COLUMBIUM (NIOBIUM) AND TANTALUM

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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 aircrafts, 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 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 the total estimated columbium mine production in 2002. 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 mining 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 accounted for more than 60% of total estimated tantalum mine production in 2002, 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). Columbium price quotations remained stable. Overall reported consumption of columbium in the form of ferrocolumbium and nickel columbium decreased, with demand for columbium in superalloys down 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 as of December 28, 2001. For fiscal year (FY) 2002 (October 1, 2001, through September 30, 2002), the DNSC sold about 10 metric tons (t) of columbium contained in columbium carbide powder valued at about $86,000 (which exhausted the DNSC's columbium carbide powder inventory) and about 9 t of columbium contained in columbium metal ingots, valued at about $301,000, from the NDS. The DNSC's ferrocolumbium inventory was exhausted in FY 2001. The DNSC also sold about 18 t of tantalum contained in tantalum metal ingots valued at about $3.53 million. There were no sales of tantalum carbide powder, tantalum metal powder, tantalum minerals, and tantalum oxide in FY 2002. As of September 30, 2002, tantalum inventory sold but not shipped from the NDS included about 16 t of tantalum contained in tantalum capacitor-grade metal, about 6 t of tantalum contained in tantalum metal ingots, and about 7 t of tantalum contained in tantalum oxide (U.S. Department of Defense, 2003, p. 12, 14, 49, 52, 55).

In its Annual Materials Plan (AMP) for FY 2003 (October 1, 2002, through September 30, 2003) and proposed AMP for FY 2004 (October 1, 2003, through September 30, 2004), the DNSC had authority to sell about 10 t of columbium contained in columbium carbide powder (FY 2003) (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 18 t of tantalum contained in tantalum metal ingots, about 227 t of tantalum contained in tantalum minerals, about 9 t of tantalum contained in tantalum oxide, and about 23 t in FY 2003 and about 18 t in FY 2004 of tantalum contained in tantalum metal powder (actual quantity limited to the remaining sales authority or inventory) (Bureau of Industry and Security, 2002; U.S. Department of Defense, 2003, p. 9-10). For FY 2003, through August 31, 2003, the DNSC sold about 1 t of tantalum contained in tantalum capacitor-grade metal powder valued at about $107,000, about 17 t of tantalum contained in tantalum vacuum-grade metal ingots valued at about $2.05 million, and about 199 t of tantalum contained in tantalum minerals valued at about $10.1 million.

Production

Neither columbium nor tantalum was mined domestically in 2002. Domestic production data for ferrocolumbium are developed by the U.S. Geological Survey (USGS) from the annual voluntary domestic survey for ferroalloys. Ferrocolumbium production data for 2002, however, were 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 February, Cabot Corp., Boston, MA, purchased the remaining shares in Showa Cabot Supermetals KK (SCSM), Higashi-Nagahara, Japan, from its joint-venture partner Showa Denko KK. The purchase price was $89 million in cash, along with the assumption of $54 million of long-term debt and bank notes, as well as certain other assets and liabilities. SCSM was a supplier of tantalum metal and powder products to the global aerospace, chemical processing, and electronics industries (Cabot Corp., 2002, p. 1, 3, 45; 2002a§[1], d§).

Cabot announced in February 2003 that the company was changing the name of its Cabot Performance Materials division to Cabot Supermetals. Cabot Supermetals operates tantalum-manufacturing facilities in Boyertown and in Higashi-Nagahara, Japan. "This name change will allow us to promote our products with one consistent name to our customers and help strengthen our recognition as the leader for quality tantalum powders and other metal products for numerous applications in the technology market" (Cabot Corp., 2003§).

In June, Cabot and Vishay Intertechnology Inc., Malvern, PA (a tantalum capacitor manufacturer) announced that they had achieved an amicable resolution of the pending legal dispute relating to their long-term tantalum supply contracts. The parties agreed to amend the contracts; the minimum total value of the contracts was approximately $425 million, with one contract extended through to 2006 (Cabot Corp., 2002b§).

In April, Cabot filed a suit alleging that KEMET Corp., Greenville, SC, (a major tantalum capacitor manufacturer) had failed to take delivery of certain tantalum products relating to a tantalum supply agreement entered into in December 2000 between Cabot and a KEMET subsidiary. The agreement required the subsidiary to purchase and Cabot to sell certain specified amounts of tantalum powder and wire in 2001 through 2003 and tantalum ore in 2001 and 2002. In September, a Massachusetts Superior Court dismissed Cabot's claims concerning KEMET's alleged obligations to identify particular products for purchase, dismissed KEMET's counterclaim alleging unfair and deceptive practices by Cabot during negotiation of the supply agreement, and ruled that the parties should attempt to agree on product mix, volumes, and delivery periods for tantalum products for 2003 (Cabot Corp., 2002e§; KEMET Corp., 2002a§, d§).

In December, Cabot and KEMET announced that the companies had agreed to extend the term of their tantalum supply agreement. The extended agreement calls for reduced prices and higher volumes through 2006 for tantalum powder and tantalum wire products. The minimum total commitment of the contract is approximately $121 million, with KEMET receiving approximately $32.5 million of material in 2002. Cabot has the option to sell additional product to KEMET on certain conditions throughout the term of the contract. In connection with the tantalum supply extension, Cabot and KEMET settled all claims in the litigation regarding the original supply agreement (Cabot Corp., 2002c§; KEMET Corp., 2002b§).

