COLUMBIUM (NIOBIUM) AND TANTALUM

By Larry D. Cunningham

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

Tantalum (Ta) is a refractory metal that is ductile, easily fabricated, has a high melting point (2,996 °C), is highly resistant to corrosion by acids, and is a good conductor of heat and electricity. Tantalum is also 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.

Domestic columbium and tantalum resources are of low grade. Some are mineralogically complex, and most are not currently commercially recoverable. The last significant mining of columbium and tantalum was during the Korean conflict when increased military demand resulted in columbium and tantalum ore shortages.

In 1994, the United States continued to be dependent on imports of columbium and tantalum materials. Brazil continued as the major source for columbium imports, and Australia continued as the major source for tantalum imports. Columbium price quotations were unchanged for the year, and tantalum price quotations remained stable.

The President of the United States granted General System of Preferences (GSP) status to Kazakhstan, Ukraine, and the Republic of South Africa.

Overall reported consumption of columbium in the form of ferrocolumbium and nickel columbium continued to increase, with demand for columbium in superalloys up significantly. Overall demand for tantalum was at the highest level since 1984.

Legislation and Government Programs

The high degree of import reliance for columbium and tantalum is the principal strategic problem faced by the United States. Summaries of important columbium and tantalum statistics are shown in tables 1 and 2, respectively. *(See tables 1 and 2.)*

To ensure a supply of columbium and tantalum during an emergency, goals for both materials have been established for the National Defense Stockpile (NDS). However, inventories for both materials are substantially under set goals. As of September 30, 1994, NDS overall goal for the columbium group was 5.05 million kilograms, and the overall goal for the tantalum group was 3.96 million kilograms. *(See table 3.)*

On December 8, 1994, the President signed legislation adopting the Uruguay Round accords of the General Agreements on Tariffs and Trade (GATT) which included renewal of the GSP program until July 31, 1995. The GSP program had expired on September 30, 1994. The legislation extending the GSP was retroactive to September 30. Under GSP, the United States grants duty-free access to goods from more than 140 developing countries and territories. In 1994, U.S. imports for columbium and tantalum products ranged from duty free to 5.5% ad valorem for most-favored-nation (MFN) status and from duty free to 45% ad valorem for non-MFN status.

In Proclamation 6650 of February 16, 1994, the President of the United States designated Kazakhstan as a beneficiary developing country for purposes of the GSP, effective March 4, 1994. In Proclamation 6655 of March 3, 1994, the President also granted GSP status to Ukraine, effective March 23, 1994. Kazakhstan and Ukraine join Russia, October 1993, as republics in the former U.S.S.R. with GSP status. The extension of GSP status is part of the Administration's overall effort to facilitate Kazakhstan and Ukraine's transformation to free market economies. Additionally, GSP status was granted to the Republic of South Africa in Proclamation 6676 of April 21, 1994, effective May 10, 1994.

In August, it was reported that the Department of Energy (DOE) and the State of Texas had resolved Texas's claim for reimbursement of its contributions to DOE's Superconducting Super Collider (SSC), particle accelerator, project. In October 1993, Congress had voted to close down the SSC project which was under construction in Waxachachie, TX. Terms of the settlement reportedly call for a $145 million payment to Texas, a $65 million contribution toward completion of a regional medical facility, and a release by Texas of all future claims against the United States.[1]

In April, it was reported that the Defense Reutilization and Marketing Service (DRMS) sold 1,315 kilograms of tantalum scrap, guided missile components, to Charter Trading Ltd., Chicago, IL, at a price of $57.34 per kilogram ($26.011 per pound).[2]

Production

Domestic production data for ferrocolumbium are developed by the U.S. Bureau of Mines from the annual voluntary domestic survey for ferroalloys. Of the four operations to which a survey request was sent, two responded. Thus, ferrocolumbium production data for 1994 were incomplete at the time this report was prepared.

Although there was no domestic mineral production of either columbium or tantalum in 1994, there were two processors of columbium- and tantalum-bearing source materials that were integrated from raw material processing to columbium and tantalum end products. They were Cabot Corp. for columbium and tantalum processing and Shieldalloy Metallurgical Corp., dedicated solely to columbium processing. Hermann C. Starck Inc. was a major supplier of tantalum and columbium products, and Thai Tantalum Inc. produced tantalum products. Reading Alloys Inc. and Teledyne Wah Chang Albany were major producers of high-purity columbium products. Kennametal Inc. was the major producer of columbium and tantalum carbides.

