and tantalum materials; Brazil was the major source for columbium, and Australia, the major source for tantalum. The Defense National Stockpile Center (DNSC) offered and sold selected columbium and tantalum materials from the National Defense Stockpile (NDS). The Generalized System of Preferences (GSP), which is a renewable preferential trade program, expired on June 30, 1999, was renewed on December 17, 1999 (retroactive to July 1, 1999), and was extended to September 30, 2001, by a provision in the Ticket To Work and Work Incentives Improvement Act of 1999. Columbium and tantalum price quotations remained stable. Overall reported consumption of columbium in the form of ferrocolumbium and nickel columbium decreased. Tantalum consumption increased.

Legislation and Government Programs

Summaries of important columbium and tantalum statistics are listed in tables 1 and 2, respectively. To ensure supplies of columbium and tantalum during an emergency, various materials have been purchased for the NDS. As of October 5, 1999, the NDS goals for tantalum metal powder and tantalum metal were about 16 metric tons (t) and about 55 t, respectively (table 3). The NDS had no goals for columbium materials.

For fiscal year 1999 (October 1, 1998, through September 30, 1999), the DNSC sold about 178 t of columbium contained in ferrocolumbium valued at about $2.43 million, and about 9 t of columbium metal ingots valued at about $474,000 and disposed of about 83 t of columbium contained in tantalum minerals that were sold in fiscal year 1999; no columbium value obtained as the columbium was contained within the tantalum minerals. Additionally, the DNSC sold about 2 t of tantalum contained in tantalum carbide powder valued at about $260,000, about 11 t of tantalum metal powder valued at about $1.85 million, about 12 t of tantalum metal ingots valued at about $2.23 million, about 87 t of tantalum contained in tantalum minerals valued at about $11.04 million, and about 9 t of tantalum contained in tantalum oxide valued at about $1.23 million (U.S. Department of Defense, 2000, p. 15-16, 39, 41).

For fiscal year 2000 (October 1, 1999, through September 30, 2000), the DNSC had authority under its revised Annual Materials Plan to sell about 10 t of columbium contained in columbium carbide powder, about 170 t of columbium contained in columbium concentrates, about 181 t of columbium contained in ferrocolumbium, about 9 t of columbium metal ingots, about 2 t of tantalum contained in tantalum carbide powder, about 23 t of tantalum metal powder, about 18 t of tantalum metal ingots, about 136 t of tantalum contained in tantalum minerals, and about 9 t of tantalum contained in tantalum oxide (Bureau of Export Administration,

2000; Defense National Stockpile Center, 2000a).

From October 1999 through January 2000, the DNSC sold a total of about 182 t of columbium contained in ferrocolumbium valued at about $2.8 million to ABS Alloys and Metals, Inc., Mexborough, United Kingdom, Advanced Alloys, Inc., Atlanta, GA, and Triad Alloys, Inc., Wexford, PA, and about 9 t of columbium metal ingots valued at about $570,000 to H.C. Starck, Inc., Newton, MA (Defense National Stockpile Center, 1999a, b, 2000b, c). There were no sales of columbium carbide powder.

From October through December 1999, the DNSC sold about 9 t of tantalum contained in tantalum oxide valued at about $1.3 million to H.C. Starck, a total of about 23 t of capacitor-grade tantalum metal valued at about $3.7 million to H.C. Starck, Hi-Temp Specialty Metals, Inc., Willingboro, NJ, and Recovery Dynamics, Inc., Johnson City, TN, and about 18 t of vacuum-grade tantalum metal valued at about $3.9 million to Hi-Temp (Defense National Stockpile Center, 1999d, e, f). In November 1999 and April 2000, the DNSC sold a total of about 2 t of tantalum contained in tantalum carbide powder valued at about $254,000 to ABS Alloys and Metals and H.C. Starck (Defense National Stockpile Center, 1999c, 2000d).

For fiscal year 2001 (October 1, 2000, through September 30, 2001), the DNSC proposed disposal levels of about 10 t of columbium contained in columbium carbide powder (actual quantity limited to the remaining sales authority or inventory), about 170 t of columbium contained in columbium concentrates, about 136 t of columbium contained in ferrocolumbium (actual quantity limited to the remaining sales authority or inventory), about 9 t of columbium contained in columbium metal ingots, about 2 t of tantalum contained in tantalum carbide powder, about 23 t of tantalum metal powder, about 18 t of tantalum metal ingots, about 136 t of tantalum contained in tantalum minerals, and about 9 t of tantalum contained in tantalum oxide (Bureau of Export Administration, 1999, 2000).

In 1999, U.S. import duties for selected columbium and tantalum materials ranged from duty free to 5% ad valorem for normal-trade-relations (NTR) status countries and from duty free to 45% ad valorem for non-NTR status countries (U.S. International Trade Commission, 1998). Under the GSP, a renewable preferential trade program, eligible products from designated developing countries may enter the United States duty free. The GSP expired on June 30, 1999, but was renewed through September 30, 2001, effective December 17, 1999, retroactive to July 1, 1999, by a provision in the Ticket To Work and Work Incentives Improvement Act of 1999. This document provided notice to importers that Customs was again accepting claims for GSP duty-free treatment for merchandise entered or withdrawn from a warehouse for consumption and was processing refunds on all duties paid, with interest from the date the duties were deposited, on GSP-eligible merchandise that was entered during the period that the GSP program had lapsed. Customs began processing refunds owing to the GSP renewal on January 7, 2000 (U.S. Customs Service, 2000). Categories of U.S. imports from developing countries affected by the GSP included all columbium and tantalum tariff articles except columbium and tantalum ores and concentrates, synthetic tantalum-columbium concentrates, and columbium and tantalum unwrought waste and scrap, for which the general rate of duty already was zero.

Production

Neither columbium nor tantalum was mined domestically in 1999. Domestic production data for ferrocolumbium are developed by the U.S. Geological Survey from the annual voluntary domestic survey for ferroalloys. Ferrocolumbium production data for 1999 were, however, incomplete at the time this report was prepared.

Cabot Performance Materials (CPM), Boyertown, PA, had production capability that ranged from raw material processing through to the production of columbium and tantalum end products. Shieldalloy Metallurgical Corp., Newfield, NJ, was a producer of ferrocolumbium. H.C. Starck was a major supplier of tantalum and columbium products. Reading Alloys, Inc., Robesonia, PA, and Oremet-Wah Chang, Albany, OR, were major producers of high-purity columbium products. Kennametal, Inc., Latrobe, PA, was a major supplier of columbium and tantalum carbides (table 9).

In July, Cabot Corp., Boston, MA, announced several initiatives that focused on improving shareholder value, including $30 million to $35 million per year cost-reduction initiatives across the company's core businesses and management's intention to review the ownership structure of its CPM Division. The company "concluded that our CPM business operates in an industry where merger, consolidation or vertical integration opportunities will best enhance CPM's competitiveness and value." Cabot intended to use the cash generated from the capital structure initiatives to continue its share repurchase program (Cabot Corp., 1999, 2000, p. 21).