In July, KEMET announced plans to close a manufacturing facility in Greenwood, SC, and to close one of two facilities in Matamoros, Mexico, with resulting annualized cost reduction of approximately $10 million. The closures include a reduction of manufacturing and support personnel of approximately 185 employees in the United States and approximately 240 employees in Mexico. The actions are part of KEMET's cost saving initiatives to respond to the prolonged downturn in the electronics industry (KEMET Corp., 2002c§).

Consumption

Overall U.S. reported consumption of columbium as ferrocolumbium and nickel columbium decreased by about 26% compared with that of 2001 (table 4). Consumption of columbium by the steelmaking industry decreased by about 16%, with consumption down in all major reported steel end-use categories except high-strength low-alloy steel, which was up by about 6%. A major columbium-consuming operation was idle for a large portion of the year. Demand for columbium in superalloys decreased to about 813 t from about 1,440 t owing in part to slumping conditions in the aerospace industry and declining superalloy consumption in land-based gas turbine power generating systems. That portion used in the form of nickel columbium decreased to about 365 t from about 730 t. Overall U.S. apparent consumption of all columbium materials was estimated to be about 4,100 t compared with about 4,400 t in 2001.

In 2002, estimated overall U.S. apparent consumption of all tantalum materials decreased to about 500 t from about 550 t, owing to excess tantalum inventories and the depressed state of the electronics industry. Tantalum was consumed mostly in the form of alloys, compounds, fabricated forms, ingot, and metal powder. More than 60% of total tantalum consumed was in the electronics industry, mainly in the form of tantalum capacitors. Major end uses for tantalum capacitors included automotive electronics, pagers, personal computers, and portable telephones.

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

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 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.

Columbium was recycled mostly from products of columbium-bearing steels and superalloys; little was recovered from products specifically for their columbium content (Cunningham, 2003a).

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.

Tantalum was recycled mostly from new scrap that was generated during the manufacture of tantalum-related electronic components and new and old scrap products of tantalum-containing cemented carbides and superalloys (Cunningham, 2003b).

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 yearend 2002 American Metal Market published price for regular-grade ferrocolumbium was at a range of $6.50 to $6.70 per pound of contained columbium compared with a range of $6.75 to $7 per pound at yearend 2001.

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 2001 at a range of $5.50 to $7 per pound. The American Metal Market published price for high-purity (vacuum-grade) ferrocolumbium was discontinued in February-March at a range of $17.50 to $18 per pound of contained columbium. The most recent industry sources (August 1999 and December 1999) indicated that nickel columbium was sold at about $18.50 per pound of contained columbium, columbium metal products were sold in the range of about $24 to $100 per pound in ingot and special shape forms, and columbium oxide for master alloy production was 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. Yearend 2002 published prices for tantalite ore (per pound of contained oxide) were as follows: Platts Metals Week, a range of $40 to $50, unchanged since October 2001; Metal Bulletin, a range of $20 to $30 compared with a range of $25 to $35 at yearend 2001; and Ryan's Notes, a range of $20 to $25 compared with a range of $32 to $39 at yearend 2001. 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, over 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 but was at the lowest level in the past two decades. For exports, overall trade value and total volume decreased. In descending order, Israel, the United Kingdom, Mexico, Germany, and Japan were the major recipients of the columbium and tantalum materials, on the basis of value, with more than 90% of the total. For imports, overall trade value was down by about 40%, with total volume down by about 20%. In descending order, Australia, Brazil, Japan, Canada, Kazakhstan, and China were the major sources of columbium and tantalum imports, on the basis of value, with about 80% of the total.

Imports for consumption of columbium ores and concentrates decreased significantly (table 6). Imports at an average grade of approximately 29% Nb_2O_5 and 30% Ta_2O_5 were estimated to contain about 4 t of columbium and about 6 t of tantalum. Columbium oxide imports decreased significantly, with Brazil, China, and Estonia accounting for more than 75% of the total. Ferrocolumbium imports were down, with Brazil and Canada accounting for most of the total.

Imports for consumption of tantalum ores and concentrates increased (table 7); imports from Australia accounted for about 80% of quantity and about 86% of value. Imports at an average grade of approximately 36% Ta_2O_5 and 17% Nb_2O_5 were estimated to contain about 704 t of tantalum and about 286 t of columbium.

The schedule of tariffs applied during 2002 to U.S. imports of selected columbium and tantalum materials is found in the Harmonized Tariff Schedule of the United States (U.S. International Trade Commission, 2001). Brazil, which was the major source for U.S. columbium imports, accounted for about 67% of total, in units of contained columbium, and Australia, which was the major source for U.S. tantalum imports, accounted for about 65% of total, in units of contained tantalum (figures 1, 2).

Net import reliance as a percentage of apparent consumption is used to measure the adequacy of current domestic columbium and tantalum production to meet U.S. demand. For columbium in 2002, net import reliance as a percentage of apparent consumption was 100%. For tantalum, net import reliance as a percentage 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, Brazil, and Zimbabwe were the major producers of tantalum mineral concentrates. Tantalum-containing low-grade tin slags continued to decline as a source of tantalum supply. Tin slags currently provide less than 15% of total tantalum feed/raw material supply (Sons of Gwalia Ltd., 2002, p. 29).