Consumption

Overall reported consumption of columbium as ferrocolumbium and nickel columbium rose by more than 10% compared with that of 1993. *(See table 4.)* Consumption of columbium by the steelmaking industry increased by about 8%, affected by a 3% increase in raw steel production and a 5% increase in the percentage of columbium usage per ton of steel produced. Columbium consumption in carbon and stainless and heat-resisting steels were both up by more than 10%, while columbium consumption in high-strength low-alloy steel was up modestly. Demand for columbium in superalloys increased to more than 400,000 kilograms, the highest level since 1991. That portion used in the form of nickel columbium rose to more than 260,000 kilograms.

Overall consumption of tantalum rose to about 430,000 kilograms, the highest level since 1984, aided mostly by increased consumption of capacitor-grade tantalum powder in the electronics sector. The Electronic Industries Association reported that factory sales of tantalum capacitors were up by about 30%, a twofold increase compared with sales in 1990. However, the amount of tantalum capacitor-grade powder consumed per capacitor continued to decline, owing to the trend toward higher capacitance tantalum powders and capacitor miniaturization.

Columbium.—Columbium and niobium are synonymous names for the chemical element with atomic number 41; columbium was the first name given, and niobium was the name officially designated by the International Union of Pure and Applied Chemistry in 1950. The metal conducts heat and electricity relatively well, has a high melting point (2,480 °C), is readily fabricated, and is highly resistant to many chemical environments.

Columbium, in the form of ferrocolumbium, is used worldwide, principally as an additive to improve the strength and corrosion resistance of steel. Because of its refractory nature, appreciable amounts of columbium in the form of high-purity ferrocolumbium and nickel columbium are used in nickel-, cobalt-, and iron-base superalloys for applications such as jet engine components, rocket subassemblies, and heat-resisting and combustion equipment. Columbium carbide is used in cemented carbides to modify the properties of the cobalt-bonded tungsten carbide-based material. It is usually used with carbides of metals such as tantalum and titanium. Columbium oxide is the intermediate product used in the manufacture of high-purity ferrocolumbium, nickel columbium, columbium metal, and columbium carbide.

Tantalum.—The major end use for tantalum, as tantalum metal powder, is in the production of electronic components, mainly tantalum capacitors. Applications for tantalum capacitors include computers, communication systems, and instruments and controls for aircraft, missiles, ships, and weapon systems. The tantalum capacitor exhibits reliable performance and combines compactness and high efficiency with good shelf-life. Because of its high melting point, good strength at elevated temperatures, and good corrosion resistance, tantalum is combined with cobalt, iron, and nickel to produce superalloys that are employed in aerospace structures and jet engine components. Tantalum carbide, used mostly in mixtures with carbides of such metals as columbium, titanium, and tungsten, is used in cemented-carbide cutting tools, wear-resistant parts, farm tools, and turning and boring tools. Because of its excellent corrosion-resistant properties, tantalum mill and fabricated products are used in the chemical industry in applications such as heat exchangers, evaporators, condensers, pumps, and liners for reactors and tanks.

Prices

A published price for pyrochlore concentrates produced in Brazil and Canada was not available. A price for Brazilian pyrochlore has not been available since 1981, and the published price for Canadian pyrochlore was suspended in early 1989. However, the Platt's Metals Week published price for regular-grade ferrocolumbium, produced from pyrochlore concentrates, was $6.58 per pound of contained columbium, f.o.b. shipping port.

The Metal Bulletin published price for columbite ore, on the basis of a minimum 65% contained Cb_2O_5 and Ta_2O_5, remained unchanged at a range of $2.40 to $2.80 per pound. For the year, the Metals Week published price for columbium oxide was quoted at $8.17 per pound of oxide; the published price for high-purity ferrocolumbium containing 62% to 68% columbium was quoted at $18.50 per pound of contained columbium, f.o.b. shipping point; the published price for nickel columbium was quoted at $20.50 per pound of contained columbium; and the published price for columbium metal was quoted at a range of $30 to $50.

The Metals Week published spot price for tantalite ore, on the basis of contained Cb_2O_5 and Ta_2O_5, c.i.f. U.S. ports, quoted since March 1993 at a range of $25.50 to $26.50 widened to $25.50 to $27 in mid-January, where it remained through December. The Metal Bulletin published price for tantalite fell from a range of $28 to $32 per pound of contained Ta_2O_5 to a range of $26 to $30 in April, where it remained through December. For the year, the Metal Bulletin published price for tantalite produced by Greenbushes Ltd. of Australia on the basis of 40% contained Ta_2O_5 was quoted at $40 per pound. A published price for tantalite from the Canadian producer, Tanco, was not available. Industry sources indicated that tantalum mill products sold at an average of about $170 per pound, depending on specification, and that tantalum capacitor-grade powder sold at an average of about $145 per pound.

