COLUMBIUM (NIOBIUM) AND TANTALUM

By Larry D. Cunningham

Domestic survey data and tables were prepared by Robin C. Kaiser, statistical assistant, and the world production table was prepared by Regina R. Coleman, international data coordinator.

Columbium [niobium (Nb)] is vital as an alloying element in steels and in 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. 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, 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 U.S. resources are of low grade. Some resources are mineralogically complex, and most are not currently (2001) 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 most of total estimated columbium mine production in 2001. 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, which was more than 50% of total estimated tantalum mine production in 2001, and from other tantalum mine operations in Brazil, Canada, and certain African countries. The reliance on tantalum-containing tin slags as a source of tantalum supply continued to decline.

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), a renewable preferential trade program, was allowed to expire after September 30, 2001. Columbium price quotations remained stable. Overall reported consumption of columbium in the form of ferrocolumbium and nickel columbium increased, with demand for columbium in superalloys up significantly. Tantalum price quotations for tantalite ore decreased significantly and tantalum consumption was down, owing to weak demand for tantalum from the electronics sector and a downturn in the global economy.

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 (table 3). The NDS had no goals for columbium and tantalum materials effective as of December 28, 2001. For fiscal year (FY) 2001 (October 1, 2000, through September 30, 2001), the DNSC sold about 9 metric tons (t) of columbium contained in columbium metal ingots valued at about $323,000 and about 48 t of columbium contained in ferrocolumbium valued at about $1.29 million, which exhausted DNSC's ferrocolumbium inventory. Additionally, the DNSC sold about 2 t of tantalum contained in tantalum carbide powder valued at about $1.34 million, about 20 t of tantalum contained in tantalum metal powder valued at about $14.3 million, about 18 t of tantalum contained in tantalum metal ingots valued at about $16.1 million, about 5 t of tantalum contained in tantalum minerals valued at about $4.11 million, and about 11 t of tantalum oxide valued at about $2.55 million. As of September 30, 2001, tantalum inventory sold but not shipped from the NDS included about 16 t of tantalum capacitor-grade metal and about 7 t of tantalum oxide (U.S. Department of Defense, 2002, p. 13, 14, 50, 53, 54, 57).

In its revised Annual Materials Plan (AMP) for FY 2002 (October 1, 2001, through September 30, 2002) and proposed AMP for FY 2003 (October 1, 2002, through September 30, 2003), the DNSC had authority to sell about 10 t of columbium contained in columbium carbide powder (actual quantity limited to the remaining sales authority or inventory), about 254 t of columbium contained in columbium concentrates, 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 contained in tantalum metal powder (actual quantity limited to the remaining sales authority or inventory), about 18 t of tantalum contained in tantalum metal ingots, about 227 t of tantalum contained in tantalum minerals, and about 9 t of tantalum contained in tantalum oxide (Bureau of Export Administration, 2001; Defense National Stockpile Center, 2002). For FY 2002, through June 30, 2002, the DNSC sold about 9 t of columbium contained in columbium metal ingots valued at about $301,000, about 10 t of columbium contained in

columbium carbide powder valued at about $86,000, which exhausted DNSC's columbium carbide powder inventory, and about 9 t of tantalum contained in tantalum metal ingots valued at about $1.87 million.

Under the GSP, the United States grants duty-free access to eligible products from designated developing countries. In 2001, U.S. import duties for selected columbium and tantalum materials ranged from duty free to 5% ad valorem for normal-trade-relations (NTR) status and from duty free to 45% ad valorem for non-NTR status (U.S. International Trade Commission, 2000). The GSP program was allowed to expire after September 30, 2001, temporarily ending duty-free treatment for imports of selected goods from qualifying developing countries and territories. In October 2001, the U.S. Customs Service provided notice to importers that claims for duty-free treatment under GSP would not be processed by Customs for merchandise entered or withdrawn from a warehouse for consumption on or after October 1, 2001. The notice also set forth the mechanisms that would facilitate refunds, should the GSP be renewed with retroactive effect (U.S. Customs Service, 2001). Categories of U.S. imports from developing countries affected by the GSP included all columbium and tantalum materials on which tariffs were levied except columbium and tantalum ores and concentrates, synthetic tantalum-columbium concentrates (NTR), and columbium and tantalum unwrought waste and scrap, for which the general rate of duty already was zero. The GSP program had not been renewed at yearend 2001.

Production

Neither columbium nor tantalum was mined domestically in 2001. 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 2001 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 the production of columbium and tantalum end products. H.C. Starck Inc. was a major supplier of tantalum and columbium products. Reading Alloys Inc., Robesonia, PA, and 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 May, Cabot Corp., Boston, MA, announced plans to double capacity at its CPM business for producing tantalum and columbium metallurgical products to meet the growing demand for these materials used by the electronics, superconductor, aerospace, and chemical process industries. The expansion would include immediate improvements to an existing electron beam (EB) melting furnace and the purchase of a third, new, 2,400-kilowatt EB furnace. The improvements will increase capacity and allow the company to continue manufacturing and casting metal ingots as large as 16 inches in diameter (Cabot Corp., 2001§[1]).

In the first quarter, Wah Chang announced plans for the purchase and installation of a new EB furnace at a project capital investment of more than $9 million. "The additional furnace will complement [sic] the three existing furnaces operating at Wah Chang and will increase overall EB capacity by 40%." When completed, the new furnace will be capable of producing columbium metal ingots of up to 19 inches in diameter, 120 inches long, and weighing up to about 4.5 t. The furnace was expected to be operational by spring 2002 (Wah Chang, 2001, p. 1, 6).

In December, KEMET Corp., Greenville, SC, announced cost saving initiatives in response to inventory correction experienced in the electronics industry. Company initiatives included streamlining of manufacturing facilities, the acceleration of productivity improvement programs, and the reduction in force of approximately 600 employees in the United States and approximately 1,000 employees in Mexico. "Early in calendar 2001, KEMET shipments dropped by two-thirds as customers began correcting an enormous accumulation of inventory, which in some cases was five times greater than normal levels. Prior cost saving initiatives have reduced operating costs in excess of $80 million annually, so this latest initiative brings the total savings to over $110 million." KEMET is the world's largest manufacturer of solid tantalum capacitors (KEMET Corp., 2001§).