Australia.—For its 2002 financial year ending June 30, 2002, Sons of Gwalia Ltd., West Perth, Western Australia, reported that tantalum production (Ta_2O_5 contained in mineral concentrates) totaled a record of about 970 t at its Greenbushes and Wodgina Mines. Production at Greenbushes approximately 300 kilometers (km) south of Perth and 80 km east of the Port of Bunbury was a record 530 t, up by about 24% from that of 2001. Greenbushes' increased production was achieved through mining higher grade ore, productivity improvements in the processing plant, and increased production capacity following successful early completion of the tantalum plant expansion. Production at Wodgina approximately 100 km south of Port Hedland in the Pilbara region of Western Australia increased by more than 40% to about 440 t. Wodgina's increased production was attributed to productivity improvements in the tantalum processing plant and increased production capacity following successful early completion of the tantalum plant expansion. For 2003, the Greenbushes and Wodgina operations were expected to produce at levels similar to their respective 2002 levels. In July 2000, Gwalia had announced a $65 million expansion at the Greenbushes operation to increase tantalum production capacity to more than 590 metric tons per year (t/yr) by increasing the plant's ore treatment capacity and the development of an underground mine. At Wodgina, a $35 million expansion to increase tantalum production capacity to more than 450 t/yr by increasing the plant's ore treatment capacity was planned. The expansion programs were completed ahead of schedule and below budget cost early in calendar year 2002 (Sons of Gwalia Ltd., 2002, p. 1, 5, 29-31).

As of June 30, Sons of Gwalia reported that Greenbushes tantalum mineral resource base was about 48,900 t of contained Ta_2O_5, including about 19,900 t of contained Ta_2O_5 classified as being tantalum reserves, and that Wodgina's tantalum mineral resource base was about 26,800 t of contained Ta_2O_5, including about 23,200 t of contained Ta_2O_5 classified as being tantalum ore reserves (Sons of Gwalia Ltd., 2002, p. 35).

Tantalum Australia NL (formerly Australasian Gold Mines NL), Perth, Western Australia, produced about 45 t of Ta_2O_5 contained in tantalum mineral concentrates at its Dalgaranga tantalum operation in Western Australia. The company also secured its first tantalum concentrate sales contract valued at $600,000 with a Japanese customer. In May, Tantalum Australia signed an agreement with Boston University for development of a patented process that uses solid oxygen-ion-conducting membranes (SOMs) to produce tantalum metal. Under the terms of the agreement, Tantalum Australia would acquire exclusive rights to apply the SOM process in the fields of columbium, gallium, germanium, tantalum, tungsten, and yttrium. The SOM process, developed by Boston University's Manufacturing Engineering School, converts metal oxides directly to the pure metal form. A license has been issued for its use in producing magnesium metal. The research and development program will evolve through three stages with anticipated establishment of a pilot plant facility in Western Australia within 3 years: The first stage (1 year duration at a cost of $180,000) would confirm proof of concept that both tantalum oxide and tantalum mineral concentrates can be converted successfully to tantalum metal at laboratory scale; the second stage (1 year duration at a cost of $500,000) would entail scaling up the successful stage one laboratory process; and stage three would include the construction of a semicommercial pilot plant for the production of tantalum metal. In work completed, tantalum yields approaching 100% had been achieved. At yearend, Boston University had successfully conducted laboratory scale tests of the process to produce tantalum metal from tantalum oxide (Australasian Gold Mines NL, 2002; Tantalum Australia NL, 2002a, b).

Brazil.—Cia. Brasileira de Metalurgia e Mineração (CBMM), which was the world's largest columbium producer, discontinued operation of its chemical leaching plant in July. The chemical plant had been in operation since 1976 and was used to purify pyrochlore (columbium) concentrate by reducing its lead and phosphorous content. The plant was replaced by a new pyrometallurgical plant, which started partial operation in April 2000. The pyrometallurgical process consists of filtering, pelletizing, and sintering the concentrate in a "sinter belt furnace," which eliminates moisture and the sulphur content. The sintered concentrate is mixed with carbon and steel chips and charged in a 10.5 megavoltampere electric arc furnace for smelting. The refined concentrate is poured and granulated with water. The granulated concentrate is dried and becomes the feed material for ferrocolumbium and other columbium products. The new pyrometallurgical process is said to remove approximately 95% of the phosphorous and lead and 99% of the sulfur content from the concentrate at a lower cost compared with the chemical process, which allowed CBMM to reduce its price for ferrocolumbium during 2002. Since July 2002, the process has supplied all of CBMM's requirements for refined concentrate to manufacture columbium products (Carneiro and others, undated).

In 2002, Paranapanema Group (Brazil's largest tin producer) reportedly produced 1,200 t of columbium oxide and 90 t of tantalum oxide compared with 500 t of columbium oxide and 50 t of tantalum oxide produced in 2001. The increase in production resulted from the startup of a new crushing and grinding plant at the company's Pitinga tin mine operation in western Amazonas State. Columbium and tantalum containing concentrates produced at Pitinga are then processed into columbium oxide and tantalum oxide at a plant in east-central Minas Gerais State (Platts Metals Week, 2003).