A published price for columbium and tantalum carbide was not available.

Foreign Trade

Data for exports and imports are summarized in table 5. Net trade for columbium and tantalum continued at a deficit. Overall trade value for exports was up by 5%, with total volume down by 8%. For imports, trade value and volume were up by more than 20%. *(See table 5.)*

Imports for consumption of columbium mineral concentrates increased by about 30%. Canada continued as the leading supplier, providing most of both total quantity and total value. *(See table 6.)* Imports at an average grade of approximately 60% Cb_2O_5 and less than 1% Ta_2O_5 were estimated to contain 1.29 million kilograms of columbium and a small quantity of tantalum.

Imports for consumption of tantalum mineral concentrates were down by more than 10%, with the average unit value for overall imports down by 8%. Imports from Australia and Brazil, producing countries, accounted for more than 50% of total quantity and more than 60% of total value. *(See table 7.)* Imports at an average grade of approximately 34% Ta_2O_5 and 24% Cb_2O_5 were estimated to contain 310,000 kilograms of tantalum and 190,000 kilograms of columbium.

Imports for consumption of synthetic tantalum-columbium concentrates totaled 25,000 kilograms valued at $160,000 compared with 36,000 kilograms valued at $912,000 in 1993. These figures are not included in the salient statistics data.

The schedule of applied tariffs during 1994 to U.S. imports of selected columbium and tantalum materials is found in the U.S. International Trade Commission's (USITC's) 1994 Harmonized Tariff Schedule of the United States, USITC Publication 2690. Brazil continued as the major source for U.S. columbium imports, accounting for more than 60% of the total, and Australia remained the major source for U.S. tantalum imports, accounting for more than 30% of the total. *(See figures 1 and 2.)*

World Review

Industry Structure.—Principal world columbium and tantalum raw material and product producers are shown in tables 8 and 9, respectively. Brazil and Canada remained the major producers of columbium raw materials feedstock, while tantalum raw materials continued to be produced mainly in Australia, Brazil, and Canada and in Thailand in the form of high-grade tantalum-bearing tin slags. Annual world production of columbium and tantalum mineral concentrates, by country, is given in table 10. *(See tables 8, 9, and 10.)*

Australia.—For its fiscal year ending June 30, 1994, Gwalia Consolidated Ltd. reported that sales of tantalum oxide produced in tantalum concentrates at its Greenbushes Mine, southwest Western Australia, was about 153 tons compared with about 130 tons the previous year. Gwalia continues as the world's largest producer of tantalum concentrates, with contractual relationships with the two largest processors of tantalum concentrates in Germany and North America. The tantalum processing plant at the Greenbushes Mine has an annual ore throughput capacity of about 850,000 tons, and the company indicates that the plant will operate at this capacity for the foreseeable future.[3]

Brazil.—Cia. Brasileira de Metalurgia e Mineracao (CBMM) was reported to have installed a new electric furnace to produce ferrocolumbium at its facility in Araxa. Since 1991, CBMM had relied on a semicontinuous autothermic reduction pro-cess to produce ferrocolumbium, which subsequently was put on stand by status. The electric furnace process will have an initial annual ferrocolumbium capacity of about 19,500 tons, operating at 260 days per year. CBMM plans to increase this capacity to about 28,000 tons annually.[4]

Canada.—As reported by Teck Corp., production of Cb_2O_5 at the Niobec Mine at St. Honoré, Quebec, decreased to about 3.3 million kilograms. Niobec is a 50-50 joint venture between Teck, operator, and Cambior Inc., product marketing. Ore milled was 809,000 tons, as the mill operated on the average of 2,210 tons of ore per day. Average recovery was 59.2% with Cb_2O_5 grade of concentrate at 69%. Teck reported that mine ore reserves are sufficient for another 12 years. Late in the year, operations commenced at the newly constructed ferrocolumbium plant at the Niobec minesite. First deliveries of ferrocolumbium to customers began in December. The mine is budgeted to produce about 3.4 million kilograms of ferrocolumbium in 1995. Starting early in the year, the plan is to convert all columbium concentrates produced at the mine to ferrocolumbium.[5]

Since midyear 1992, tantalum mining at the Bernic Lake, Manitoba, tantalum operation of Tantalum Mining Corp. of Canada Ltd. has remained suspended. However, an estimated 34,000 kilograms of contained tantalum oxide was produced from tailings retreatment.