Consumption

Overall U.S. reported consumption of columbium as ferrocolumbium and nickel columbium increased by about 3% compared with that of 2000 (table 4). Consumption of columbium by the steelmaking industry decreased by about 5% as a result of a decline in raw steel production, with consumption down in all major reported steel end-use categories. Demand for columbium in superalloys increased to about 1,230 t from 942 t, with continued strong demand from the aerospace industry and superalloy consumption in land-based gas turbine power generating systems. That portion, used in the form of nickel columbium, increased to almost 730 t. Overall U.S. apparent consumption of all columbium materials was estimated to be about 4,400 t, compared with about 4,300 t in 2000.

Estimated overall U.S. apparent consumption of all tantalum materials was down by about 15% to about 550 t, owing to a slowdown in the electronics sector. Industry sources indicated that forecasts for electronic products in 2001 were overly optimistic. However, more than 60% of total tantalum consumed was in the electronics industry. Major end uses for tantalum capacitors included automotive electronics, pagers, personal computers, and portable telephones. Tantalum consumption continued to be affected by increased demand for tantalum-containing superalloys for jet engine and gas turbine components.

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, has a high melting point (about 2,470 °C), is readily fabricated, and is highly resistant to many chemical environments.

Columbium in the form of ferrocolumbium is used worldwide, mostly as an alloying element in steels and in

[1]References that include a section twist (§) are found in the Internet References Cited section.

superalloys. Because of its refractory nature, appreciable amounts of columbium in the form of high-purity ferrocolumbium and nickel columbium are used in cobalt-, iron-, and nickel-base superalloys for such applications as heat-resisting and combustion equipment, jet engine components, and rocket subassemblies. Columbium carbide is used in cemented carbides to modify the properties of the cobalt-bonded tungsten carbide-based material to impart toughness and shock resistance. It is usually used along with carbides of other metals, such as tantalum and titanium. Columbium oxide is the intermediate product used in the manufacture of columbium carbide, columbium metal, high-purity ferrocolumbium, and nickel columbium. 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 shelf life. Applications for tantalum capacitors include communication systems, computers, 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 boring tools, cemented-carbide cutting tools, farm tools, and wear-resistant parts. Owing to tantalum's excellent corrosion-resistant properties, tantalum mill and fabricated products are used for corrosion and heat-resistant chemical plant equipment, such as condensers, evaporators, heat exchangers, heating elements, and liners for pumps and reactors. 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, based on a minimum 65% contained columbium oxide (Nb_2O_5) and tantalum oxide (Ta_2O_5), was discontinued in October at a range of $5.50 to $7 per pound. 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. The most recent industry sources (August 1999 and December 1999) 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, 1999a; Tantalum-Niobium International Study Center, 1999a, p. 5). Public information on current prices for these products was not available. Significant events affecting columbium prices since 1958 include the following: 1960-70, development of pyrochlore deposits in Brazil and Canada; 1970-79, increased demand and consequent rising prices; 1980, columbium oxide produced from pyrochlore-based feed material; 1981, exports of Brazilian pyrochlore ceased; 1994, production of ferrocolumbium began in Canada; 1997-98, sales of ferrocolumbium from the NDS; and 1998, expansion of ferrocolumbium production capacity in Brazil (Cunningham, 1999a).

The price for tantalum products is affected most by events in the supply of and demand for tantalum minerals. During 2001, published prices for tantalite ore (per pound contained oxide) decreased significantly, a reversal of the price increase that occurred in 2000: Platts Metals Week, fell to a range of $40 to $50 from a range of $145 to $175; Metal Bulletin, fell to a range of $25 to $35 from a range of $180 to $240; and Ryan's Notes, fell to a range of $32 to $39 from a range of $250 to $300. Weak demand for tantalum products from the electronics sector, increased inventories, and a downturn in the global economy contributed to the price decrease. The Metal Bulletin published price for Greenbushes tantalite ore, Australia, was $40 per pound contained oxide and has not changed since April 1991. The most recent industry source (August 1999) on tantalum product 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, 1999b). Public information on current prices for these products was not available. Significant events affecting tantalum prices since 1958 include the following: 1979-80, tantalum price accelerates to record levels, owing in part to over optimistic forecasts of market growth; 1982, industry's accumulation of large tantalum material inventories; 1988, drawdown of tantalum material inventories by processors; 1990, purchase of tantalum materials for the NDS; 1991, long-term tantalum supply contracts between major producer and processors; 1998, sales of tantalum minerals from the NDS (Cunningham, 1999b); and 2000, optimistic forecasts of market growth and an apparent shortage of tantalum source materials for processing.

Foreign Trade

Table 5 lists columbium and tantalum export and import data. Net trade for columbium and tantalum continued at a deficit. For exports, overall trade value and total volume increased significantly. In descending order, Israel, Germany, the United Kingdom, Japan, Mexico, and the Netherlands were the major recipients of the columbium and tantalum materials, on the basis of value, with more than 80% of the total. For imports, overall trade value was up by almost 30%, with total volume up by almost 10%. In descending order, Brazil, Australia, Japan,

China, Germany, Kazakhstan, and Canada were the major sources of columbium and tantalum imports, on the basis of value, with more than 80% of the total.

Imports for consumption of columbium ores and concentrates decreased by about 17% (table 6); imports from China accounted for about 90% of quantity and value. Imports at an average grade of approximately 29% Nb_2O_5 and 31% Ta_2O_5 were estimated to contain about 25 t of columbium and about 30 t of tantalum. Columbium oxide imports increased by almost 15% and ferrocolumbium imports rose slightly; Brazil accounted for more than 45% of U.S. columbium oxide imports and about 85% of ferrocolumbium imports.

Imports for consumption of tantalum ores and concentrates increased by about 8% (table 7); imports from Australia accounted for more than 70% of quantity and almost 65% of value. Imports at an average grade of approximately 35% Ta_2O_5 and 17% Nb_2O_5 were estimated to contain about 660 t of tantalum and about 265 t of columbium.

The schedule of tariffs applied during 2001 to U.S. imports of selected columbium and tantalum materials is found in the Harmonized Tariff Schedule of the United States—2001 (U.S. International Trade Commission, 2000). Brazil, which was the major source for U.S. columbium imports, accounted for about 71% of total, in units of contained columbium (figure 1), and Australia, which was the major source for U.S. tantalum imports, accounted for about 58% of total, in units of contained tantalum (figure 2).

Net import reliance as a percent of apparent consumption is used to measure the adequacy of current domestic columbium and tantalum production to meet U.S. demand. For columbium in 2001, net import reliance as a percent of apparent consumption was 100%. For tantalum, net import reliance as a percent of apparent consumption was estimated to be about 80%.