Canada.—Production of columbium at the Niobec Mine at St. Honore, 15 km northwest of Chicoutimi, Quebec, was about 3,400 t compared with about 2,910 t in 2001. Niobec was a 50-50 joint venture between Cambior Inc. (product marketing), and Mazarin Inc. (operator). Niobec produces a pyrochlore concentrate (60% Nb_2O_5) that is processed into ferrocolumbium grading 66% Nb using an aluminothermic converter. The milling capacity for ore from the mine is 3,400 metric tons per day. In 2002, Cambior's share of capital expenditures totaled $1.2 million, mainly for underground mobile equipment and deferred development. Cambior's share of capital expenditures in 2003 was estimated to be $1.9 million, mainly for underground infrastructure development and the construction of a new tailings pond. At yearend, mineral reserves at the mine totaled an estimated 23.8 million metric tons (Mt) at an average grade of 0.65% Nb_2O_5 compared with an estimated 11.9 Mt at an average grade of 0.73% Nb_2O_5 at yearend 2000. Mineral reserves were sufficient for at least 18 years of mine life at the current mining rate (Cambior Inc., 2003, p. 14-15; Mazarin Inc., 2003, p. 6).

In 2002, about 71 t of Ta_2O_5 contained in concentrate was produced at the Bernic Lake, Manitoba, tantalum operation, compared with about 94 t in 2001.

Egypt.—The Abu Dabbab tantalite deposit was reported to have measured resources estimated to be 12 Mt of ore grading 274 grams per ton (g/t) Ta_2O_5, indicated resources estimated to be 2.1 Mt of ore grading 260 g/t Ta_2O_5, and inferred resources estimated to 26 Mt of ore grading 240 g/t Ta_2O_5. Abu Dabbab is a 50-50 joint venture between Gippsland Ltd. of Australia and the Egyptian Geological and Mining Authority. The deposit is 770 km south of Cairo, 75 km from the Port of Quseir, and 25 km from an international airport. Water is said to be freely available, and no environmental or archaeological difficulties exist. A feasibility study indicated that the majority of Ta_2O_5 could be recovered by enhanced gravity separation techniques, with the remaining Ta_2O_5 recovered using a tin smelting process yielding tin metal and a glass (tin slag) containing Ta_2O_5 (Mining Journal, 2002a, b).

Estonia.—Treibacher Industrie AG, Austria, reportedly acquired a 25% interest in Silmet for $6.9 million with an option to acquire more than 50% of the company in the future. Treibacher was a producer of columbium and tantalum oxides, carbides, and ferroalloys. Silmet, a processor of ores containing columbium and tantalum, produced metal oxides and columbium metal at a plant in eastern Estonia. Silmet sourced its columbium and tantalum ores from Africa, Brazil, and Russia (Ryan's Notes, 2002a).

Japan.—In 2002, Japan's demand for tantalum was 371 t (powder, 181 t; compounds, 81 t; and products, 109 t) compared with 296 t in 2001. Demand for tantalum powder rose by more than 50% owing to increased demand for higher grade powders and powder used in miniature capacitors as well as to the completion of inventory reductions by Japanese capacitor producers. In 2003, tantalum demand is forecast to be about 372 t; powder, 180 t; compounds, 91 t; and products, 101 t. Japanese tantalum powder production capacity was estimated to be 720 t/yr. Tantalum imports (compounds, powder, and products) in 2002 were 105 t compared with 96 t in 2001. Tantalum imports in 2003 were expected to be 92 t. Japan imported 778 t of potassium fluotantalate (K-salt) in 2002 compared with 956 t in 2001; China, Germany, and the United States supplied most of the imports. Production of tantalum capacitors was about 4,720 million units compared with about 4,860 million units in 2001. Tantalum capacitor exports were about 2,120 million units compared with about 1,760 million units in 2001. World tantalum capacitor production was estimated to be as high as 18,000 million units (Roskill's Letter from Japan, 2003b).

In 2002, Japanese consumption of ferrocolumbium was 6,830 t compared with 5,870 t in 2001 and 5,170 t in 2000. The increase in consumption resulted from a rise in Japanese production of special steels, which reflected strong demand from the automotive industry. Japan, a nonproducer, imports all its requirements for ferrocolumbium. Japanese imports for ferrocolumbium totaled about 6,810 t in 2002 compared with 6,280 t in 2001 (Roskill's Letter from Japan, 2003a).

Rwanda.—The Metal Processing Association (MPA) reportedly plans to produce 15 metric tons per month of Ta_2O_5 contained in tin slags and upgraded ores. The tantalum production results from MPA's startup of a tin smelter at its tin mine operation in Gisenyi. The smelter is expected to have tin metal production capacity of 200 t/yr (Ryan's Notes, 2002b).