Japan.—According to The Tex Report, Japan's production of ferrocolumbium decreased to 947 tons from the 1,210 tons reported in 1993. Columbium ore imported for ferrocolumbium production totaled 1,480 tons, with Canada accounting for over 90% of the total. As reported by Japan Metal Journal, ferrocolumbium imports totaled about 3,640 tons, with most of the imports coming from Brazil.

Roskill's Letter from Japan reported that Japan's demand for tantalum, in the form of powder, compounds, and products, was 255 tons compared with 225 tons in 1993. Japan's production of tantalum capacitors was 4.6 billion units compared with 4.61 billion units in 1993. In 1995, the demand for tantalum capacitors is forecast to increase markedly, with the main area of growth being in portable telephones.

Outlook

Columbium.—Columbium is used principally as an additive in steelmaking, which annually accounts for more than 80% of U.S. reported consumption. No significant change to this trend is expected in the near term because there are few other significant growth markets and/or uses for columbium. Thus, future columbium demand growth will continue to be directly related to the worldwide performance of the steel industry. The reader is referred to the outlook section of the Iron and Steel Annual Mineral Industry Surveys for discussion on the outlook for the steel industry. Additionally, Metal Bulletin reported that some leading industry sources anticipate that western world steel production and consumption will increase through the year 2000. However, steel demand in countries of the former U.S.S.R. will continue to decline owing to economic problems in those countries. The outlook for columbium also will be dependent to a lesser degree on the performance of the aerospace industry. Future growth for this end use will be affected mainly by the demand for columbium-containing superalloys by the aircraft industry.

Tantalum.—For the past decade, more than 60% of the tantalum consumed in the United States has been used to produce electronic components, mainly tantalum capacitors. In 1994, U.S. factory sales of tantalum capacitors was again at an alltime high, an increase of more than 100% over that in 1990. However, overall tantalum demand growth in this sector continued to be slowed owing to the industry's emphasis on higher capacitance powders and the miniaturization of electronic components resulting in less tantalum used per unit. Industry sources indicate that the growth of tantalum capacitors, mainly chip-type, will continue with a modest increase in the demand for tantalum capacitor-grade powder. Tantalum demand in the cemented carbide sector also is expected to experience modest growth. However, the demand for tantalum in this sector will continue to be affected by the use of coatings, which prolong tool life, and the replacement of cemented carbide tools with ceramics and silicon-nitride-based cutting tools.[6]

---

[1]Chemical and Engineering News. V. 72, No. 31, Aug. 1, 1994, p. 25.
[2]American Metal Market. V. 102, No. 68, Apr. 11, 1994, p. 9.
[3]Gwalia Consolidated Ltd. 1994 Annual Report. 64 pp.
[4]The Tex Report. V. 26, No. 6162, July 21, 1994, p. 1.
[5]Teck Corp. 1994 Annual Report. 60 pp.
[6]Tantalum-Niobium International Study Center. Bulletin No. 80, Dec. 1994, 6 pp.

OTHER SOURCES OF INFORMATION

U.S. Bureau of Mines Publications

Columbium (Niobium) and Tantalum. Chs. in Mineral Commodity Summaries, annual.
Columbium (Niobium) and Tantalum. Chs. in Mineral Facts and Problems, 1985 ed.
Columbium (Niobium) and Tantalum. Ch. in Minerals Yearbook, annual.
Columbium (Niobium) and Tantalum. Preliminary annual Mineral Industry Surveys.
Metal Prices in the United States Through 1991.

Other Sources

American Metal Market, daily.
Company Annual and Quarterly Reports, and News releases.
Defense Logistics Agency, Stockpile Reports.
Engineering and Mining Journal, monthly.
Federal Register, daily.
Industrial Minerals (London), monthly.
Metal Bulletin (London), semiweekly and monthly.
Mining Annual Review (London).
Mining Engineering (London), monthly.
Mining Journal (London), weekly.
Mining Magazine (London), monthly
Platt's Metals Week, weekly.
Roskill Information Services Ltd. Reports (London):
  The Economics of Niobium 1992.
  The Economics of Tantalum 1989.
Roskill's Letter from Japan, monthly.
Tantalum-Niobium International Study Center (Brussels):
  International Symposium-Proceedings.
  Quarterly Bulletin.
The TEX Report (Tokyo; daily issues and annual ferroalloy manual).
The Wall Street Journal, daily.