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 and Brazil were the major producers of tantalum mineral concentrates. Tantalum-containing low-grade tin slags continued to decline as a source of tantalum supply. In 2000, it was reported that tin slags accounted for about 18% of tantalum supply compared with about 70% around 1980. Tantalum supply from the mining of primary tantalum-bearing ores, such as in Australia, continued to increase (Mining Journal, 2000; Tantalum-Niobium International Study Center, 2001c, p. 1-6).

In 2001, world consumption of columbium was estimated to be about 27,500 t of contained columbium compared with about 28,500 t in 2000. Europe was the largest columbium consuming market accounting for about 6,990 t, with Japan and the United States each accounting for more than 4,000 t. The steel industry was estimated to consume approximately 86% of columbium processor shipments, with approximately 8% of steel produced in the world containing some columbium. World shipments of columbium contained in ferrocolumbium were about 23,400 t (Roskill Information Services Ltd., 2002a, p. 3). World consumption of tantalum was expected to be approximately 2,000 t in 2001, with demand projected to reach about 2,800 t in 2005 (Roskill Information Services Ltd., 2002b, p. 1, 115).

Exploration.—Some columbium and tantalum exploration projects (not all inclusive) were as follows: In Alaska, two Canadian companies, Chapleau Resources Ltd. and Navigator Exploration, Vancouver, were re-prospecting the Kougarok Tantalum Deposit on the Seward Peninsula. The mineral potential of Kougarok was believed to be 20,000 to 30,000 t of contained Ta_2O_5. In Canada, Avalon Ventures Ltd., was conducting a feasibility study on the Separation Rapids property near Kenora, Ontario. Avalon was also exploring the East Braintree property near Falcon Lake, southeastern Manitoba, the Lilypad Lakes property near Pickle Lake, Ontario, and the Raleigh Lake property near Ignace, Ontario. Commerce Resources Corp. was exploring its Verity and Fir properties near Blue River, British Columbia. The more explored Verity property was reported to contain an inferred resource of 3.1 million metric tons (Mt) of ore averaging 196 grams per ton (g/t) Ta_2O_5 and 645 g/t Nb_2O_5. Platinova A/S announced encouraging results of its sampling and drilling programs at the Case tantalum project near Cochrane, Ontario. War Eagle Mining announced positive sample results (encouraging values of Ta_2O_5) from its MAC property in the MacKenzie Mountains, Northwest Territories. Gippsland Ltd. of Australia was investigating Egypt's Abu Dabbab tantalite deposit south of Cairo on the western shore of the Red Sea. Tertiary Minerals plc, United Kingdom, reported "highly promising" metallurgical results on samples from the Rosendal tantalum-bearing pegmatite deposit in Finland. The Geological Survey of Finland estimated Rosendal's resource at 1.3 Mt of ore averaging 289 g/t Ta_2O_5. In Greenland, Angus and Ross plc, United Kingdom, reported "excellent results" of its drilling program at the Motzfeldt deposit and was recommending an expansion of drilling and associated studies. Tertiary Minerals was awarded a 5-year exploration license to explore the Ghurayyah deposit in northwest Saudi Arabia. Previous exploration of the Ghurayyah deposit indicated a resource of 385 Mt of ore averaging 245 g/t Ta_2O_5 and 2,840 g/t Nb_2O_5 (Northern Miner, 2001; Tantalum Niobium International Study Center, 2002, p. 4, 6-8).

Australia.—For its 2001 financial year ending June 30, 2001, Sons of Gwalia Ltd., West Perth, Western Australia, reported that tantalum production (tantalum oxide contained in mineral concentrates) totaled about 737 t at its Greenbushes and Wodgina Mines. Production at Greenbushes, located approximately 300 kilometers (km) south of Perth and 80 km east of the port of Bunbury, was a record 426 t, up 35% from that of 2000. Greenbushes increased production was achieved through the mining of higher grade ore, productivity improvements in the processing plant, and the modification and diversion of surplus lithium production capacity for tantalum concentrate production. Production at Wodgina, located approximately 100 km south of Port Hedland in the Pilbara region of Western Australia, increased by 64% to about 311 t. Wodgina's increased production was attributed to the September 1999 plant expansion, mining of higher grade ore, processing of softer ore, and productivity improvements in the treatment plant. For 2002, the Greenbushes and Wodgina operations are expected to produce about 499 t and about 408 t, respectively. Gwalia's long-term tantalum contracts with its two customers, Cabot Corp. and H.C. Starck GmbH & Co. KG

of Germany, will underwrite the $100 million expansion programs (Sons of Gwalia Ltd., 2001, p. 26, 28, 29, 36). In its March 2002 quarterly report, Sons of Gwalia reported that installed production capacity at Greenbushes and Wodgina had increased to in excess of 590 t and 450 t, respectively (Sons of Gwalia Ltd., 2002, p. 13-14).

As of June 30, 2001, Sons of Gwalia reported that Greenbushes tantalum resource base was about 44,000 t of contained tantalum oxide, including about 20,400 t classified as tantalum reserves, and that Wodgina's tantalum resource base was about 27,400 t of contained tantalum oxide, including about 24,200 t classified as tantalum reserves (Sons of Gwalia Ltd., 2001, p. 31).

In April, Australasian Gold Mines NL, Balcatta, Western Australia, announced the finalization of a 50-50 joint venture with KEMET Corp. launching the new company Tantalum Australia Pty. Ltd. KEMET invested $10 million for its 50% share in Tantalum Australia and $4.6 million for a 10% stake in Australasian Gold. Tantalum Australia would own and fund development of Australasian Gold's existing tantalum assets in Australia and seek new project opportunities on a global basis. Company assets in Australia included the Dalgaranga project in Western Australia, the Walwa project in Victoria, and the Binneringie project in Western Australia. A pilot plant at Dalgaranga was commissioned early in the year and KEMET agreed to purchase all tantalum concentrate produced by the plant. KEMET also agreed to assist the new company in procuring project financing of up to $40 million for the construction of a full scale plant at Dalgaranga. In November, Australasian Gold Mines announced the discovery of a major tantalum deposit at its recently acquired Mt. Deans project in the Western Australia Eastern Goldfields. Drilling results indicated the potential for a significant tantalum resource containing about 2,270 t of tantalum oxide (Australasian Gold Mines NL, 2001a§, p. 1-5, 10, b§, c§). In early 2002, Australasian Gold Mines acquired KEMET's 50% equity in Tantalum Australia and regained full control of its tantalum business.