Consumption

Overall reported consumption of columbium as ferrocolumbium and nickel columbium was down by about 7% compared with that of 1998 (table 4). Consumption of columbium by the steelmaking industry decreased as a result of the decrease in raw steel production. The percentage of columbium usage per ton of steel produced, however increased. Columbium consumption in carbon and high-strength low-alloy steels decreased by more than 10%, and columbium consumption in stainless and heat-resisting steel increased by more than 15%. Demand for columbium in superalloys was down by about 8%. That portion used in the form of nickel columbium decreased to about 350 t. The consumption of columbium in superalloys continued to be dependent on the market for aircraft engines.

Overall consumption of tantalum increased to about 550 t; more than 60% of the total was consumed in the electronics industry. Industry sources indicated that factory sales of tantalum capacitors increased by more than 20% to about 4.2 billion units, which was an almost 300% increase since 1990. Demand for tantalum capacitors in such products as portable telephones, pagers, personal computers, and automotive electronics continued to be strong.

Columbium.—"Columbium" and "niobium" are synonymous names for the chemical element with atomic number 41; "columbium" was the name given in 1801, and "niobium" was the name officially designated by the International Union of Pure and Applied Chemistry in 1950. The metal conducts heat and electricity well and is characterized by a high melting point (about 2,470° C), resistance to corrosion, and ease of fabrication.

Columbium in the form of ferrocolumbium is used worldwide, mostly as an alloying element in steels and in superalloys. Because of its refractory nature, appreciable amounts of columbium in the form of high-purity ferrocolumbium and nickel columbium are used in nickel-, cobalt-, and iron-base superalloys for such applications as jet engine components, rocket subassemblies, and heat-resisting and combustion equipment. Columbium carbide is used in cemented carbides to modify the properties of the cobalt-bonded tungsten carbide-based material. It is usually used with carbides of such metals as tantalum and titanium. Columbium oxide is the intermediate product used in the manufacture of high-purity ferrocolumbium, nickel columbium, columbium metal, and columbium carbide. Acceptable substitutes, such as molybdenum, tantalum, titanium, tungsten, and vanadium, are available for some columbium applications, but substitution may lower performance and/or cost-effectiveness.

Tantalum.—The major use for tantalum as tantalum metal powder is in the production of electronic components, mainly tantalum capacitors. The tantalum capacitor exhibits reliable performance and combines compactness and high efficiency with good shelflife. Applications for tantalum capacitors include computers, communication systems, and instruments and controls for aircraft, missiles, ships, and weapon systems. Because of its high melting point (about 3,000° C), good strength at elevated temperatures, and good corrosion resistance, tantalum is combined with cobalt, iron, and nickel to produce superalloys that are used in aerospace structures and jet engine components. Tantalum carbide, which is used mostly in mixtures with carbides of such metals as columbium, titanium, and tungsten, is used in cemented-carbide cutting tools, wear-resistant parts, farm tools, and turning and boring tools. Because of tantalum's excellent corrosion-resistant properties, tantalum mill and fabricated products are used in the chemical industry in such applications as heat exchangers, evaporators, condensers, pumps, and liners for reactors and tanks. Substitutes, such as aluminum, rhenium, titanium, tungsten, and zirconium, can be used in place of tantalum but are usually used at either a performance or economic penalty.

Prices

Published prices for pyrochlore concentrates produced in Brazil and Canada were not available because these concentrates were consumed internally by producers of regular-grade ferrocolumbium in Brazil and Canada and are no longer being exported. A price for Brazilian pyrochlore has not been available since 1981, and the published price for pyrochlore produced in Canada was discontinued in early 1989. The columbium price is affected most by the availability of regular-grade ferrocolumbium produced from pyrochlore. The American Metal Market published price for regular-grade ferrocolumbium ranged from $6.75 to $7 per pound of contained columbium and has not changed since September 1997.

The Metal Bulletin price for columbite ore, which is based on a minimum 65% contained columbium oxide (Nb_2O_5) and tantalum oxide (Ta_2O_5), ranged from $2.80 to $3.20 per pound, and has not changed since February 1995. The American Metal Market published price for high-purity (vacuum-grade) ferrocolumbium ranged from $17.50 to $18 per pound of contained columbium and has not changed since September 1997. Industry sources indicated that nickel columbium sold at about $18.50 per pound of contained columbium, columbium metal products sold in the range of about $24 to $100 per pound in ingot and special shape forms, and columbium oxide for master alloy production sold for about $8.80 per pound (Mining Journal, 1999b; Tantalum-Niobium International Study Center, 1999a, p. 5).

The price for tantalum products is affected most by events in the supply and demand of tantalum minerals. The Platt's Metals Week published price for tantalite ore, which is based on contained Ta_2O_5, f.o.b. U.S. ports, ranged from $33 to $35 per pound and has not changed since March 1998. The Metal Bulletin published price for tantalite ranged from $28 to $31.50 per pound of contained Ta_2O_5 and has not changed since October 1995 and that for Greenbushes tantalite, Australia, which is based on 40% contained Ta_2O_5, was $40 per pound and has not changed since April 1991. The most recent industry source on tantalum prices indicated that the average selling prices per pound of contained tantalum for some tantalum products were as follows: capacitor-grade powder, $135 to $260; capacitor wire, $180 to $270; and vacuum-grade metal for superalloys, $75 to $100 (Mining Journal, 1999d).

The chapters for columbium and tantalum in the U.S. Geological Survey publication Metal Prices in the United States Through 1998 include graphs of annual current and 1992 constant dollar prices for 1959 through 1998, a list of significant events that affected prices, a brief discussion of the metal and its history, and tables that list yearend average prices for columbium and tantalum concentrates and ferrocolumbium prices (Cunningham, 1999a, b; U.S. Geological Survey, 2000). Individual chapters, which include the 4-page columbium and 3-page tantalum chapters, may be accessed on the World Wide Web at URL http://minerals.usgs.gov/minerals/pubs/metals_prices.

Foreign Trade

Table 5 lists columbium and tantalum export and import data. Net trade for columbium and tantalum continued at a deficit. Overall trade value and volume for exports increased. For imports, overall trade value was up by about 2% with total volume down slightly.

Imports for consumption of columbium ores and concentrates rose by more than 30%, the first increase since 1994; China and Russia were the only sources (table 6). Imports at an average grade of approximately 29% Nb_2O_5 and 30% Ta_2O_5

were estimated to contain about 19 t of columbium and about 24 t of tantalum. Ferrocolumbium imports decreased by about 9%, and columbium oxide imports rose by about 40%; Brazil accounted for more than 60% of U.S. ferrocolumbium imports and about 85% of columbium oxide imports.

Imports for consumption of tantalum ores and concentrates were up by about 35% (table 7); imports from Australia accounted for about 60% of quantity and value. Imports at an average grade of approximately 37% Ta_2O_5 and 20% Nb_2O_5 were estimated to contain about 296 t of tantalum and about 121 t of columbium.

The schedule of tariffs applied during 1999 to U.S. imports of selected columbium and tantalum materials is found in U.S. International Trade Commission (1998). Brazil, which was the major source for U.S. columbium imports, accounted for about 76% of total, in units of contained columbium (figure 1), and Australia, which was the major source for U.S. tantalum imports, accounted for about 40% of total, in units of contained tantalum (figure 2).