TABLE 1
SALIENT COLUMBIUM STATISTICS 1/

(Thousand kilograms of columbium content unless otherwise specified)

	1990	1991	1992	1993	1994
United States:					
Mine production of columbium-tantalum concentrates	(2/)	(2/)	(2/)	--	--
Releases from Government excesses	--	--	--	--	--
Production of ferrocolumbium	NA	NA NA	NA	NA NA	NA
Exports: Columbium metal, compounds, alloys (gross weight)	NA	NA NA	NA	NA NA	NA
Imports for consumption:					
Mineral concentrates e/	1,130	1,160	1,230	1,210	1,480
Columbium metal and columbium-bearing alloys e/	2	1	1	111	172
Ferrocolumbium e/	1,900	2,130	2,450	2,190	2,590
Tin slag	NA	NA NA	NA	NA NA	NA
Consumption:					
Raw materials	NA	NA NA	NA	NA NA	NA
Ferrocolumbium and nickel columbium e/	2,590	2,410	2,470	2,470 r/	2,750
Apparent	3,360	3,310	3,500	3,500	3,700
Prices:					
Columbite, dollars per pound 3/	3.25	2.83	2.83	2.67	2.60
Pyrochlore, dollare per pound 4/	2.75	2.75	2.75	2.75	NA
World: Production of columbium-tantalum concentrates e/	15,300 r/	15,700 r/	15,300 r/	12,400 r/	15,200

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

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits, except prices.

2/ A small unreported quantity was produced.

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

4/ Average value, contained pentoxide.

TABLE 2
SALIENT TANTALUM STATISTICS

(Thousand kilograms of tantalum content unless otherwise specified)

	1990	1991	1992	1993	1994
United States:					
Mine production of columbium-tantalum concentrates	(1/)	(1/)	(1/)	--	--
Releases from Government excesses	--	--	--	--	--
Exports:					
Tantalum ores and concentrates (gross weight) 2/	1	11	17	11	23
Tantalum metal, compounds, alloys (gross weight)	161	219	136	235	242
Tantalum and tantalum alloy powder (gross weight)	82	66	61	57	46
Imports for consumption:					
Mineral concentrates e/	299	340	420	390	310
Tantalum metal and tantalum-bearing alloys 3/	21	19	14	67	73
Tin slag	NA	NA	NA	NA	NA
Consumption:					
Raw materials	NA	NA	NA	NA	NA
Apparent	390	370	375	410	430
Prices:					
Tantalite, dollars per pound 4/	31.17	30.06	28.19	26.41	26.24
World: Production of columbium-tantalum concentrates e/	396 r/	477	399 r/	310 r/	325

e/ Estimated. r/ Revised. NA Not available.
1/ A small unreported quantity was produced.
2/ Includes reexports.
3/ Exclusive of waste and scrap.
4/ Average value, contained tantalum pentoxides.

TABLE 3
COLUMBIUM AND TANTALUM MATERIALS IN GOVERNMENT
INVENTORIES AS OF DECEMBER 31, 1994 1/

(Thousand kilograms of columbium or tantalum content)

Material	Stockpile goals	Disposal authority	National Defense Stockpile inventory			
			Uncommitted 2/			Committed
			Stockpile-grade	Nonstockpile-grade	Total	
Columbium:						
Concentrates	--	--	520	344	864	--
Carbide powder	--	--	10	--	10	--
Ferrocolumbium	--	--	271	151	422	--
Metal	--	--	7	--	7	--
Total	5,050 3/	--	808	495	1,300	--
Tantalum:						
Minerals	--	--	761	460	1,220	--
Carbide powder	--	--	13	--	13	--
Metal 4/	--	--	73	(5/)	73	--
Total	3,960 3/	--	847	460	1,310	--

1/ Data rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.
2/ The stockpile also contained uncommitted inventories of 26,000 kilograms in columbium concentrates, 113,000 kilograms in ferrocolumbium, 37,000 kilograms in tantalum minerals, 46,000 kilograms in tantalum metal, and 74,000 kilograms in tantalum oxide with status (inventory) not yet determined.
3/ Overall goals for the columbium and tantalum groups as of Sept. 30, 1994.
4/ Capacitor grade.
5/ 45 kilograms.

Source: Defense Logistics Agency, Defense National Stockpile Center.