Brazil.—Cia. Brasileira de Metalurgia e Mineração (CBMM), which was the world's largest columbium producer, was expected to produce about 25,000 t of ferrocolumbium in 2001 compared with about 23,300 t in 2000. Columbium concentrate output was projected to be about 45,000 t compared with about 39,600 t in 2000. In addition, the company produces annually about 60 t of columbium metal, about 1,000 t of vacuum-grade alloys, about 2,400 t of high-purity columbium oxide, and about 150 t of optical-grade columbium oxide (Mining Journal, 2001a; Tantalum-Niobium International Study Center, 2001a, p. 8). In June, it was reported that CBMM had purchased two oil-powered gas power generators, which would allow the company to run certain production operations independently of power suppliers. On June 1, the Brazilian Government had mandated a 25% cut in energy consumption owing to severe drought conditions (American Metal Market, 2001a).

Canada.—In late March 2001, Mazarin Inc. finalized the acquisition of Teck Corporation's 50% interest in the Niobec Mine near Chicoutimi, Quebec. Niobec was a 50-50 joint venture between Cambior Inc. (product marketing), and Mazarin (operator). In 2001, based on Cambior's 50% share, production of columbium oxide contained in pyrochlore concentrate at the mine totaled about 4,550 t compared with about 3,270 t in 2000; columbium contained in ferrocolumbium production was about 3,000 t compared with about 2,170 t in 2000; and pyrochlore-to-ferrocolumbium converter recovery was 97% compared with 96% in 2000. Ore milled increased to about 1.1 Mt. Average recovery increased to 58%, with the Nb_2O_5 grade of concentrate at 71%. Capital expenditures totaled about $2 million, mainly for underground mobile equipment and deferred development. For 2002, columbium contained in ferrocolumbium production was budgeted for about 3,110 t, with capital expenditures at the 2001 level. A plan to gradually increase ferrocolumbium production by an additional 20%, requiring an estimated $5.8 million investment, was being evaluated. Niobec's proven and probable ore reserves totaled about 18.2 Mt at an average grade of 0.68% Nb_2O_5 compared with about 11.5 Mt at an average grade of 0.73% Nb_2O_5 in 2000. Ore reserves were sufficient for at least 16 years of mine life at the current mining rate (Cambior Inc., 2002a§, b§; Mazarin Inc., 2002, p. 4).

In 2001, about 94 t of tantalum oxide contained in concentrate was produced at the Bernic Lake, Manitoba, tantalum operation, compared with about 70 t in 2000.

China.—China's Xinjiang Western Tantalum Works was producing about 15 to 20 tons per year of tantalum concentrate at Aletai in the Xinjiang Region. The new miner was also expected to develop two other properties in the region by yearend 2002 (Platts Metals Week, 2001). Minning Tantalum & Niobium Co. Ltd.'s, Nanping City, Fujian Province, columbium and tantalum mine project was completed by July 1. The project was expected to treat 600 tons per day (t/d) of columbium and tantalum ores. A planned upgrade/expansion of the project was projected to increase ore treatment to more than 1,200 t/d (China Metal Market, 2001, p. 14).

Japan.—In 2001, Japan's demand for tantalum was 296 t (powder, 116 t; compounds, 85 t; and products, 95 t) compared with 552 t in 2000. Tantalum raw material shortages and rising prices in 2000, owing to increased demand for tantalum products, was followed by material oversupply and falling prices in 2001. Japan's sources of tantalum raw materials were domestically produced tantalum powder, imported tantalum ingots and products, and tantalum ingots produced from domestic and imported scrap. Tantalum imports (powder, compounds, and products) in 2001 were 96 t compared with 139 t in 2000. In 2002, tantalum demand is forecast to increase to about 329 t; powder, 130 t; compounds, 95 t; and products, 104 t (Roskill's Letter from Japan, 2002a, b). Production of tantalum capacitors, which accounts for about 70% of tantalum demand, was about 4,860 million units compared with about 8,670 million units in 2000. Tantalum capacitor exports were about 1,760 million units compared with about 3,240 million units in 2000. Tantalum capacitor demand was affected by a downturn in the information technology sector, especially a decrease in the production of cellular telephones (Roskill's Letter from Japan, 2002c).

On January 25, Showa Cabot Supermetals K.K. (SCSM), a joint venture between Showa Denko K.K. and Cabot Corp., announced expansion of capacitor-grade tantalum power production capacity at its Higashinagahara plant in Fukushima Prefecture. SCSM's expansion work started in 1999 and a new powder adjustment process facility was completed in October 2000. The expansion was scheduled to be completed in April 2001 with startup of a new powder reduction process facility.

Tantalum powder production capacity was expected to increase from 18 to 30 tons per month (t/mo). Expansion of research and development facilities for the development of high performance tantalum powders was also undertaken (Showa Cabot Supermetals K.K., 2001§).

Namibia.—The Tantalite Valley tantalite mine, about 100 km south of Karasburg, was reportedly reopened at the end of July after being shut down since the late 1980s. A subsidiary of Severin Mining was the mine operator. Mine ore reserves were estimated to be about 2.5 Mt containing 299 g/t of Ta_2O_5. Tantalite Valley was expected to produce 1.5 t/mo of Ta_2O_5 contained in concentrate over an 8-year period, with output going to Marubeni Corp. of Japan under a long-term contract (Mining Journal, 2001b).

Outlook

Columbium.—The principal use for columbium will continue as an additive in steelmaking, mostly in the manufacture of microalloyed steels used for automobiles, bridges, pipelines, and so forth. The production of high-strength low-alloy steel is the leading use for columbium, and the trend for columbium demand, domestically and globally, will continue to follow closely that of steel production (see the Outlook section of the Iron and Steel chapter for a discussion of the future of the steel industry). The Spring 2002 short-term forecast of the International Iron and Steel Institute projected an annual growth rate of 2.2% in finished steel products consumption between 2001 and 2003 for the world, with Chinese steel consumption projected to rise by 11.5%. World economic recovery was forecast in 2003, with possible recovery starting in 2002 (International Iron and Steel Institute, undated§).

The outlook for columbium also will be dependent on the performance of the aerospace industry and the use of columbium-bearing alloys. 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). For 2002, the Aerospace Industries Association (2002, p. 6) projected industry sales to decrease by $6.6 million from 2001 sales of $151 million owing to commercial transport production declines following September 11, 2001, terrorist events. Land-based gas turbine power generating systems also are expected to gain in importance in terms of columbium consumption. Industry sources estimate that about 14,500 t of superalloys are used annually in the production of large-diameter turbines. These turbines typically consume up to 10 times the quantity of superalloys required to build the average aircraft engines, especially those that use nickel-base superalloys in discs and shafts (American Metal Market, 2001b, c). 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 2001 compared with about 650 t in 2000. 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 capacitor demand is projected to grow by about 9% to 10% per year through to 2005. For the near term, tantalum carbide in the metal cutting industry is expected to grow at an estimated 5% per year (Tantalum-Niobium International Study Center, 2001b, p. 5-7; Roskill Information Services Ltd., 2002b, p. 1-4, 124-176).