Saudi Arabia.—Tertiary Minerals plc, United Kingdom, announced positive results from the economic and technical scoping study for development of its Ghurayyah columbium and tantalum deposit. The deposit is in the Midyan region of northwestern Saudi Arabia, 85 km southwest of Tabuk and 55 km from the Red Sea. The study, conducted by London, United Kingdom-based St. Barbara Consulting, envisions a base case scenario of mine production of 1.52 million metric tons per year of ore during an initial 20-year mine life, producing a columbium-tantalum concentrate containing about 2,860 t of Nb_2O_5 and about 272 t of Ta_2O_5. The first years of operation would be devoted to producing a marketable concentrate for sale to existing concentrate processors, with later downstream production of ferrocolumbium and columbium and tantalum oxides and salts a possibility. The study anticipates a 3-year payback on estimated capital costs of $101 million. The Ghurayyah deposit was estimated to have an inferred resource of 385 Mt of ore grading 2,840 g/t Nb_2O_5 and 245 g/t Ta_2O_5 (Tertiary Minerals plc, 2002, p. 3-6; 2003§).

Thailand.—Thailand's H.C. Starck (Thailand) Co. Ltd. planned to spend $69.9 million to expand its tantalum metal powder production capacity by 30% to about 2,700 t/yr. The 3-year expansion program would take place at Starck's existing tantalum operation at the Mab Ta Phut industrial estate. The additional output would be exported to Europe and Japan (Platts Metals Week, 2002).

Outlook

Columbium.—The principal use for columbium will continue to be as an additive in steelmaking, mostly in the manufacture of microalloyed steels used for automobiles, bridges, pipelines, and so forth. However, less than 10% of steel produced in the world has been estimated to benefit from the advantages of columbium addition (Roskill Information Services, 2002a, p. 3). 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. (Additional information about the future of the steel industry can be found in the USGS Minerals Yearbook chapter on iron and steel.) In 2002, global crude steel production increased by more than 6% compared with that of 2001; production in China increased by 20.3% (more than 50% of the total global increase); South America, 9.1%; Japan, 4.7%; other Asia, 4.6%; North America, 3.4%, and Europe, 1.4% (International Iron and Steel Institute, 2003§).

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. Nickel-base superalloys (such as alloy 718, which contains about 5% columbium) can account for about 40% to 50% of engine weight, and 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, p. 6). The Aerospace Industries Association Update (2003, p. 1, 4) projected that U.S. aerospace industry sales will decline to $138 billion in 2003 from sales of $148 billion in 2002 owing to continued commercial transport production declines.

Tantalum.—U.S. apparent consumption of tantalum totaled about 500 t in 2002 compared with about 550 t in 2001. 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, 2001, p. 5-7; Roskill Information Services Ltd., 2002b, p. 1-4, 124-176).

In 2002, world tantalum supply was estimated to be about 2.5 Mt of contained tantalum. For 2003, world tantalum supply was projected to be about 2.7 Mt of contained tantalum. 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 September 30, 2003, tantalum materials authorized for disposal from the NDS totaled about 750 t of contained tantalum, including about 670 t contained in tantalum minerals.

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TABLE 1

SALIENT COLUMBIUM STATISTICS[1]

		1998	1999	2000	2001	2002
United States:						
Government stockpile releases, columbium content[2]	metric tons	145	280	217	(4) r	9
Production of ferrocolumbium, columbium content	do.	NA	NA	NA	NA	NA
Exports, columbium metal, compounds, alloys, gross weight	do.	NA	NA	NA	NA	NA
Imports for consumption:						
Mineral concentrates, columbium content[e]	do.	200	140	300	290	290
Columbium metal and columbium-bearing alloys, columbium content[e]	do.	563	468	607	1,050	673
Columbium oxide, columbium content	do.	860	1,200	1,190	1,360	660
Ferrocolumbium, columbium content[e]	do.	4,900	4,450	4,400	4,480	4,030
Tin slag, columbium content	do.	NA	NA	NA	NA	NA
Consumption:						
Raw materials, columbium content	do.	NA	NA	NA	NA	NA
Ferrocolumbium and nickel columbium, columbium content[e]	do.	3,640	3,460	4,090	4,230	3,150
Apparent, columbium content[e]	do.	4,150	4,100	4,300	4,400	4,100
Prices:						
Columbite[3, 4]	dollars per pound	3.00	3.00	6.25	NA	NA
Ferrocolumbium[5]	do.	6.88	6.88	6.88	6.88	6.60
Pyrochlore[6]	do.	NA	NA	NA	NA	NA
World production of columbium-tantalum concentrates, columbium content[e]	metric tons	26,200	24,500 r	24,600	29,700 r	29,900

[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). Parentheses indicate negative number (increase in inventory).

[3]Yearend average value, contained pentoxides for material having a columbium pentoxide to tantalum pentoxide ratio of 10 to 1.

[4]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.

[5]Yearend average value of contained columbium, standard (steelmaking) grade.

[6]Yearend average value of contained pentoxide.