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

(Kilograms of contained columbium 2/)

End use	1993	1994
Steel:		
Carbon	819,000	920,000
Stainless and heat-resisting	317,000	350,000
Full alloy	(3/)	(3/)
High-strength low-alloy	1,020,000	1,050,000
Electric	--	--
Tool	(4/)	(4/)
Unspecified	5,960	9,450
Total	2,160,000	2,330,000
Superalloys	294,000	411,000
Alloys (excluding alloy steels and superalloys)	(5/)	(5/)
Miscellaneous and unspecified	17,500 r/	8,840
Total consumption	2,470,000 r/	2,750,000
STOCKS		
Dec. 31:		
Consumer	NA	NA
Producer 6/	NA	NA
Total stocks	NA	NA

r/ Revised. NA Not available.
1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.
2/ Includes columbium and tantalum in ferrotantalum-columbium, if any.
3/ Included with "Steel: High-strength low alloy."
4/ Included with "Steel: Unspecified."
5/ Included with "Miscellaneous and unspecified."
6/ Ferrocolumbium only.

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

(Thousand kilograms, gross weight, and thousand dollars)

Class	1993 Quantity	1993 Value	1994 Quantity	1994 Value	Principal destinations and sources, 1994
EXPORTS 2/					
Columbium:					
Ores and concentrates	6	$46	489 3/	$4,500	Netherlands 477, $4,380; Germany 8, $78; Taiwan 4, $25; Korea, Republic of (4/), $10; India (4/), $9.
Ferrocolumbium	815	7,310	234	2,080	Canada 151, $1,260; Mexico 74, $739; Netherlands 3, $57; Brazil 5, $12; Italy (4/), $9.
Tantalum:					
Synthetic concentrates	--	--	2	9	All to Singapore.
Ores and concentrates	11	111	23 3/	319	Brazil 18, $196; Latvia 4, $84; Netherlands 2, $39.
Unwrought and waste and scrap	177	5,010	146	6,610	Germany 34, $3,060; Hong Kong 83, $1,210; Canada 13, $949; United Kindom 7, $620; Japan 4, $456.
Unwrought powders	57	17,500	46	12,800	United Kingdom 13, $4,630; France 15, $4,120; Germany 9, $ 2,640; Japan 2, $588; Austria 4, $453; Australia 2, $162.
Unwrought alloys and metal	8	2,390	8	1,670	Canada 3, $766; Barbados 1, $399; France (4/), $152; Singapore (4/), $142; Germany 3, $105.
Wrought	50	18,700	88	25,600	Japan 29, $11,700; United Kingdom 11, $4,110; Germany 13, $3,280; Canada 25, $2,870; France 7, $2,380.
Total	XX	51,000	XX	53,600	Japan $12,700; United Kingdom $9,400; Germany $9,200; France $6,700; Canada $5,800.
IMPORTS FOR CONSUMPTION					
Columbium:					
Ores and concentrates	2,350	8,610	3,080	11,400	Canada 3,070, $11,300; Thailand 9, $136.
Oxide	301	5,390	757	11,600	Brazil 431, $6,060; Germany 136, $4,260; Russia 161, $938; Thailand 29, $353.
Ferrocolumbium	3,370	29,000	3,980	34,000	Brazil 3,970, $33,600; Germany 18, $336.
Unwrought alloys, metal, and powder	111	2,380	171	3,770	Germany 63, $1,220, Brazil 47, $1,090; Kazakhstan 25, $690; Russia 27, $588; Ukraine 7, $91; United Kingdom 5, $61.
Tantalum:					
Synthetic concentrates	36	912	25	160	Zimbabwe 16, $115; Hong Kong 9, $45.
Ores and concentrates	1,260	31,800	1,090	25,400	Australia 410, $12,500; Brazil 162, $3,340; Burundi 122, $2,690; China 116, $2,080; Rwanda 72, $1,400; Thailand 100, $1,100.
Unwrought waste and scrap	101	4,270	268	13,600	Germany 54, $4,120; Japan 45, $3,440; Mexico 78, $1,770; Hong Kong 23, $1,520; United Kingdom 24, $973; Russia 13, $796.
Unwrought powders	56	9,460	60	10,700	Thailand 30, $6,270; Germany 20, $2,530; China 8, $1,650; Japan 1, $103; Estonia 1, $69; Netherlands 1, $39.
Unwrought alloys and metal	8	1,040	12	1,790	Germany 10, $1,220; Japan 1, $437; Kazakhstan 1, $102; United Kingdom (4/), $15; The Czech Republic (4/), $6.
Wrought	3	547	1	368	Japan 1, $153; Switzerland (4/), $81; Austria (4/), $66; Germany (4/), $37; United Kingdom (4/), $22; Canada (4/), $9.
Total	XX	93,400	XX	113,000	Brazil $44,300; Germany $13,700; Australia $12,500; Canada $11,800; Thailand $7,900.