In 2001, world tantalum supply was estimated to be about 2.1 Mt of contained tantalum. For 2002 and 2003, world tantalum supply was projected to be about 2.5 Mt and 2.7 Mt of contained tantalum, respectively. World tantalum supply will come mostly from Australia, Brazil, Canada, China, Southeast Asia, and certain African countries (including Burundi, Congo (Kinshasa), Ethiopia, Mozambique, Nigeria, Rwanda, Uganda, and Zimbabwe) (Tantalum-Niobium International Study Center, undated, p. 19-33). An important component of world tantalum supply is the U.S. Government sales of tantalum materials from the NDS. As of June 30, 2002, tantalum materials authorized for disposal from the NDS totaled about 970 t of contained tantalum, including about 870 t contained in tantalum minerals.

References Cited

Aerospace Industries Association Update, 2002, Terrorism fallout will drop 2002 commercial sales: Aerospace Industries Association Update, v. 6, no. 7, January-February, 8 p.

American Metal Market, 2001a, Brazilian ferroalloy output to decline in 2001: American Metal Market, Ferroalloys Special Report, v. 109, no. 127, July 2, p. 9.

American Metal Market, 2001b, Land-based gas turbines spur superalloy demand: American Metal Market, Superalloys Special, v. 109, no. 166, August 27, p. 9, 12.

American Metal Market, 2001c, Superalloy producer sees strong market in 2002: American Metal Market, Superalloys Special, v. 109, no. 166, August 27, p. 10.

Bureau of Export Administration, 2001, National Defense Stockpile market impact committee request for public comments: Federal Register, v. 66, no. 207, October 25, p. 53981-53983.

China Metal Market, 2001, Tantalum & Niobium—Nanping Ta & Nb mining and dressing project completed: China Metal Market, Precious & Minor Metals Monthly, no. 19, July, 16 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.

Cunningham, L.D., 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, 2002, Revised FY 2002 Annual Materials Plan: Fort Belvoir, VA, Defense National Stockpile Center news release, May 6, 2 p.

Mazarin Inc., 2002, Annual report—2001: Sainte-Foy, Quebec, Mazarin Inc., 36 p.

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

Mining Journal, 1999b, Tantalum: Mining Journal, Speciality Metals Annual Review Supplement, v. 333, no. 8544, August 13, p. 89.

Mining Journal, 2000, Tantalum comes of age: Mining Journal, v. 334, no. 8583, May 19, p. 391, 393.

Mining Journal, 2001a, CBMM completes expansion: Mining Journal, v. 336, no. 8626, March 23, p. 211-212.

Mining Journal, 2001b, Severin reopens tantalite valley: Mining Journal, v. 337, no. 8646, August 10, p. 98-99.

Northern Miner, 2001, Junior companies target tantalum prospects: Northern Miner, Exploration Roundup, v. 87, no. 40, November 26, p. B1-B2, B4.

Platts Metals Week, 2001, New tantalum miner in China: Platts Metals Week, v. 72, no. 40, October 1, p. 5.

Roskill Information Services Ltd., 2002a, The economics of niobium (9th ed.): Roskill Information Services Ltd., 254 p.
Roskill Information Services Ltd., 2002b, The economics of tantalum (8th ed.): Roskill Information Services Ltd., 188 p.
Roskill's Letter from Japan, 2002a, Tantalum—Sharp fall in consumption of processed products in 2001: Roskill's Letter from Japan, no. 305, January, p. 9-10.
Roskill's Letter from Japan, 2002b, Tantalum—11% growth in Japanese demand forecast for 2002: Roskill's Letter from Japan, no. 309, May, p. 9-10.
Roskill's Letter from Japan, 2002c, Tantalum capacitors—Recovery in exports to China and South Korea: Roskill's Letter from Japan, no. 311, July, p. 18.
Sons of Gwalia Ltd., 2001, Annual report—2001: West Perth, Western Australia, Sons of Gwalia Ltd., 82 p.
Sons of Gwalia Ltd., 2002, Quarterly report for the quarter ended 31 March 2002: West Perth, Western Australia, Sons of Gwalia Ltd., 20 p.
Tantalum-Niobium International Study Center, 1999a, Overview of the tantalum and niobium industries for 1998 and 1999: Tantalum-Niobium International Study Center, no. 100, December, 12 p.
Tantalum-Niobium International Study Center, 1999b, Technical and commercial development of the European niobium market: Tantalum-Niobium International Study Center, no. 98, June, 8 p.
Tantalum-Niobium International Study Center, 2001a, Member company news—Reference Metals/CBMM: Tantalum-Niobium International Study Center, no. 106, June, 8 p.
Tantalum-Niobium International Study Center, 2001b, Niobium and tantalum—Review of industry statistics: Tantalum-Niobium International Study Center, no. 108, December, 12 p.
Tantalum-Niobium International Study Center, 2001c, Tantalum—Raw material supply: Tantalum-Niobium International Study Center, no. 105, March, 8 p.
Tantalum-Niobium International Study Center, 2002, Exploration news—Member company news: Tantalum-Niobium International Study Center, no. 109, March, 8 p.
Tantalum-Niobium International Study Center, [undated], Tantalum raw materials, *in* International symposium on tantalum and niobium: Tantalum-Niobium International Study Center, San Francisco, CA, October 22-25, 2000, Proceedings, 374 p.
U.S. Customs Service, 2001, Procedyres [sic] if the Generalized System of Preferences program expires: Federal Register, v. 66, no. 191, October 2, p. 50248-50249.
U.S. Department of Defense, 2002, Strategic and critical materials report to the Congress—Operations under the Strategic and Critical Materials Stock Piling Act during the period October 2000 through September 2001: Washington, DC, U.S. Department of Defense, 64 p.
U.S. International Trade Commission, 2000, Harmonized tariff schedule of the United States—2001: Washington, DC, U.S. Government Printing Office, U.S. International Trade Commission Publication 3378, variously paginated and unpaginated.
Wah Chang, 2001, Wah Chang adds new EB furnace: Albany, OR, Wah Chang, Outlook first quarter—2001, v. 22, no. 1, 6 p.