World Review

Industry Structure.—Principal world columbium and tantalum raw material and product producers are listed in tables 8 and 9, respectively. Annual world production of columbium and tantalum mineral concentrates, by country, is listed in table 10. Brazil and Canada were the major producers of columbium mineral concentrates, and Australia, Brazil, and Canada were the major producers of tantalum mineral concentrates. The importance of tantalum-containing tin slags as a source of tantalum supply has decreased owing to structural changes in the tin industry. Tantalum-containing tin slags account for about 18% of tantalum supply compared with about 70% 20 years ago (Mining Journal, 2000; Tantalum-Niobium International Study Center, 1998, p. 2-6).

Australia.—For its 1998-99 financial year ending June 30, 1999, Sons of Gwalia, Ltd., West Perth, Western Australia, reported that tantalum production (tantalum oxide contained in mineral concentrates) totaled about 421 t at its Greenbushes and Wodgina Mines and that tantalum sales also totaled about 421 t. Greenbushes production was about 336 t, and sales, about 342 t. Production at Wodgina was about 85 t, and sales, about 79 t. Greenbushes and Wodgina reportedly produced about 25% of the world's annual tantalum requirements. Greenbushes long-term development plan called for annual tantalum production to be maintained at more than 270 t of contained tantalum oxide. Approximately $15 million was expended at Wodgina to expand ore-processing capacity, which will increase annual tantalum production capacity to about 180 t of contained tantalum oxide. Total annual sales in excess of about 450 t of contained tantalum oxide was expected for the foreseeable future. Tantalum production from Greenbushes and Wodgina was committed to Cabot Corp. and H.C. Starck of Germany through to calendar year 2003 with options for an additional 2 years. The fixed-rate currency forward contracts total about $221 million with delivery dates from July 1, 1999, through June 30, 2003. Greenbushes tantalum "resource base" (measured and indicated) increased significantly from about 17,600 t of contained tantalum oxide to about 34,100 t, including about 8,030 t classified as tantalum reserves. Owing to a very successful drilling program undertaken during the year, Wodgina's tantalum "resource base" increased substantially to about 14,000 t of contained tantalum oxide from about 2,490 t; this included about 11,300 t classified as tantalum reserves (Sons of Gwalia, Ltd., 1999, p. 10, 21-23).

Brazil.—Cia. Brasileira de Metalurgia e Mineração (CBMM), which was the world's largest columbium producer, continued with its $80 million expansion program that was initiated in 1998. The program includes an increase in annual columbium ore concentration capacity to 80,000 tons per year (t/yr) in 2000 from 50,000 t/yr in 1999; replacement of the existing leaching and calcination plant with a new 80,000-t/yr pyrometallurgical plant to purify pyrochlore concentrates; introduction of new facilities for crushing, sizing, and automated packaging of ferrocolumbium; and the installation of a second electric furnace for ferrocolumbium production. The expansion was "undertaken in response to an underlying growth trend in ferro-niobium markets, to reduce costs and to have permanent idle capacity in order to avoid sudden price fluctuations which could cause customers to move towards use of alternative materials." The expansion will raise annual ferrocolumbium production capacity to 45,000 t in 2000 from 30,000 t in 1999. In a joint venture with Nissho Iwai Corp., CBMM also set up CBMM Asia Co., Ltd., which was a new distribution company in Tokyo, to sell CBMM's products and to develop Asian markets for its columbium products. CBMM sold some 14% of its annual ferrocolumbium production to Japan (Metal Bulletin, 1999; Mining Journal, 1999b).

Canada.—Production of columbium oxide contained in pyrochlore concentrate at the Niobec Mine near Chicoutimi, Quebec, was about 3,370 t compared with about 3,290 t in 1998. Niobec was a 50-50 joint venture between Cambior, Inc. (product marketing), and Teck Corp. (operator). Columbium contained in ferrocolumbium production was about 2,290 t compared with about 2,180 t in 1998. Pyrochlore-to-ferrocolumbium converter recovery was 97.1%. Ore milled decreased slightly to 818,000 t as the mill operated, on the average, at about 2,240 metric tons per day. Average recovery increased slightly to 58.3% with the Nb_2O_5 grade of concentrate at 71%. In late 1999, the joint venture approved a plan to increase columbium production by a total of 40% in two phases. Capital expenditures for the first phase were projected at $7 million; $3.4 million was planned for the second phase when market demand for columbium warrants. Construction of the first phase was expected to be completed by the third quarter of 2000, at which time annual columbium production capacity will increase by about 20% to about 2,680 t. In 2000, Niobec was expected to produce about 2,360 t of columbium. Total capital expenditures for 2000 were budgeted at $10.6 million. Teck reported total ore reserves of 10.2 million tons (Mt), with minable reserves sufficient for 10 years of operation following the first phase of production expansion (Cambior, Inc., 2000, p. 12; Teck Corp., 2000, p. 19, 22-23, 35).

In 1999, about 64 t of tantalum oxide contained in concentrate was produced at the Bernic Lake, Manitoba, tantalum operation compared with about 70 t in 1998.

In July 1999, Niocan Inc. had raised a reported $3 million to pursue development of its columbium property west of Montreal in Oka, Quebec. The funds will be used for "an environmental-impact study and permitting; marketing and sales agreements; basic engineering; process optimization work at Centre de Recherches Minerales in Quebec City; and the purchase of surface rights." Since 1995, Niocan has spent $3 million to develop the property, which contains ore reserves of 13.3 Mt grading 0.63% Nb_2O_5 within two zones that are exploitable by underground methods. A favorable feasibility study estimated that a capital cost of $90 million could yield an annual production of 4,500 t of ferrocolumbium that would contain 65% columbium (Northern Miner, 1999c).

Avalon Ventures, Ltd., Toronto, reportedly discovered tantalum mineralization in a pegmatite dike at its Raleigh Lake rare metal property 5 kilometers (km) south of the Trans-Canada Highway near Ignace, Ontario. The property was optioned from prospectors in May 1998 by issuing 20,000 shares, making a $100,000 cash payment, and incurring $400,000 in exploration expenditures in 4 years. Avalon also signed a memorandum of understanding with the Wabaseemoong First Nations band of Whitedog, Ontario, regarding development of the Separation Rapids property north of Kenora, Ontario. The Wabaseemoong agreed to support mine development at Separation Rapids provided the environment is protected and the band receives benefits, such as job opportunities, training, and funding for social and economic development. A prefeasibility study of the property envisions first-year production of 12.6 t of tantalum minerals (Avalon Ventures, Ltd., 1999a, b; Northern Miner, 1999a, b).

Gabon.—In April, Reunion Mining Plc., United Kingdom, announced that a study of the Mabounié carbonatite complex, which is about 200 km southeast of Libreville, indicated ore resources of 14 Mt grading 1.7% Nb_2O_5. A minipilot plant designed to confirm columbium recovery was planned, and, if successful, full-scale pilot work would be initiated. Reunion envisioned constructing a plant with an annual capacity to produce up to 6,000 t of ferrocolumbium at a cost of about $50 million. Niobium Resources, which is owned by Reunion, Treibacher Industrie AG of Austria, and a private Dutch company, would have a 70% interest in the Gabonese company Société Minière de la Mabounié, which would hold the mineral rights to the deposit. A group of Gabonese private investors would hold the remaining 30% (Northern Miner, 1999c).