TABLE 2
SALIENT TANTALUM STATISTICS

		1998	1999	2000	2001	2002
United States:						
Government stockpile releases, tantalum content[1]	metric tons	213	5	242	(53)	16
Exports:						
Tantalum ores and concentrates, gross weight[2]	do.	389	299	263	530	232
Tantalum metal, compounds, alloys, gross weight	do.	423	460	460	486	265
Tantalum and tantalum alloy powder, gross weight	do.	61	90	108	156	188
Imports for consumption:						
Mineral concentrates, tantalum content[e]	do.	380	320	650	690	710
Tantalum metal and tantalum-bearing alloys, tantalum content[3]	do.	208	244	251	316	266
Tin slag, tantalum content	do.	NA	NA	NA	NA	NA
Consumption:						
Raw materials, tantalum content	do.	NA	NA	NA	NA	NA
Apparent, tantalum content[e]	do.	738	555	650	550	500
Prices, tantalite[4]	dollars per pound	34	34	220	37	31
World production of columbium-tantalum concentrates, tantalum content[e]	metric tons	779 r	645 r	1,040 r	1,170 r	1,540

[e]Estimated. [r]Revised. NA Not available.
[1]Net quantity (uncommited 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 NATIONAL DEFENSE STOCKPILE
INVENTORIES AS OF DECEMBER 31, 2002 [1]

(Metric tons of columbium or tantalum content)

Material	Stockpile goal[2]	Disposal authority	Uncommitted: Stockpile-grade	Uncommitted: Nonstockpile-grade	Uncommitted: Total	Committed
Columbium:						
Concentrates	--	594	351	244	594	--
Carbide powder	--	--	--	--	--	--
Ferrocolumbium	--	--	--	--	--	--
Metal ingots	--	37	37	--	37	--
Total	--	631	387	244	631	--
Tantalum:						
Minerals	--	866	541	325	866	--
Carbide powder	--	6	6	--	6	--
Metal:						
Capacitor grade	--	18	18	(3)	18	16
Ingots	--	46	46	--	46	6
Oxide	--	28	28	--	28	--
Total	--	963	638	325	963	22

-- 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	2001	2002
Steel:		
Carbon	1,080 r	705
Stainless and heat-resisting	660	529
Full alloy	(2)	(2)
High-strength low alloy	1,030	1,090
Electric	(2)	(2)
Tool	(2)	(2)
Unspecified	--	--
Total	2,770 r	2,330
Superalloys	1,440 r	813
Alloys (excluding alloy steels and superalloys)	(3)	(3)
Miscellaneous and unspecified	11	9
Grand total	4,230	3,150
Stocks, December 31:		
Consumer	NA	NA
Producer[4]	NA	NA
Total	NA	NA

[r]Revised. 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	2001 Gross weight (metric tons)	2001 Value (thousands)	2002 Gross weight (metric tons)	2002 Value (thousands)	Principal destinations and sources, 2002 (gross weight in metric tons and values in thousand dollars)
Exports:[2]					
Columbium:					
Ores and concentrates	15	$246	64	$435	Japan 30, $259; United Kingdom 10, $89; China 23, $40; Italy 2, $30; Brazil[3], $16.
Ferrocolumbium	109	1,260	126	1,500	United Kingdom 36, $712; Canada 53, $569; Mexico 37, $216; Taiwan [3], $3.
Tantalum:					
Synthetic concentrates	42	84	74	63	Mexico 33, $25; Vietnam 18, $18; China 22, $15; France [3], $5.
Ores and concentrates	530	22,900	232	1,950	Brazil 205, $1,480; China 22, $356; United Kingdom 4, $96; India 1, $15; Netherlands[3], $5.
Unwrought and waste and scrap	213	17,900	59	3,940	Germany 29, $2,290; Hong Kong 22, $824; United Kingdom 4, $485; Japan 3, $232; Estonia[3], $51; France[3], $31.
Unwrought powders	156	75,600	188	109,000	United Kingdom 71, $52,000; Israel 87, $50,400; Germany 9, $4,230; Sweden 18, $2,290; Japan 1, $166; France 1, $148.
Unwrought alloys and metal	59	33,300	16	5,600	United Kingdom 3, $2,340; Israel 7, $1,710; Germany 3, $1,060; Portugal[3], $176; Japan[3], $106; Sweden 1, $82.
Wrought	214	89,400	190	96,200	Mexico 74, $26,800; Israel 32, $16,400; Japan 29, $14,800; Germany 21, $13,700; United Kindgom 13, $12,600; Taiwan 3, $3,390.
Total	XX	241,000	XX	219,000	Israel $68,500; United Kingdom $68,300; Mexico $27,000; Germany $21,300; Japan $15,400; Taiwan $3,630; France $3,140; Sweden $2,470.
Imports for consumption:					
Columbium:					
Ores and concentrates	126	1,740	22	326	Japan 16, $174; China 7, $152.
Oxide	1,940	30,000	935	14,600	China 274, $3,650; Brazil 243, $3,440; Germany 67, $2,870; Estonia 192, $2,560; Russia 159, $2,110.
Ferrocolumbium	6,890	61,500	6,200	52,500	Brazil 5,200, $42,500; Canada 969, $9,690; Germany 31, $141; France 8, $97.
Unwrought alloys, metal and powder	1,050	26,700	673	19,000	Estonia 244, $9,330; Brazil 205, $4,770; Kazakhstan 74, $2,640; Germany 115, $1,420; Japan 2, $448; China 32, $374.
Synthetic concentrates	2	4	--	--	
Tantalum:					
Ores and concentrates	2,240	95,700	2,400	83,500	Australia 1,920, $71,600; Canada 250, $5,500; Zimbabwe 42, $2,330; Brazil 66, $1,150; Mozambique 34, $909; Rwanda 34, $809; Nigeria 29, $670.
Unwrought waste and scrap	964	34,500	285	17,100	Japan 108, $7,270; Germany 57, $3,280; United Kingdom 29, $2,120; Israel 28, $1,570; Austria 11, $1,500; China 3, $476; Mexico 20, $455.
Unwrought powders	138	81,300	105	24,600	Thailand 47, $8,640; Japan 16, $7,970; China 33, $5,970; Germany 8, $2,050.
Unwrought alloys and metal	117	19,900	110	9,340	Kazakhstan 91, $7,030; Germany 15, $1,180; Austria 1, $370; China 2, $347; Russia 1, $259; Switzerland 1, $109.
Wrought	62	40,100	51	10,900	Kazakhstan 30, $5,090; China 8, $3,230; Netherlands 6, $986; Switzerland 4, $617; Japan 1, $338; Austria 1, $278; United Kingdom 1, $257.
Total	XX	391,000	XX	232,000	Australia $71,600; Brazil $51,900; Japan $16,200; Canada $15,200; Kazakhstan $14,700; China $14,400; Estonia $11,900; Germany $11,000.