Internet References Cited

Australasian Gold Mines NL, 2001a, Annual report—2001, accessed July 22, 2002, at URL http://www.australasiangold.com.au/annual.html.
Australasian Gold Mines NL, 2001b (November 26), Australasian announces significant tantalum discovery at Mt Deans, accessed July 22, 2002, at URL http://www.australasiangold.com.au/announcements.html.
Australasian Gold Mines NL, 2001c (April 17), Australasian finalises [sic] $14.6 million tantalum deal, accessed July 22, 2002, at URL http://www.australasiangold.com.au/announcements.html.
Cabot Corp., 2001 (May 23), Cabot Performance Materials doubles manufacturing capacity for tantalum and niobium metallurgical products, accessed July 22, 2002, at URL http://www.shareholder.com/cabot/news/20010523-42464.cfm.
Cambior Inc., 2002a, Annual report—2001, assessed July 22, 2002, at URL http://www.cambior.com/english/02_investors/rapport_ang01.htm.
Cambior Inc., 2002b (January 31), Significant increase in mineral reserves at Niobec Mine life increased to more than 16 years, accessed July 11, 2002, at URL http://www.cambior.com/communique/2002/anglais/03_2002e.htm.
International Iron and Steel Institute, [undated], Short term outlook for steel demand—Spring 2002, accessed July 1, 2002, at URL http://www.worldsteel.org/article/iisi20020506.
KEMET Corp., 2001 (December 17), KEMET Corporation announces reduction in labor force, accessed July 22, 2002, at URL http://www.kemet.com/kemet/web/homepage/kechome.nsf/vabypagename/new200130.
Showa Cabot Supermetals K.K., 2001 (January 25), Capacitor-grade tantalum powder production capacity expanded, accessed July 16, 2002, at URL http://www.sdk.co.jp/enews/news01/01-01-25.htm.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

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

Other

Aerospace Industries Association.
American Metal Market, daily.
China Metal Market, Precious & Minor Metals Monthly.
Columbium (niobium). Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.
Company reports and news releases.
Defense National Stockpile Center stockpile reports and news releases.
Federal Register, daily.
Interfax International Ltd., Mining & Metals Report, weekly.
Metal Bulletin, semiweekly and monthly.
Metal Bulletin Books Ltd.:
Ferroalloy Directory and Data Book, 5th ed., 1998.
Ores & Alloys for the Global Steel Industry, 2000.
Mining Journal, weekly.
Platts Metals Week, weekly.
Roskill Information Services Ltd. Reports:
The Economics of Niobium, 9th ed., 2002.
The Economics of Tantalum, 8th ed., 2002.
Roskill's Letter from Japan, monthly.
Ryan's Notes, weekly.
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)

	1997	1998	1999	2000	2001
United States:					
Government stockpile releases 2/	126	145	280	217	(3)
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/	220	200	140	300	290
Columbium metal and columbium-bearing alloys e/	423	563	468	607	1,050
Columbium oxide	1,220	860	1,200	1,190	1,360
Ferrocolumbium e/	4,260	4,900	4,450	4,400	4,480
Tin slag	NA	NA	NA	NA	NA
Consumption:					
Raw materials	NA	NA	NA	NA	NA
Ferrocolumbium and nickel columbium e/	3,770	3,640	3,460	4,090	4,230
Apparent e/	4,030	4,150	4,100	4,300	4,400
Prices:					
Columbite, dollars per pound 4/	$3.00	$3.00	$3.00	$6.25	(3/)
Pyrochlore, dollars per pound 5/	NA	NA	NA	NA	NA
World production of columbium-tantalum concentrates e/	20,500 r/	26,200	24,600 r/	24,600 r/	25,600

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

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

2/ Net quantity (uncommitted inventory). Parentheses indicate negative number (increase in inventory).

3/ The published price for columbite ore was discontinued in October 2001 at a range of $5.50 to $7.00 per pound of pentoxide content.

4/ Yearend average value, contained pentoxides for material having a columbium pentoxide to tantalum pentoxide ratio of 10 to 1.

5/ Yearend average value, contained pentoxide.

TABLE 2
SALIENT TANTALUM STATISTICS

(Metric tons of tantalum content unless otherwise specified)

	1997	1998	1999	2000	2001
United States:					
Government stockpile releases 1/	20	213	5	242	(53)
Exports:					
Tantalum ores and concentrates (gross weight) 2/	91	389	299	263	530
Tantalum metal, compounds, alloys (gross weight)	396	423	460	460	486
Tantalum and tantalum alloy powder (gross weight)	58	61	90	108	156
Imports for consumption:					
Mineral concentrates e/	280	380	320	650	690
Tantalum metal and tantalum-bearing alloys 3/	187	208	244	251	316
Tin slag	NA	NA	NA	NA	NA
Consumption:					
Raw materials	NA	NA	NA	NA	NA
Apparent e/	570	738	555	650	550
Prices:					
Tantalite, dollars per pound 4/	$33.00	$34.00	$34.00	$220.00 r/	$37.00
World production of columbium-tantalum concentrates e/	562 r/	791 r/	857 r/	1,220 r/	1,300

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

1/ Net quantity (uncommitted inventory). Parentheses indicate negative number (increase in inventory).

2/ Includes reexports.

3/ Exclusive of waste and scrap.

4/ Yearend average value, contained pentoxides.

TABLE 3
COLUMBIUM AND TANTALUM MATERIALS IN GOVERNMENT
INVENTORIES AS OF DECEMBER 31, 2001 1/

(Metric tons of columbium or tantalum content)

Material	Stockpile goal 2/	Disposal authority	National Defense Stockpile inventory			
			Uncommitted			
			Stockpile-grade	Nonstockpile-grade	Total	Committed
Columbium:						
Concentrates	--	594	351	244	594	--
Carbide powder	--	--	--	--	--	--
Ferrocolumbium	--	--	--	--	--	--
Metal ingots	--	46	46	--	46	--
Total	--	640	396	244	640	--
Tantalum:						
Minerals	--	866	541	325	866	--
Carbide powder	--	6	6	--	6	--
Metal:						
Capacitor grade	--	2	18	(3/)	18	16
Ingots	--	9	64	--	64	6
Oxide	--	25	25	--	25	5
Total	--	908	654	325	979	27

-- Zero.
1/ Data may not add to totals shown because of independent rounding.
2/ Goal effective as of December 28, 2001.
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	2000	2001
Steel:		
Carbon	1,370	1,300
Stainless and heat-resisting	682	660
Full alloy	(2/)	(2/)
High-strength low-alloy	1,090	1,030
Electric	(2/)	(2/)
Tool	(2/)	(2/)
Unspecified	--	--
Total	3,140	2,990
Superalloys	942	1,230
Alloys (excluding alloy steels and superalloys)	(3/)	(3/)
Miscellaneous and unspecified	10	11
Grand total	4,090	4,230
Stocks, December 31:		
Consumer	NA	NA
Producer 4/	NA	NA
Total	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 "Miscellaneous and unspecified."
4/ Ferrocolumbium only.