Ireland.—Angus & Ross Plc., United Kingdom, was granted eight contiguous licences in Carlow and Wexford Counties in southern Ireland to explore for tantalum. In the 1980's, the Geological Survey of Ireland recorded high tantalum values associated with lithium-bearing pegmatites at several locations. A review of the geology and previous work in the area concluded that further work at the known lithium prospects could establish drill targets for potentially economic tantalum mineralization. Angus & Ross was raising funds for an initial exploration program (Mining Journal, 1999a).

Japan.—Domestic production of ferrocolumbium remained idle. In 1999, ferrocolumbium imports totaled about 6,890 t valued at about $6.3 million; Brazil accounted for about 90% of quantity and value. Japanese consumption of ferrocolumbium in 1998 was about 5,760 t compared with about 4,570 t in 1995. In 1999, Japan's demand for tantalum, in the form of powder, compounds, and tantalum products, was expected to be about 330 t; demand for tantalum powder could be in the range of 165 to 170 t. In 1998, exports of tantalum products (inclusive of ingots, powder, and scrap) totaled about 242 t; China, Germany, the United Kingdom, and the United States were the recipients of about 85% of the material. For the same period, imports of tantalum products (inclusive of ingots and powder) totaled about 58 t; China and the United States accounted for almost 80% of the imports. From January through September 1999, Japan's production of tantalum capacitors totaled about 4.7 billion units and exports of tantalum capacitors totaled about 1.9 billion units. Tantalum capacitors account for about 90% of total tantalum powder demand in Japan (American Metal Market, 1999; Roskill's Letter from Japan, 1999a, b; TEX Report, 2000).

Kazakhstan.—Kazatomprom, which is Kazakhstan's national nuclear industry concern, signed an agreement in June with members of the Russian TVEL nuclear fuel concern to "swap" shares (34%) of the Ulba Metallurgical Works for shares in a Russian metallurgical plant during the first quarter of 2000. Kazatomprom, which owned 90% of the common stock in Ulba, planned to invest $6 million in tantalum production. Ulba planned to restart tantalum and superconductor production at the beginning of November, with tantalum production expected to be about 10 metric tons per month, "enough to cover all its costs." All the tantalum will be exported because Kazakhstan has no demand for the production. In December, Kazakhstan reportedly signed an agreement to supply Russia with tantalum valued at $2 million in 2000 (Interfax International, Ltd., 1999a, b, c).

Russia.—In February 1999, Russia imposed a 5% duty for a period of 6 months on nonferrous and rare metals exported to all countries outside the Commonwealth of Independent States (CIS). In September, the Russian Government extended export duties on nonferrous and rare metals for shipments to all countries except members of the CIS Customs Union. Resolution no. 978, September 7, 1999, stated that duties on metals, which included columbium and tantalum, and waste and scrap would become effective 7 days from the document's official publication (Interfax International, Ltd., 1999d, e). In September, Etaginsky GOK, which was a mining complex in Zolotorechensk, Chita region, had started columbium and tantalum production from the Etaginskoye field, Balei District. In 2000, Etaginsky planned to produce 60 t of columbium, 40 t of tantalum, and 100 t of tin in concentrate; all the production would be supplied to the Russian TVEL nuclear fuel concern (Interfax International, Ltd., 1999f).

Spain.—Golden Dynasty Resources Ltd., Vancouver, signed an agreement with Hardrock Resources Ltd. to acquire the latter's tantalum concessions and concession applications in northwestern Spain. Two pegmatite zones that contain tantalum mineralization have been identified. The concessions and concession applications include areas previously worked for columbium, tantalum, and tin (Mining Journal, 1999c).

Outlook

Columbium.—The principal use for columbium will continue as an additive in steelmaking, mostly in the manufacture of microalloyed steels used for pipelines, bridges, automobiles, etc. The production of high-strength low-alloy steel is the leading use for columbium, and the trend of columbium demand, domestically and globally, will continue to follow closely that of steel production; the reader is referred to the Outlook section of Fenton (in press) for a discussion of the future of the steel industry. The October 1999 medium-term forecast of the International Iron and Steel Institute projected an annual growth rate in steel consumption between 1995 and 2005 for the world of 1.6%; the North American Free Trade Agreement countries, 1.8%; European Union countries, 1.1%; and total Asian countries, 1.9% (Iron & Steelmaker, 1999).

The outlook for columbium also will be dependent on the performance of the aerospace industry and the use of columbium-bearing alloys in it. Columbium consumption in the production of superalloys, which is the second largest end use for columbium, will be most dependent on the market for aircraft engines. Because nickel-base superalloys (such as alloy 718, which contains about 5% columbium) can account for about 40% to 50% of engine weight, they are expected to be the materials of choice for the future owing to their high temperature operating capability (Tantalum-Niobium International Study Center, 1999b). The Aerospace Industries Association (2000, p. 6) forecast that U.S. total aerospace sales will decline to about $149 billion in 2000 from record sales of about $155 billion in 1999 owing to decreased sales to commercial customers. The majority of U.S. demand for columbium units will continue to be met by imports. Brazil will continue as the leading source for U.S. imports of columbium, and Canada will also be a major source of supply.

Tantalum.—U.S. apparent consumption of tantalum totaled about 550 t in 1999 compared with about 525 t in 1998. World tantalum demand was estimated to be about 1.8 Mt with an annual growth rate of about 4.5%. More than 60% of the tantalum consumed was used to produce electronic components, mainly tantalum capacitors. This market sector is expected to be stimulated by the growth in the use of cellular telephones; each phone may contain from 10 to 20 capacitors (Mining Journal, 2000). Tantalum consumption in superalloys, mostly in the aircraft industry, is expected to grow by about 3% per year. Tantalum carbide in the metal cutting industry and tantalum in the chemical processing industry will be dependent on the growth of the general economy, and both are expected to grow at an estimated 2% per year (Tantalum-Niobium International Study Center, 1998).

World tantalum supply will come mostly from mining operations in Australia, Brazil, Canada, and certain African countries. Another important component of world supply is the U.S. Government sales of tantalum materials from the NDS. As of April 30, 2000, tantalum materials authorized for disposal from the NDS totaled about 1,100 t of contained tantalum, including about 1,000 t contained in tantalum minerals.

References Cited

Aerospace Industries Association Update, 2000, Industry sales reached record $155 billion last year: Aerospace Industries Association Update, v. 4, no. 7, January-February, 6 p.

American Metal Market, 1999, Japanese tantalum use runs high: American Metal Market, v. 107, no. 181, September 20, p. 6.

Avalon Ventures, Ltd., 1999a, Avalon and Wabaseemoong Independent Nations sign memorandum of understanding regarding co-operative development of the big whopper petalite deposit: Toronto, Avalon Ventures, Ltd. news release, August 12, 1 p.

———1999b, Significant tantalum mineralization discovered in new Raleigh Lake pegmatite field near Ignace, Ontario: Toronto, Avalon Ventures, Ltd. news release, August 30, 1 p.