XX Not applicable. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown. Revised as of March 3, 2004.

[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]

	2001		2002	
Country	Gross weight (metric tons)	Value (thousands)	Gross weight (metric tons)	Value (thousands)
Brazil	8	$75	--	--
China	112	1,600	7	$152
Japan[2]	6	65	16	174
Total	126	1,740	22	326

-- 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	2001		2002	
	Gross weight (metric tons)	Value (thousands)	Gross weight (metric tons)	Value (thousands)
Australia	1,630	$61,500	1,920	$71,600
Bolivia	2	318	3	77
Brazil	88	3,940	66	1,150
Canada	332	9,460	250	5,500
China	4	40	2	224
Congo (Kinshasa)[2]	4	503	--	--
Ethiopia	20	1,910	--	--
Ivory Coast	--	--	1	46
Japan[3]	1	131	--	--
Mozambique	--	--	34	909
Netherlands[3]	10	620	1	50
Nigeria	83	11,900	29	670
Russia	(4)	5	(4)	11
Rwanda	36	3,100	34	809
Sierra Leone	--	--	10	40
South Africa	4	1,350	1	79
United Kingdom[3]	24	963	--	--
Zimbabwe	--	--	42	2,330
Total	2,240	95,700	2,400	83,500

-- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Formerly Zaire.
[3]Presumably country of transshipment rather than original source.
[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.
Do.	Sons of Gwalia Ltd. (Wodgina)	Tantalum.
Brazil	Cia. Brasileira de Metalurgia e Mineracao (CBMM) (Araxa)	Columbium.
Do.	Cia. de Estanho Minas Brasil (MIBRA)[1]	Columbium-tantalum.
Do.	Paranapanema S.A. Mineracao Indústria e Construcao (Pitinga)	Do.
Do.	Mineracao Catalao de Goias S.A. (Catalao)	Columbium.
Canada	Cambior Inc., and Mazarin Inc. (Niobec)	Do.
Do.	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)	Do.
Brazil	Cia. Industrial Fluminense[1]	Do.
Do.	Mamoré Mineracao e Metalurgia[3]	Do.
Thailand	Thailand Smelting and Refining Co. Ltd. (Thaisarco)	Do.
Production capacity for columbium- and tantalum-bearing synthetic concentrates, Germany, western states	H.C. Starck GmbH & Co. KG	Do.

[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, and NiNb.
Brazil	Cia. Brasileira de Metalurgia e Mineracao (CBMM)	Nb oxide/metal, FeNb, and NiNb.
Do.	Cia. Industrial Fluminense[2]	Nb and Ta oxide.
Do.	Mineracao Catalao de Goias S.A. (Catalao)	FeNb.
Canada	Cambior Inc. and Mazarin Inc. (Niobec)	FeNb.
Estonia	Silmet	Nb oxide/metal.
Germany, western states	Gesellschaft Für Elektrometallurgie mbH (GFE)[2]	FeNb and NiNb.
Do.	H.C. Starck GmbH & Co. KG	Nb and Ta oxide/metal/carbide, K-salt, FeNb, NiNb, and Ta capacitor powder.
Japan	Mitsui Mining & Smelting Co.	Nb and Ta oxide/metal/carbide.
Do.	Cabot Supermetals[3]	Ta capacitor powder.
Do.	H.C. Starck-V Tech Ltd.[4]	Ta capacitor powder.
Kazakhstan	Ulba Metallurgical	Ta oxide/metal.
Do.	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 Supermetals[3]	Nb and Ta oxide/metal, K-salt, and Ta capacitor powder.
Do.	H.C. Starck Inc.[5]	Nb and Ta metal, and Ta capacitor powder.
Do.	Kennametal Inc.	Nb and Ta carbide.
Do.	Reading Alloys Inc.	FeNb, NiNb.
Do.	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, NY.