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

Class	2000 Gross weight (metric tons)	2000 Value (thousand dollars)	2001 Gross weight (metric tons)	2001 Value (thousand dollars)	Principal destinations and sources, 2001 (gross weight, metric tons, thousand dollars)
Exports: 2/					
Columbium:					
Ores and concentrates	55	830	15	246	Germany 6, $176; Netherlands 2, $24; United Kingdom 4, $21; Italy 2, $15; Japan 1, $4; Venezuela (3/), $3.
Ferrocolumbium	60	526	109	1,260	United Kingdom 27, $527; Canada 36, $308; Italy 21, $192; Mexico 13, $116; Netherlands 10, $90; Australia 2, $25.
Tantalum:					
Synthetic concentrates	91	174	42	84	Czech Republic 2, $21; Mexico 33, $19; United Kingdom 2, $14; Peru 4, $11; Germany 1, $8; Singapore (3/), $3; France (3/), $3; Spain (3/), $3.
Ores and concentrates	263	11,400	530	22,900	China 157, $7,510; Netherlands 100, $6,950; Japan 146, $4,290; Kazakhstan 29, $3,290; Brazil 95, $840; Germany 1, $22; United Kingdom 1, $20.
Unwrought and waste and scrap	198	16,000	213	17,900	Germany 64, $8,400; Netherlands 96, $3,290; United Kingdom 26, $2,550; Australia 14, $1,540; Austria 2, $779; Sweden 2, $773; Japan 6, $405.
Unwrought powders	108	43,100	156	75,600	Israel 106, $50,400; United Kingdom 7, $7,860; Germany 16, $7,830; Sweden 12, $4,080; Austria 5, $2,060; Japan 4, $1,690.
Unwrought alloys and metal	123	40,100	59	33,300	United Kingdom 20, $20,400; Germany 8, $5,000; Israel 12, $3,900; China 11, $2,120; France 6, $1,040; Barbados 1, $317.
Wrought	139	47,500	214	89,400	Germany 31, $24,400; Japan 26, $20,600; Mexico 73, $14,100; United Kingdom 10, $9,780; France 10, $8,400; Israel 8, $3,590.
Total	XX	160,000	XX	241,000	Israel $57,900; Germany $45,800; United Kingdom $41,200; Japan $27,000; Mexico $14,200; Netherlands $11,700; China $10,600; France $9,600.
Imports for consumption:					
Columbium:					
Ores and concentrates	151	1,680	126	1,740	China 112, $1,600; Brazil 8, $75; Japan 6, $65.
Oxide	1,700	29,200	1,940	30,000	Brazil 919, $13,600; Russia 324, $4,530; Germany 108, $4,230; Estonia 308, $4,080; China 283, $3,550; United Kingdom (3/), $3.
Ferrocolumbium	6,770	62,100	6,890	61,500	Brazil 5,870, $51,900; Canada 799, $7,630; France 145, $1,170; Germany 76, $769.
Unwrought alloys, metal and powder	606	16,900	1,050	26,700	Brazil 577, $12,500; Estonia 188, $7,160; Germany 140, $2,520; Kazakhstan 58, $2,170; Japan 2, $867; China 58, $851.
Synthetic concentrates	--	--	2	4	All from China.
Tantalum:					
Ores and concentrates	2,080	74,800	2,240	95,700	Australia 1,630, $61,500; Nigeria 83, $11,900; Canada 332, $9,460; Brazil 88, $3,940; Rwanda 36, $3,100; Ethiopia 20, $1,910; South Africa 4, $1,350.
Unwrought waste and scrap	853	31,400	964	34,500	Germany 251, $11,000; United Kingdom 229, $8,100; Austria 120, $5,340; Japan 154, $3,470; China 69, $2,450; Portugal 28, $795; Taiwan 6, $678.
Unwrought powders	177	66,900	138	81,300	Japan 51, $39,700; China 38, $21,400; Thailand 37, $15,900; Germany 11, $3,950; United Kingdom 1, $210; Luxembourg (3/), $104.
Unwrought alloys and metal	31	5,610	117	19,900	Kazakhstan 99, $12,800; Germany 7, $3,190; Japan 5, $1,910; Aaustria 2, $903; United Kingdom 2, $538; China 2, $469; Switzerland (3/), $137.
Wrought	43	14,900	62	40,100	China 25, $15,400; Japan 16, $12,800; Kazakhstan 6, $4,940; Germany 10, $4,380; Austria 2, $1,360; Canada 2, $476; United Kingdom (3/), $380.
Total	XX	303,000	XX	391,000	Brazil $82,000; Australia $61,500; Japan $59,000; China $45,800; Germany $30,000; Kazakhstan $19,900; Canada $17,700; Thailand $16,300.

XX Not applicable. -- Zero.
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.

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	2000		2001	
	Gross weight (metric tons)	Value (thousand dollars)	Gross weight (metric tons)	Value (thousand dollars)
Belgium 2/	9	155	--	--
Brazil	17	154	8	75
China	117	1,320	112	1,600
Germany 2/	1	3	--	--
Japan 2/	--	--	6	65
Nigeria	7	47	--	--
Total	151	1,680	126	1,740

-- 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.

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	2000		2001	
	Gross weight (metric tons)	Value (thousand dollars)	Gross weight (metric tons)	Value (thousand dollars)
Australia	1,280	41,600	1,630	61,500
Belgium 2/	4	62	--	--
Bolivia	1	45	2	318
Brazil	--	--	88	3,940
Canada	178	6,940	332	9,460
China	48	828	4	40
Congo (Kinshasa) 3/	167	4,720	4	503
Ethiopia	21	2,020	20	1,910
Japan 2/	--	--	1	131
Netherlands 2/	--	--	10	620
Nigeria	287	15,800	83	11,900
Russia	1	86	(4/)	5
Rwanda	68	2,180	36	3,100
South Africa	1	23	4	1,350
Tanzania	15	377	--	--
Uganda	5	140	--	--
United Kingdom 2/	--	--	24	963
Total	2,080	74,800	2,240	95,700

-- 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/ Formerly Zaire.
4/ Less than 1/2 unit.