Bureau of Export Administration, 1999, National Defense Stockpile Market Impact Committee request for public comments: Federal Register, v. 64, no. 195, October 8, p. 54863-54865.

———2000, National Defense Stockpile Market Impact Committee request for public comments: Federal Register, v. 65, no. 57, March 23, p. 15613-15615.

Cabot Corp., 1999, Cabot announces value enhancement initiatives, Third quarter 1999: Boston, Cabot Corp. news release, July 28, p. 1.

———2000, Annual report—1999: Boston, Cabot Corp., 54 p.

Cambior, Inc., 2000, Annual report—1999: Montreal, Cambior, Inc., 48 p.

Cunningham, L.D., 1999a, Columbium (Niobium), *in* Plunkert, P.A., and Jones, T.S., comps., Metal prices in the United States through 1998: U.S. Geological Survey, p. 35-38.

———1999b, Tantalum, *in* Plunkert, P.A., and Jones, T.S., comps., Metal prices in the United States through 1998: U.S. Geological Survey, p. 143-145.

Defense National Stockpile Center, 1999a, Stockpile accepts ferrocolumbium offer: Fort Belvoir, VA, Defense National Stockpile Center news release, November 22, 1 p.

———1999b, Stockpile accepts ferrocolumbium offers: Fort Belvoir, VA, Defense National Stockpile Center news release, December 9, 1 p.

———1999c, Stockpile awards tantalum carbide powder: Fort Belvoir, VA, Defense National Stockpile Center news release, November 10, 1 p.

———1999d, Stockpile awards tantalum metal, capacitor grade: Fort Belvoir, VA, Defense National Stockpile Center news release, November 22, 1 p.

———1999e, Stockpile awards tantalum metal, vacuum grade: Fort Belvoir, VA, Defense National Stockpile Center news release, December 7, 1 p.

———1999f, Stockpile awards tantalum oxide: Fort Belvoir, VA, Defense National Stockpile Center news release, October 29, 1 p.

———2000a, Revised FY 2000 Annual Materials Plan: Fort Belvoir, VA, Defense National Stockpile Center news release, April 3, 3 p.

———2000b, Stockpile accepts columbium (niobium) metal offers: Fort Belvoir, VA, Defense National Stockpile Center news release, December 22, 1 p.

———2000c, Stockpile accepts ferrocolumbium offers: Fort Belvoir, VA, Defense National Stockpile Center news release, January 19, 1 p.

———2000d, Stockpile awards tantalum carbide powder: Fort Belvoir, VA, Defense National Stockpile Center news release, April 7, 1 p.

Fenton, M.D. (in press), Iron and steel, *in* Metals and minerals: U.S. Geological Survey Minerals Yearbook 1999, v. I.

Interfax International, Ltd., 1999a, Kazakh, Russian nuclear concerns to swap shares: Mining & Metals Report, v. 8, issue 26 (380), June 18-25, p. 10.

———1999b, Kazakhstan may process U.S. Uranium for General Electric—Kazatomprom to modernize Ulba Works: Mining & Metals Report, v. 8, issue 52 (406), December 17-23, p. 12-13.

———1999c, Kazkah [sic] enterprise to restart tantalum production: Mining & Metals Report, v. 8, issue 42 (396), October 8-14, p. 10.

———1999d, Russia renews export duties on nonferrous, rare metals...: Mining & Metals Report, v. 8, issue 37 (391), September 3-9, p. 20.

———1999e, Russia slaps 5 percent export duty on nonferrous, rare metals: Mining & Metals Report, v. 8, issue 10 (365), March 5, p. 3.

———1999f, Russian mine starts producing tantalum, niobium: Mining & Metals Report, v. 8, issue 38 (392), September 10-16, p. 10.

Iron & Steelmaker, 1999, Short- and medium-term outlook for steel demand: Iron & Steelmaker, v. 26, no. 12, December, p. 41-44.

Metal Bulletin, 1999, CBMM sets up Japan sales venture: Metal Bulletin, no. 8364, April 1, p. 9.

Mining Journal, 1999a, Irish tantalum: Mining Journal, v. 333, no. 8558, November 19, p. 412.

———1999b, Niobium: Mining Journal, Steel Industry Metals Annual Review Supplement, v. 333, no. 8543, August 6, p. 78.

———1999c, Spanish tantalum deal: Mining Journal, v. 332, no. 8524, March 26, p. 211.

———1999d, Tantalum: Mining Journal, Speciality Metals Annual Review

Supplement, v. 333, no. 8544, August 13, p. 89.
———2000, Tantalum comes of age: Mining Journal, v. 334, no. 8583, May 19, p. 391, 393.
Northern Miner, 1999a, Avalon completes big whopper study: Northern Miner, v. 85, no. 21, July 19-25, p. 3.
———1999b, Avalon finds tantalum at Raleigh Lake: Northern Miner, v. 85, no. 28, September 6-12, p. 3.
———1999c, Niobium projects jostle for potential market share: Northern Miner Base Metals Supplement, v. 85, no. 18, June 28, p. B7.
Roskill's Letter from Japan, 1999a, May—1999: Roskill's Letter from Japan, no. 277, May, p. 5-7, 11-17.
———1999b, Tantalum—Starck Witech raise production capacity for tantalum powder: Roskill's Letter from Japan, no. 284, December, p. 4-5.
Sons of Gwalia, Ltd., 1999, Annual report—1999: West Perth, Western Australia, Sons of Gwalia, Ltd., 80 p.
Tantalum-Niobium International Study Center, 1998, Tantalum supply and demand: Tantalum-Niobium International Study Center, no. 96, December, 12 p.
———1999a, Overview of the tantalum and niobium industries for 1998 and 1999: Tantalum-Niobium International Study Center, no. 100, December, 12 p.
———1999b, Technical and commercial development of the European niobium market: Tantalum-Niobium International Study Center, no. 98, June, 8 p.
Teck Corp., 2000, Annual report—1999: Vancouver, Teck Corp., 76 p.
TEX Report, 2000, Customs statistics—Japan's imports of ferro-alloys in Dec. 1999: TEX Report, v. 32, no. 7493, February 17, p. 10.
U.S. Customs Service, 2000, Renewal of the Generalized System of Preferences: Federal Register, v. 65, no. 42, March 2, p. 11367-11368.
U.S. Department of Defense, 2000, Strategic and critical materials report to the Congress—Operations under the Strategic and Critical Materials Stock Piling Act during the period October 1998 through September 1999: Washington, DC, U.S. Department of Defense, 50 p.
U.S. Geological Survey, 2000, Prices and events in U.S. metals sector detailed in new report: U.S. Geological Survey news release, January 6, 1 p.
U.S. International Trade Commission, 1998, Harmonized tariff schedule of the United States—1999: Washington, DC, U.S. Government Printing Office, U.S. International Trade Commission Publication 3138, variously paginated and unpaginated.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Columbium (niobium) and tantalum. Chs. in Mineral Commodity Summaries, annual.[1]
Columbium (niobium) and tantalum. Ch. in Minerals Yearbook, annual.[1]
Columbium (niobium) and tantalum. Ch. in United States Mineral Resources, Professional Paper 820, 1973.
Columbium (niobium) and tantalum. Mineral Industry Surveys, annual.[1]
Niobium (columbium) and tantalum. International Strategic Minerals Inventory Summary Report, Circular 930-M, 1993.

