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. 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, 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 1995, the United States continued to be dependent on imports of columbium and tantalum materials, with Brazil remaining the major source for columbium imports, and Australia and Thailand the major source for tantalum imports. The U.S. net trade deficit for columbium and tantalum was at the highest level since 1981. Columbium price quotations were virtually unchanged for the year, and tantalum price quotations continued to be stable.

The General System of Preferences (GSP) expired on July 31 and had not been extended by yearend.

Overall reported consumption of columbium in the form of ferrocolumbium and nickel columbium was at the highest level since 1980. Tantalum consumption was up for the year, owing to increased demand from the electronics industry.

Legislation and Government Programs

The high degree of import reliance for columbium and tantalum is a major concern of 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, 1995, 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.)*

During fiscal year 1995 (October 1, 1994 through September 30, 1995), upgraded columbium and tantalum materials (about $8.2 million) were accepted into the stockpile from contracts executed in prior years. The material included about 8,410 kilograms of columbium metal from powder, about 33,900 kilograms of columbium metal from concentrates, and about 8,910 kilograms of tantalum metal from concentrates. For the same period, about 123,000 kilograms ($7 million contract value) of tantalum oxide contained in tantalum/columbium concentrates were used as payment-in-kind for NDS upgrading programs.

The interagency National Defense Stockpile Market Impact Committee announced in the Federal Register (60 FR 56139, November 7, 1995) that it was seeking public comment on the potential market impact of the Department of Defense's (DOD) proposed disposals of excess commodities from the NDS. The Committee provides advice to the DOD on the projected domestic and foreign economic effects of all acquisitions and disposals of materials from the NDS that are to be included in an Annual Materials Plan (AMP). The AMP in turn must be approved by the Congress. DOD's proposed new material disposal authority for columbium and tantalum materials for fiscal years 1996 and 1997, respectively, are as follows (in kilograms, contained metal): columbium carbide, 907; ferrocolumbium, 27,200; tantalum carbide, 454; tantalum minerals, 34,000; and tantalum oxide, 9,070. The deadline for comments to the Committee was December 7, 1995.

The GSP program expired on July 31, 1995. The program had not been extended by yearend. Under GSP, the United States grants duty-free access to goods from more than 140 developing countries and territories. In 1995, U.S. imports for columbium and tantalum materials ranged from duty free to 5.3% ad valorem for most-favored-nation (MFN) status and from duty free to 45% ad valorem for non-MFN status.

Production

Domestic production data for ferrocolumbium are developed by the U.S. Geological Survey from the annual voluntary domestic survey for ferroalloys. However, ferrocolumbium production data for 1995 were incomplete at the time this report was prepared.

Although there was no domestic mineral production of either columbium or tantalum in 1995, 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., Boyertown, PA, for columbium and tantalum processing, and Shieldalloy Metallurgical Corp., Newfield, NJ, dedicated solely to columbium processing. H. C. Starck Inc., Newton, MA, was a major supplier of tantalum and columbium products, and Thai Tantalum Inc., Gurnee, IL, produced tantalum products. Reading Alloys Inc., Robesonia, PA, and Teledyne Wah Chang Albany, Albany, OR, were major producers of high-purity columbium products. Kennametal Inc., Latrobe, PA, was a major supplier of columbium and tantalum carbides.

Cabot Corp. completed a $2.7 million tantalum expansion at its Cabot Performance Materials (CPM) division in Boyertown, PA. The new facility reportedly will double the company's capacity for producing flaked tantalum powders used in the manufacture of tantalum capacitors for the electronics industry. The project was part of CPM's 3-year, $70 million facility-modernization program focusing on upgrading manufacturing facilities, reengineering shop-floor processes, and restructuring its organization. CPM also earmarked an additional $50 million to expand the company's tantalum powder production capacity by about 70%, and to expand by about 100% both its tantalum wire and flaked tantalum production capacities over the next 3 years.[1]

Consumption

Overall reported consumption of columbium as ferrocolumbium and nickel columbium increased by about 5% to the highest level since 1980. *(See table 4.)* Consumption of columbium by the steelmaking industry increased by about 2%, in line with about a 4% increase in raw steel production. However, the percentage of columbium usage per ton of steel produced decreased by about 2%. Columbium consumption in all major reported steel end-use categories was down slightly with the exception of stainless and heat-resisting steels, which increased by about 16%. Demand for columbium in superalloys increased to more than 500,000 kilograms. That portion used in the form of nickel columbium rose to more than 330,000 kilograms.

Overall consumption of tantalum was up to about 515,000 kilograms, the highest level since 1984, aided mostly by a significant increase in shipments of tantalum powder and wire to the capacitor industry. The Electronic Industries Association reported that factory sales of tantalum capacitors rose by more than 30%, a 180% increase compared with sales in 1990.

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 (about 2,470° 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 (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 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. Unchanged since June 1989, 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, quoted since May 1993 at a range of $2.40 to $2.80 per pound, on the basis of a minimum 65% contained Nb_2O_5 and Ta_2O_5, rose to a range of $2.80 to $3.20 per pound in February, where it remained through December. 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 Ta_2O_5, c.i.f. U.S. ports, which began the year at a range of $25.50 to $27 rose to a range of $27 to $28.50 by late October, where it remained through December. The Metal Bulletin published price for tantalite rose from a range of $26 to $30 per pound of contained Ta_2O_5 to a range of $28 to $31.50 in early October, where it remained through December. The Metal Bulletin published price for tantalite produced at the Greenbushes Mine in Australia, on the basis of 40% contained Ta_2O_5, remained unchanged at $40 per pound. Industry sources indicated that tantalum mill products sold at an average of about $170 per pound, and that tantalum capacitor-grade powder sold at an average of about $150 per pound.