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	Mazarin 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)	Columbium-tantalum.
Brazil	Cia. Industrial Fluminense 1/	Columbium-tantalum.
	Mamoré Mineracao e Metalurgia 3/	Columbium-tantalum.
Thailand	Thailand Smelting and Refining Co. Ltd. (Thaisarco)	Columbium-tantalum.
Production capacity for columbium- and tantalum-bearing synthetic concentrates: Germany: Western States	H.C. Starck GmbH & Co. KG	Columbium-tantalum.

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	Company	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, 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.
	Wah Chang 6/	Nb metal, FeNb.

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 Technologies 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/	1997	1998	1999	2000	2001	1997	1998	1999	2000	2001	1997	1998	1999	2000	2001
Australia, columbite-tantalite	1,010	1,150	1,230	1,600	2,220	125	140	140	160	230	302	330	350	485	660
Brazil:															
Pyrochlore	42,900	56,200	52,100 r/	51,900 r/	52,400	18,000	23,600	21,900 r/	21,800 r/	22,000	--	--	--	--	--
Tantalite	445 r/	1,100 r/	1,400 r/	1,210 r/	1,210	NA r/	NA r/	NA r/	NA r/	NA	125 r/	310 r/	320 r/	340 r/	340
Burundi	46	30 6/	42 6/	20 r/ 6/	30	NA	NA	NA	NA	NA	11	7	10	5 r/	7
Canada:															
Pyrochlore	5,090	5,110	5,240	5,070	7,070	2,290	2,300	2,360	2,280	3,180	--	--	--	--	--
Tantalite	196	228	208	228	308	10	11	10	11	15	49	57	54	57	77
Congo (Kinshasa), columbite-tantalite	NA	NA	NA	450	200	NA	NA	NA	110 r/	50	NA	NA	NA	130	60
Ethiopia, tantalite	20	40	50 6/	65 6/	80	2	4	5	7	8	12	24	29	38	47
Nigeria, columbite	60	70	70	80	70	23	30	30	35	30	3	3	3	4	3
Rwanda	224 6/	224 6/	330 r/ 6/	603 r/ 6/	350	76	76	110 r/	200 r/	120	60	60	90 r/	160 r/	95
Zimbabwe	NA	NA	NA	NA	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	9
Total	50,000 r/	64,200 r/	60,400 r/	61,200 r/	64,000	20,500 r/	26,200	24,600 r/	24,600 r/	25,600	562 r/	791 r/	857 r/	1,220 r/	1,300

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: 1997--40 and 1998-2001--NA according to data from the Tantalum-Niobium International Study Center. Table includes data available through July 9, 2002.

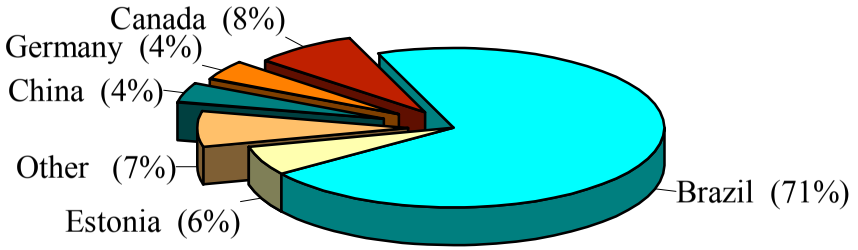
3/ Data on gross weight generally have been presented as reported in official sources of the respective countries, divided into concentrates of columbite, tantalite, and pyrochlore where information is available to do so, and reported in groups, such as columbite and tantalite, where it is not.

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

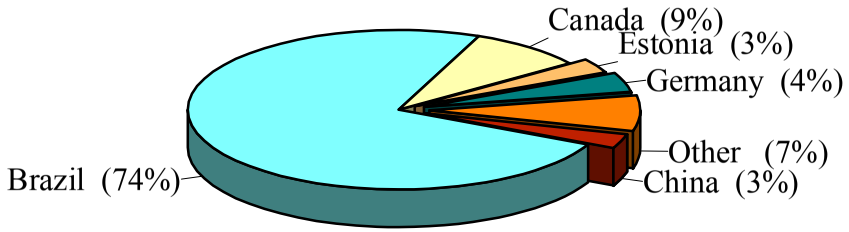
5/ In addition to the countries listed, Bolivia, China, Côte d'Ivoire, French Guiana, Namibia, Russia, and Zambia also produce, or are believed to produce, columbium and tantalum mineral concentrates, but available information is inadequate to make reliable estimates of output levels.

6/ Reported figure.

FIGURE 1
MAJOR SOURCES OF U.S. COLUMBIUM IMPORTS
(Columbium content)

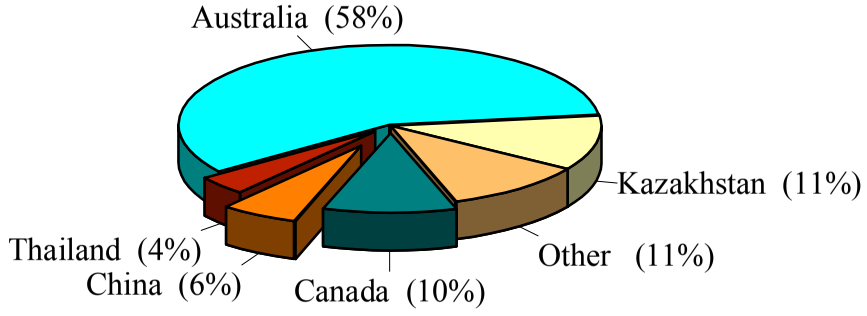


2001

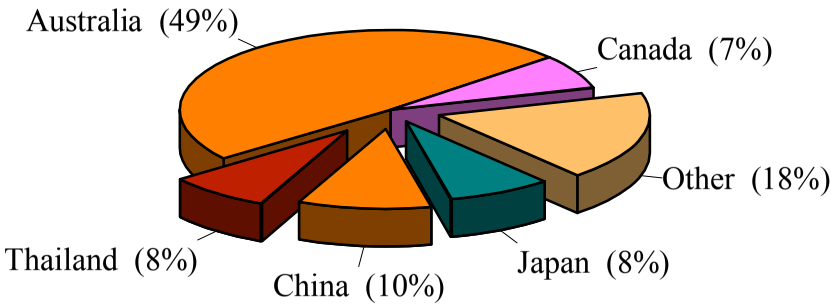


1998 - 2001

FIGURE 2
MAJOR SOURCES OF U.S. TANTALUM IMPORTS
(Tantalum content)



2001



1998 - 2001