[1]Prior to January 1996, published by the U.S. Bureau of Mines.

Other

Aerospace Industries Association.
American Metal Market, daily.
Chemical and Engineering News, weekly.
Columbium (niobium). Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.
Company annual reports.
Defense National Stockpile Center (stockpile reports and news releases).
Electronic Industries Alliance.
Engineering and Mining Journal, monthly.
Federal Register, daily.
Ferroalloy Directory and Data Book, 5th ed., Metal Bulletin Books Ltd., 1998.
Metal Bulletin (London), semiweekly and monthly.
Mining Journal (London), weekly.
Platt's Metals Week, weekly.
Roskill Information Services Ltd. Reports (London):
The Economics of Niobium, 8th ed., 1998.
The Economics of Tantalum, 7th ed., 1999.
Roskill's Letter from Japan, monthly.
Ryan's Notes, weekly.
Skillings Mining Review.
Tantalum. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.
Tantalum-Niobium International Study Center (Brussels):
International Symposium-Proceedings.
Quarterly Bulletin.
The Northern Miner.
The TEX Report (Tokyo: daily issues and annual ferroalloy manual).

TABLE 1
SALIENT COLUMBIUM STATISTICS 1/

(Metric tons of columbium content unless otherwise specified)

	1995	1996	1997	1998	1999
United States:					
Government Stockpile Releases 2/	(106) r/	30 r/	126 r/	145 r/	280
Production of ferrocolumbium	NA	NA	NA	NA	NA
Exports: Columbium metal, compounds, alloys (gross weight)	NA	NA	NA	NA	NA
Imports for consumption:					
Mineral concentrates e/	615	285	220	200	140
Columbium metal and columbium-bearing alloys e/	257	322	423	563	468
Ferrocolumbium e/	3,580	2,970	4,260	4,900	4,450
Tin slag	NA	NA	NA	NA	NA
Consumption:					
Raw materials	NA	NA	NA	NA	NA
Ferrocolumbium and nickel columbium e/	2,860 r/	3,380 r/	3,770	3,640	3,380
Apparent e/	3,800	3,800	3,900	4,000	3,800
Prices:					
Columbite, dollars per pound 3/	2.97	3.00	3.00	3.00	3.00
Pyrochlore, dollars per pound 4/	NA	NA	NA	NA	NA
World: Production of columbium-tantalum concentrates e/	15,600	16,200 r/	20,500 r/	26,200 r/	23,600

e/ Estimated. r/ Revised. NA Not available.

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

2/ Net quantity (uncommited inventory), data in parentheses denote increase in inventory.

3/ Average value, contained pentoxides for material having a columbium pentoxide to tantalum pentoxide ratio of 10 to 1.

4/ Average value, contained pentoxide.

TABLE 2
SALIENT TANTALUM STATISTICS

(Metric tons of tantalum content unless otherwise specified)

	1995	1996	1997	1998	1999
United States:					
Government Stockpile Releases 1/	(12) r/	34 r/	20 r/	215 r/	3
Exports:					
Tantalum ores and concentrates (gross weight) 2/	1	53	91	389	299
Tantalum metal, compounds, alloys (gross weight)	281	342	396	423	460
Tantalum and tantalum alloy powder (gross weight)	41	26	58	61	90
Imports for consumption:					
Mineral concentrates e/	300	360	280	380	320
Tantalum metal and tantalum-bearing alloys 3/	181	203	187	208	244
Tin slag	NA	NA	NA	NA	NA
Consumption:					
Raw materials	NA	NA	NA	NA	NA
Apparent e/	515	490	550	525	550
Prices:					
Tantalite, dollars per pound 4/	26.98	27.75	28.76	33.79	34.00
World: Production of columbium-tantalum concentrates e/	361	389	409	480 r/	495

e/ Estimated. r/ Revised. NA Not available.

1/ Net quantity (uncommited inventory), data in parenthese denote increase in inventory.

2/ Includes reexports.

3/ Exclusive of waste and scrap.

4/ Average value, contained tantalum pentoxides.

TABLE 3
COLUMBIUM AND TANTALUM MATERIALS IN GOVERNMENT
INVENTORIES AS OF DECEMBER 31, 1999 1/

(Metric tons of columbium or tantalum content)

Material	Stockpile goals	Disposal authority	National Defense Stockpile inventory			
			Uncommitted			
			Stockpile-grade	Nonstockpile-grade	Total	Committed
Columbium:						
Concentrates	--	677	335	342	677	49
Carbide powder	--	10	10	--	10	--
Ferrocolumbium	--	112	112	--	112	124
Metal ingots	--	55	55	--	55	18
Total	--	853	511	342	853	191
Tantalum:						
Minerals	--	1,000	549	453	1,000	42
Carbide powder	--	8	8	--	8	--
Metal:						
Capacitor grade	(2/)	23	39	(3/)	39	25
Ingots	(2/)	27	81	--	81	23
Oxide	--	37	37	--	37	--
Total	71 2/	1,100	714	453	1,170	90

-- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Goals as of October 5, 1999; about 16 tons for tantalum metal powder, and about 55 tons for tantalum metal.
3/ About 60 kilograms.

Source: Defense National Stockpile Center.

TABLE 4
REPORTED CONSUMPTION, BY END USE, AND INDUSTRY STOCKS OF
FERROCOLUMBIUM AND NICKEL COLUMBIUM
IN THE UNITED STATES 1/

(Metric tons of contained columbium)

End use	1998	1999
Steel:		
Carbon	1,410	1,270
Stainless and heat-resisting	522	603
Full alloy	(2/)	(2/)
High-strength low-alloy	980	856
Electric	(3/)	--
Tool	(3/)	(2/)
Unspecified	17	--
Total	2,930	2,730
Superalloys	694	639
Alloys (excluding alloy steels and superalloys)	(4/)	(4/)
Miscellaneous and unspecified	13	9
Total consumption	3,640	3,380
Stocks, December 31:		
Consumer	NA	NA
Producer 5/	NA	NA
Total stocks	NA	NA

NA Not available. -- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Included with "Steel: High-strength low alloy."
3/ Included with "Steel: Unspecified."
4/ Included with "Miscellaneous and unspecified."
5/ Ferrocolumbium only.