XX Not applicable.
1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to 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/ All or part of these data have been referred to the Bureau of the Census for verification.
4/ Less than 1/2 unit.

Sources: Bureau of the Census and U.S. Bureau of Mines.

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

(Thousand kilograms and thousand dollars)

Country	1993		1994	
	Gross weight	Value	Gross weight	Value
Belgium 2/	10	151	--	--
Canada	2,220	7,970	3,070	11,300
Germany 2/	73	347	--	--
Nigeria	47	146	--	--
Thailand	--	--	9	136
Total	2,350	8,610	3,080	11,400

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.
2/ Presumably country of transshipment rather than original source.

Sources: Bureau of the Census and U.S. Bureau of Mines.

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

(Thousand kilograms and thousand dollars)

Country	1993 Gross weight	1993 Value	1994 Gross weight	1994 Value
Australia	440	14,600	410	12,500
Austria 2/	5	181	--	--
Belgium 2/	--	--	26	727
Bolivia	2	43	--	--
Brazil	135	3,190	162	3,340
Burundi	50	1,060	122	2,690
Canada	40	830	19	420
China	32	602	116	2,080
Estonia	7	305	--	--
Germany 2/	146	3,190	--	--
Japan 2/	40	2,970	--	--
Kazakhstan	--	--	17	182
Namibia	1	43	--	--
Nigeria	66	171	5	142
Rwanda	193	3,000	72	1,400
Singapore 2/	--	--	6	99
Spain	6	99	9	162
Thailand	45	615	100	1,100
Zaire	48	898	10	181
Zimbabwe	--	--	15	322
Total	1,260	31,800	1,090	25,400

1/ Previously published and 1994 data are rounded by the U. S. Bureau of Mines to three significant digits; may not add totals shown.
2/ Presumably country of transshipment rather than original source.

Sources: Bureau of the Census and U.S. Bureau of Mines.

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	Gwalia Consolidated Ltd. (Greenbushes)	Columbium-tantalum.
	Pan West Tantalum Pty. 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 Goiás S.A. (Catalao)	Columbium.
Canada	Cambior/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	Gwalia Consolidated Ltd. (Greenbushes).	
Brazil	Cia. Industrial Fluminense. 1/	
	Mamoré Mineracao e Metalurgia. 3/	
Malaysia	Malaysia Smelting Corp. Sdn. Bhd.	
Thailand	Thailand Smelting and Refining Co. Ltd. (Thaisarco).	
	PRODUCTION OF COLUMBIUM- AND TANTALUM-BEARING SYNTHETIC CONCENTRATES	
Germany:		
Western states	Gesellschaft Für Elektrometallurgie mbh (GFE). 1/	
	Hermann C. Starck Berlin KG.	

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

TABLE 9
PRINCIPAL WORLD PRODUCERS OF COLUMBIUM AND TANTALUM PRODUCTS

Country	Company	Products1/
Austria	Treibacher Chemische Werke AG	Cb and Ta oxide/carbide, FeCb, NiCb.
Brazil	Cia. Brasileira de Metalurgia e Mineracao (CBMM)	Cb oxide/metal, FeCb, NiCb.
	Cia. Industrial Fluminense 2/	Cb and Ta oxide,Ta carbide.
	Mineracao Catalao de Goias S.A. (Catalao)	FeCb.
Germany:		
Western states	Gesellschaft Fur Elektrometallurgie mbH (GFE) 2/	FeCb, NiCb.
	Hermann C. Starck Berlin KG	Cb and Ta oxide/metal/carbide, K-salt, FeCb, NiCb, Ta capacitor powder.
Japan	Japan Metals & Chemicals Co. Ltd.	FeCb.
	Mitsui Mining & Smelting Co.	Cb and Ta oxide/metal/carbide.
	Showa Cabot Supermetals 3/	Ta capacitor powder.
	Hermann C. Starck-V Tech Ltd. 4/	Ta capacitor powder.
Kazakhstan	Ulba Metallurgical	Ta oxide, Ta metal.
Russia	Solikamsk Magnesium Works	Cb and Ta oxide, Cb and Ta metal.
United Kingdom	London & Scadinavian Metallurgical Co. Ltd. 2/	Cb and Ta carbide.
United States	Cabot Corp.	Cb and Ta oxide/metal, K-Salt, FeCb, NiCb, Ta capacitor powder.
	Hermann C. Starck Inc. 5/	Cb and Ta metal, Ta capacitor powder.
	Kennametal, Inc.	Cb and Ta carbide.
	Reading Alloys, Inc.	FeCb, NiCb.
	Shieldalloy Metallurgical Corp. 2/	FeCb, NiCb.
	Teledyne Wah Chang Albany	Cb oxide/metal, FeCb, NiCb.
	Thai Tantalum Inc.	Ta capacitor powder.