[3]A wholly owned subsidiary of 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)

Country[5]	Gross weight[3]					Columbium content[4]					Tantalum content[4]				
	1998	1999	2000	2001	2002	1998	1999	2000	2001	2002	1998	1999	2000	2001	2002
Australia, columbite-tantalite	1,150	1,230	1,600	2,220	3,100	140	140	160	230	290	330	350	485	660	940
Brazil:															
Pyrochlore	56,200	52,100	51,900	62,100 [r]	62,000	23,600	21,900	21,800	26,100 [r]	26,000	--	--	--	--	--
Tantalite	1,100	590 [r]	680 [r]	750 [r]	715	NA	NA	NA	NA	NA	310	165 [r]	190 [r]	210 [r]	200
Burundi	31 [r, 6]	42 [6]	31 [r, 6]	123 [r, 6]	88	NA	NA	NA	NA	NA	8 [r]	10	8 [r]	32 [r]	28
Canada:															
Pyrochlore	5,110	5,240	5,070	7,070	7,550	2,300	2,360	2,280	3,180	3,400	--	--	--	--	--
Tantalite	228	208	228	308	232	11	10	11	15	12	57	54	57	77	58
Congo (Kinshasa), columbite-tantalite	NA	NA	450	200	200	NA	NA	110	50	50	NA	NA	130	60	60
Ethiopia, tantalite	40	50 [6]	65 [6]	80	60	4	5	7	8	6	24	29	38	47	35
Mozambique	--	--	--	27 [6]	30	--	--	--	5	5	--	--	--	11	12
Nigeria, columbite-tantalite	70	70	80	70	70	30	30	35	30	30	3	3	4	3	3
Rwanda	224 [6]	147 [r, 6]	561 [r, 6]	241 [r, 6]	240	71 [r]	46 [r]	176 [r]	76 [r]	76	47 [r]	33 [r]	124 [r]	53 [r]	53
Uganda	--	--	3 [6]	11 [6]	10	--	--	1	3	3	--	--	1	6	5
Zimbabwe	NA	NA	NA	30	480	NA	NA	NA	NA	NA	NA	NA	NA	9	144
Total	64,200	59,700 [r]	60,700 [r]	73,200 [r]	74,800	26,200	24,500 [r]	24,600	29,700 [r]	29,900	779 [r]	645 [r]	1,040 [r]	1,170 [r]	1,540

[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 production of columbium and tantalum contained in tin ores and slags. Table includes data available through July 9, 2003.

[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.

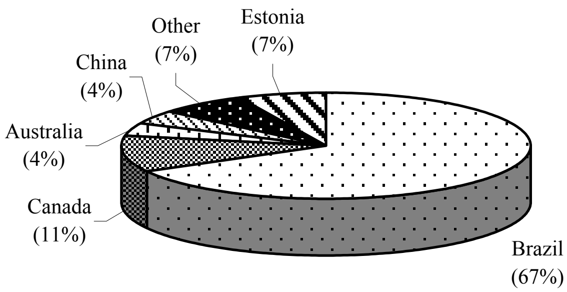
[4]Unless otherwise specified, data presented for metal content are estimates based on, in most part, reported gross weight and/or pentoxide content.

[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.

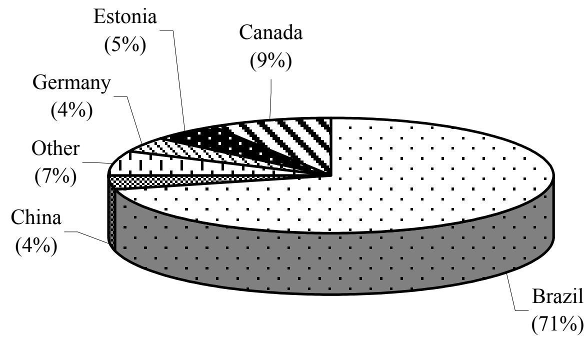
[6]Reported figure.

FIGURE 1
MAJOR SOURCES OF U.S. COLUMBIUM IMPORTS

(Columbium content)



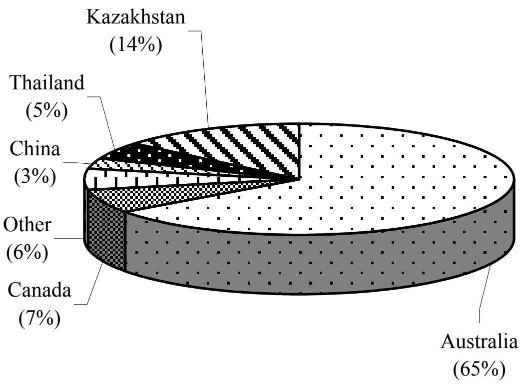
2002



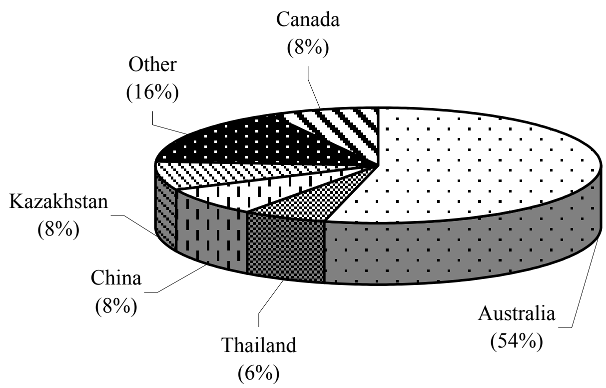
1999-2002

FIGURE 2
MAJOR SOURCES OF U.S. TANTALUM IMPORTS

(Tantalum content)



2002



1999-2002