TABLE 5
U.S. FOREIGN TRADE IN COLUMBIUM AND TANTALUM METAL AND ALLOYS, BY CLASS 1/

Class	1998 Gross weight (metric tons)	1998 Value (thousand dollars)	1999 Gross weight (metric tons)	1999 Value (thousand dollars)	Principal destinations and sources, 1999 (gross weight, metric tons, thousand dollars)
Exports: 2/					
Columbium:					
Ores and concentrates	20	181	12	566	Belgium 3, $469; Switzerland 5, $38; China 1, $27; United Kingdom 1, $16.
Ferrocolumbium	23	206	166	1,110	Mexico 79, $847; United Kingdom 82, $195; India 2, $43; Canada 3, $26.
Tantalum:					
Synthetic concentrates	1	5	18	129	Germany 12, $85; France 4, $20; Estonia 1, $8; Hong Kong (3/), $6; Belgium (3/), $6; Thailand (3/), $4.
Ores and concentrates	389	3,050	299	7,150	Singapore 170, $5,880; China 60, $526; Netherlands 24, $364; Brazil 38, $274; Japan 3, $62; United Kingdom 2, $51.
Unwrought and waste and scrap	230	9,710	233	11,100	United Kingdom 22, $3,500; Hong Kong 136, $2,910; Germany 30, $2,350; China 30, $1,340; Austria 3, $589; Taiwan 11, $221.
Unwrought powders	61	18,400	90	31,900	Israel 53, $21,900; United Kingdom 7, $3,370; Germany 10, $3,190; Austria 14, $1,780; Japan 4, $1,240; Korea, Republic of 1, $285.
Unwrought alloys and metal	110	24,800	95	22,000	Isreal 51, $12,100; United Kingdom 10, $4,000; France 23, $2,670; Germany 3, $886; Japan 1, $690; Barbados 2, $498.
Wrought	83	28,600	132	43,500	Japan 41, $14,200; Germany 39, $11,700; United Kingdom 19, $7,240; Israel 7, $2,380; France 4, $1,960; Singapore 4, $1,200.
Total	XX	85,000	XX	118,000	Israel $36,400; United Kingdom $18,400; Germany $18,200; Japan $16,300; Singapore $7,220; France $4,710; Hong Kong $3,210; Austria $2,380.
Imports for consumption:					
Columbium:					
Ores and concentrates	72	729	95	1,620	China 75, $1,320; Russia 20, $291.
Oxide	1,230	23,200	1,720	30,600	Brazil 1,060, $17,400; Germany 158, $6,140; China 230, $3,270; Russia 200, $2,600; Japan 40, $640; Estonia 30, $475.
Ferrocolumbium	7,530	68,400	6,850	62,200	Brazil 5,890, $52,000; Canada 920, $9,440; Germany 40, $762.
Unwrought alloys, metal, and powder	563	14,600	468	13,500	Estonia 143, $5,410; Brazil 182, $4,380; Germany 94, $2,020; Canada 4, $894; China 24, $442; United Kingdom 9, $179.
Tantalum:					
Ores and concentrates	1,220	35,000	992	33,600	Australia 597, $20,100; Canada 173, $6,440; Congo (Kinshasa) 4/ 81, $2,000; Ethiopia 20, $1,540; Rwanda 59, $1,270; Uganda 24, $645.
Unwrought waste and scrap	481	21,400	809	14,500	Israel 660, $3,140; Austria 14, $2,460; United Kingdom 45, $2,040; China 28, $1,990; Hong Kong 15, $1,260; Germany 6, $997.
Unwrought powders	122	37,100	165	49,800	Japan 40, $20,800; Thailand 51, $12,700; China 50, $12,300; Germany 21, $3,990; Mexico 2, $26.
Unwrought alloys and metal	43	9,490	23	4,110	Kazakhstan 14, $2,250; Russia 8, $1,570; United Kingdom (3/), $157; China 1, $77; Japan (3/), $55; Germany (3/), $8.
Wrought	43	9,200	56	13,000	China 49, $10,000; Japan 4, $1,820; Austria 1, $397; Canada 1, $226; Germany (3/), $222; United Kingdom (3/), $191.
Total	XX	219,000	XX	223,000	Brazil $73,800; China $29,600; Japan $23,700; Austalia $20,200; Canada $17,000; Germany $14,100; Estonia $5,890; Russia $5,200.

XX Not applicable.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ For columbium, data on exports of metal and alloys in unwrought and wrought form, including waste and scrap, are not available; included in nonspecific tariff classification.
3/ Less than 1/2 unit.
4/ Formerly Zaire.

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

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF COLUMBIUM ORES AND CONCENTRATES, BY COUNTRY 1/

Country	1998 Gross weight (metric tons)	1998 Value (thousand dollars)	1999 Gross weight (metric tons)	1999 Value (thousand dollars)
China	21	283	75	1,320
Nigeria	51	416	--	--
Russia	--	--	20	291
Switzerland 2/	(3/)	29	--	--
United Kingdom 2/	(3/)	1	--	--
Total	72	729	95	1,620

-- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Presumably country of transshipment rather than original source.
3/ Less than 1/2 unit.

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

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF TANTALUM ORES AND CONCENTRATES, BY COUNTRY 1/

Country	1998 Gross weight (metric tons)	1998 Value (thousand dollars)	1999 Gross weight (metric tons)	1999 Value (thousand dollars)
Australia	703	21,000	597	20,100
Bolivia	15	401	11	395
Brazil	43	583	--	--
Burundi	36	1,130	7	186
Canada	(2/)	3	173	6,440
China	--	--	3	206
Congo (Kinshasa) 3/	186	3,380	81	2,000
Ethiopia	77	5,140	20	1,540
France 4/	(3/)	5	--	--
Ivory Coast 4/	2	150	--	--
Japan 4/	(3/)	11	--	--
Nigeria	9	500	8	549
Russia	(3/)	2	--	--
Rwanda	71	1,610	59	1,270
Tanzania	--	--	9	169
Thailand	51	524	--	--
Uganda	18	429	24	645
United Kingdom 4/	--	--	(2/)	17
Zimbabwe	8	48	--	--
Total	1,220	35,000	992	33,600

-- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Less than 1/2 unit.
3/ Formerly Zaire.
4/ Presumably country of transshipment rather than original source.

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

TABLE 8
PRINCIPAL WORLD COLUMBIUM AND TANTALUM RAW MATERIAL PRODUCERS

Country	Company and/or mine	Material type
Mining of columbium- and tantalum-bearing ores:		
Australia	Sons of Gwalia, Ltd. (Greenbushes)	Columbium-tantalum.
	Sons of Gwalia, Ltd. (Wodgina)	Tantalum.
Brazil	Cia. Brasileira de Metalurgia e Mineracao (CBMM) (Araxa)	Columbium.
	Cia. de Estanho Minas Brasil (MIBRA) 1/	Columbium-tantalum.
	Paranapanema S.A. Mineracao Indústria e Construcao (Pitinga)	Columbium-tantalum.
	Mineracao Catalao de Goias S.A. (Catalao)	Columbium.
Canada	Cambior Inc., and Teck Corp. (Niobec)	Columbium.
	Tantalum Mining Corp. of Canada, Ltd. (Tanco) 2/	Tantalum.
China	Government-owned	Columbium-tantalum.
Production of columbium- and tantalum-bearing tin slags:		
Australia	Sons of Gwalia, Ltd. (Greenbushes)	
Brazil	Cia. Industrial Fluminense 1/	
	Mamoré Mineracao e Metalurgia 3/	
Thailand	Thailand Smelting and Refining Co. Ltd. (Thaisarco)	
Production capacity for columbium- and tantalum-bearing synthetic concentrates: Germany: Western states	Gesellschaft Für Elektrometallurgie mbH (GFE) 1/	
	H.C. Starck GmbH & Co. KG.	