1/ Cb, columbium; Ta, tantalum; FeCb, ferrocolumbium; NiCb, 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 Hermann C. Starck Berlin KG.
5/ Jointly owned by Bayer USA. and Hermann C. Starck Berlin KG.

rbide, FeCb, NiCb.
Cb, NiCb. carbide.
etal/carbide, K-salt, FeCb, r powder.
etal/carbide. r. r.
o and Ta metal.
etal, K-Salt, FeCb, NiCb, er. a capacitor powder.
Cb, NiCb. r.
entoxide.

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

(Thousand kilograms)

Country 3/	Gross weight 4/				^ ^	Columbium content 5/					Tantalum content 5/				
	1990	1991	1992	1993	1994 e/	1990	1991	1992	1993	1994	1990	1991	1992	1993	1994
Australia: Columbite-tantalite	529	703	656	495	700	69	94	69	50	81	165	218	224	170	238
Brazil:															
Columbite-tantalite	310	290 e/	200 e/	175 e/	175	71	66	45	40	40	90	84	60	50	50
Pyrochlore	29,400	30,500	29,600	22,700 r/	30,300	12,300	12,800	12,500	9,540 r/	12,700	--	--	--	--	--
Canada:															
Pyrochlore	5,270	5,230	5,100	5,320	5,130	2,370	2,350	2,300	2,390	2,310	--	--	--	--	--
Tantalite e/	350	380	200	100 r/	120	14	15	8	5	6	86	93	48	25 r/	28
Malaysia: Columbite-tantalite	4	--	--	--	--	1	--	--	--	--	(6/) r/	--	--	--	--
Namibia: Tantalite	4	(6/)	(6/)	-- r/	--	1	(6/)	(6/)	-- r/	--	1	(6/)	(6/)	-- r/	--
Nigeria: Columbite	44	36	40 e/	40 e/	40	18	15	17	17	17	2	2	2	2	2
Rwanda: Columbite-tantalite	110	100 e/	100 e/	100 e/	10	33	30	30	30	3	24	22	22	22	2
South Africa, Republic of:															
Columbite-tantalite	(6/)	(6/)	(6/)	(6/)	-- 7/	(6/) e/	(6/) e/	(6/) e/	(6/) e/	-- 7/	(6/) e/	(6/) e/	(6/) e/	(6/) e/	-- 7/
Spain: e/ Tantalite	10	8	8	6	6	NA	NA	NA	NA	--	3	2	2	2	2
Thailand: Columbite-tantalite	9	3	-- r/	-- r/	--	2	1	-- r/	-- r/	--	2	1	-- r/	-- r/	--
Zaire:															
Columbite-tantalite	36	57	29	20	4 7/	9	15	8	5	1	10	16	8	6	1
Pyrochlore e/	780 r/	780 r/	780 r/	780 r/	--	350 r/	350 r/	350 r/	350 r/	--	--	--	--	--	--
Zimbabwe: Columbite-tantalite	35	111	94	94 e/	7 7/	5	17	14	14	1	12	39	33	33	2
Total	36,900 r/	38,100 r/	36,800 r/	29,800 r/	36,500	15,300 r/	15,700 r/	15,300 r/	12,400 r/	15,200	396 r/	477	399 r/	310 r/	325

e/ Estimated. r/ Revised. NA Not available.
1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to 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 thousand kilograms: 1990--343; 1991--244; 1992--160; 1993--132; and 1994--NA according to data from the Tantalum-Niobium International Study Center. Table includes data available through July 5, 1995.
3/ In addition to the countries listed, Bolivia, China, Russia, and Zambia also produce, or are believed to produce, columbium and tantalum mineral concentrates, but available information is inadequate to make reliable estimates of output levels.
4/ 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.
5/ Unless otherwise specified, data presented for metal content are U. S. Bureau of Mines estimates based on, in most part, reported gross weight and/or pentoxide content.
6/ Less than 1/2 unit.
7/ Reported figure.