1/ A wholly owned subsidiary of Metallurg, Inc., New York, NY.
2/ A wholly owned subsidiary of Cabot Corp.
3/ A subsidiary of Paranapanema S.A. Mineracao Indústria e Construcao.

TABLE 9
PRINCIPAL WORLD PRODUCERS OF COLUMBIUM AND TANTALUM PRODUCTS

Country		Products 1/
Austria	Treibacher Industrie AG	Nb and Ta oxide/carbide, FeNb, NiNb.
Brazil	Cia. Brasileira de Metalurgia e Mineracao (CBMM)	Nb oxide/metal, FeNb, NiNb.
	Cia. Industrial Fluminense 2/	Nb and Ta oxide.
	Mineracao Catalao de Goias S.A. (Catalao)	FeNb.
Canada	Cambior, Inc., and Teck Corp. (Niobec)	FeNb.
Estonia	Silmet	Nb oxide/metal.
Germany: Western states	Gesellschaft Fur Elektrometallurgie mbH (GFE) 2/	FeNb, NiNb.
	H.C. Starck GmbH & Co. KG	Nb and Ta oxide/metal/carbide, K-salt, FeNb, NiNb, Ta capacitor powder.
Japan	Mitsui Mining & Smelting Co.	Nb and Ta oxide/metal/carbide.
	Showa Cabot Supermetals 3/	Ta capacitor powder.
	H.C. Starck-V Tech Ltd. 4/	Ta capacitor powder.
Kazakhstan	Ulba Metallurgical	Ta oxide/metal.
	Irtysh Chemical & Metallurgical Works	Nb oxide/metal.
Russia	Solikamsk Magnesium Works	Nb and Ta oxide.
Thailand	H.C. Starck (Thailand) Co. Ltd. 4/	K-salt, Ta metal.
United States	Cabot Performance Materials	Nb and Ta oxide/metal, K-Salt, FeNb, NiNb, Ta capacitor powder.
	H.C. Starck, Inc. 5/	Nb and Ta metal, Ta capacitor powder.
	Kennametal, Inc.	Nb and Ta carbide.
	Reading Alloys, Inc.	FeNb, NiNb.
	Shieldalloy Metallurgical Corp. 2/	FeNb.
	Oremet-Wah Chang 6/	Nb oxide/metal, FeNb, NiNb.

1/ Nb, columbium; Ta, tantalum; FeNb, ferrocolumbium; NiNb, nickel columbium; K-salt, potassium fluotantalate; oxide, pentoxide.
2/ A wholly owned subsidiary of Metallurg, Inc., New York.
3/ A joint venture between Showa Denko and Cabot Corp.
4/ A subsidiary of H.C. Starck GmbH & Co. KG.
5/ Jointly owned by Bayer Corp. and H.C. Starck GmbH & Co. KG.
6/ A subsidiary of Allegheny Teledyne, Inc.

TABLE 10
COLUMBIUM AND TANTALUM: ESTIMATED WORLD PRODUCTION OF MINERAL CONCENTRATES, BY COUNTRY 1/ 2/

(Metric tons)

	Gross weight 3/					Columbium content 4/					Tantalum content 4/				
Country 5/	1995	1996	1997	1998	1999	1995	1996	1997	1998	1999	1995	1996	1997	1998	1999
Australia: Columbite-tantalite	900	920	1,010	1,150	1,230	109	112	125	140	140	274	276	302	330	350
Brazil:															
Columbite-tantalite	175	190	190	330 r/	330	40	45	45	70 r/	70	50	55	55	90 r/	90
Pyrochlore	31,200	32,600 r/	42,900 r/	56,200 r/	50,000	13,100	13,700 r/	18,000 r/	23,600 r/	21,000	--	--	--	--	--
Canada:															
Pyrochlore	5,230	5,160	5,090	5,110	5,240	2,350	2,320	2,290	2,300	2,360	--	--	--	--	--
Tantalite	130	220	196	228 r/	208	7	11	10	11 r/	10	33	55	49	57 r/	52
Congo (Kinshasa): 6/ Columbite-tantalite	4	--	--	--	--	1	--	--	--	--	1	--	--	--	--
Namibia: Tantalite	(7/)	--	--	--	--	NA	--	--	--	--	(7/)	--	--	--	--
Nigeria: Columbite	65 8/	57 8/	60	70 r/	70	26	23	23	30 r/	30	3	3	3	3	3
Zimbabwe: Columbite-tantalite	1	--	--	--	--	(7/)	--	--	--	--	(7/)	--	--	--	--
Total	37,700	39,100 r/	49,400 r/	63,100 r/	57,100	15,600	16,200 r/	20,500 r/	26,200 r/	23,600	361	389	409	480 r/	495

r/ Revised. NA Not available. -- Zero.

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

2/ Excludes columbium- and tantalum-bearing tin ores and slags. Production of tantalum contained in tin slags was, in metric tons: 1995--126; 1996--82; 1997--40; 1998-99--NA according to data from the Tantalum-Niobium International Study Center. Table includes data available through July 7, 2000.

3/ Data on gross weight generally have been presented as reported in official sources of the respective countries, divided into concentrates of columbite, tantalite, and pyrochlore where information is available to do so, and reported in groups, such as columbite and tantalite, where it is not.

4/ Unless otherwise specified, data presented for metal content are estimates based on, in most part, reported gross weight and/or pentoxide content.

5/ In addition to the countries listed, Bolivia, China, Russia, and Zambia also produce, or are believed to produce, columbium and tantalum mineral concentrates, but available information is inadequate to make reliable estimates of output

6/ Formerly Zaire.

7/ Less than 1/2 unit.

8/ Reported figure.

FIGURE 1

MAJOR SOURCES OF U.S. COLUMBIUM IMPORTS

(Columbium content)

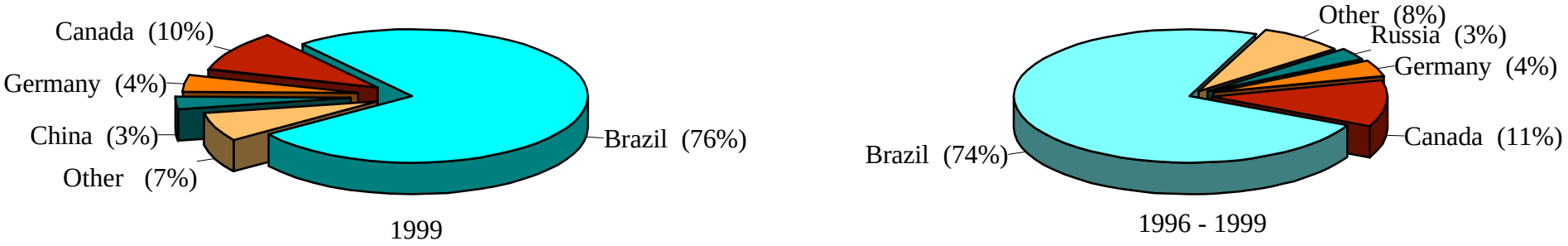

FIGURE 2

MAJOR SOURCES OF U.S. TANTALUM IMPORTS

(Tantalum content)