Foreign Trade

Data for exports and imports are summarized in table 5. Net trade for columbium and tantalum continued at a deficit and was at the highest level since 1981. Overall trade value for exports was up by about 20%, with total volume down by 8%. For imports, trade value was up by more than 40%, owing in part to significant increases in the overall value for both columbium and tantalum imports, with total volume up by 4%. *(See table 5.)*

Imports for consumption of columbium mineral concentrates were down by more than 60%, owing to a substantial decrease in the volume of imports from Canada. *(See table 6.)* Imports at an average grade of approximately 59% Nb_2O_5 and 2% Ta_2O_5 were estimated to contain about 423,000 kilograms of columbium and about 20,000 kilograms of tantalum.

Imports for consumption of tantalum mineral concentrates were down by 6%, with imports from Australia, Brazil, and Burundi accounting for 60% of total quantity and 70% of total value. *(See table 7.)* Imports at an average grade of approximately 33% Ta_2O_5 and 27% Nb_2O_5 were estimated to contain about 280,000 kilograms of tantalum and about 190,000 kilograms of columbium.

Imports for consumption of synthetic tantalum-columbium concentrates totaled 100,000 kilograms valued at $872,000 compared with 25,000 kilograms valued at $160,000 in 1994. These figures are not included in the salient statistics data.

The schedule of applied tariffs during 1995 to U.S. imports of selected columbium and tantalum materials is found in the U.S. International Trade Commission's (USITC's) 1995 Harmonized Tariff Schedule of the United States, USITC Publication 2690. Brazil was the major source for U.S. columbium imports, accounting for 75% of the total. Australia and Thailand were the major sources for U.S. tantalum imports, together accounting for more than 40% 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 were the major producers of columbium raw materials feedstock, while tantalum raw materials were produced mainly in Australia, Brazil, and Canada. 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, 1995, Gwalia Consolidated Ltd. reported that tantalum oxide produced in tantalum concentrates at its Greenbushes Mine, southwest Western Australia, was about 211 tons, a record level, compared with about 130 tons in 1994. Ore milled increased to about 806,000 tons from the 535,000 tons reported in 1994, owing in part to the movement to continuous production shifts in the second half of the year. For the same period, sales of tantalum oxide in concentrate increased to about 225 tons. Gwalia anticipates that sales will remain at these levels through yearend 1997, due to the extension of existing sales contracts with Cabot Corp. and H. C. Starck. Also, annual production and sales of tantalum oxide in concentrates are expected to be comparable for the next 3 years at about 227 tons.[2]

Brazil.—The TEX Report reported that Brazil's production of columbium oxide in concentrates was about 21,900 tons, 18,300 tons produced by Cia. Brasileira de Metalurgia e Mineracao (CBMM) and 3,550 tons produced by Mineracao Catalao de Goias S.A. CBMM also produced about 16,800 tons of ferrocolumbium, about 1,100 tons of columbium oxide, about 200 tons of vacuum-grade columbium alloys, and 55 tons of columbium metal. Brazil's consumption of columbium, based on contained columbium oxide, totaled 1,020 tons, compared with 1,250 tons in 1994.

Canada.—As reported by Teck Corp., production of columbium oxide contained in concentrate at the Niobec Mine at St. Honoré, Quebec, rose to about 3.37 million kilograms. About 96% of the material was processed at the mine's new concentrate-to-ferrocolumbium converter plant to produce about 2.2 million kilograms of columbium contained in ferrocolumbium, with the remaining material sold as concentrate. Niobec is a 50-50 joint venture between Teck, operator, and Cambior Inc., product marketing. Ore milled was 802,000 tons, as the mill operated on the average of 2,200 tons of ore per day. Ore blend for the year resulted in a decrease in average recovery to 57.9% and an increase in Nb_2O_5 grade of concentrate to 73%. Teck reported that mine ore reserves are sufficient for another 11 years. In 1996, mine production is expected to be about 3.31 million kilograms of columbium oxide contained in concentrate which will be converted to produce about 2.18 million kilograms of columbium contained in ferrocolumbium.[3]

In 1995, tantalum mining at the Bernic Lake, Manitoba, tantalum operation remained suspended. However, about 32,000 kilograms of contained tantalum oxide in concentrate was produced from tailings retreatment.

Japan.—According to The Tex Report, Japan's production of ferrocolumbium decreased substantially to 39 tons from the 947 tons reported in 1994. Columbium ore imported for ferrocolumbium production totaled 81 tons, with Nigeria accounting for more than 90% of the total. Ferrocolumbium imports totaled about 5,050 tons, with almost 90% of the

imports coming from Brazil. Ferrocolumbium exports totaled 56 tons, with most of the exports going to the Republic of Korea. Japan's consumption of ferrocolumbium totaled about 4,570 tons compared with about 4,550 tons in 1994.

Roskill's Letter from Japan reported that Japan's demand for tantalum, in the form of powder, compounds, and processed products, was about 315 tons compared with about 255 tons in 1994. Japan's production of tantalum capacitors was about 5.8 billion units compared with about 4.6 billion units in 1994.

Thailand.—In July, it was reported that Amalgamated Metal Corp. (AMC), United Kingdom, would buy into the Thailand Smelting and Refining Co. Ltd. (Thaisarco) tin smelter. The planned acquisition would give AMC approximately 75% control of Thaisarco.[4] Thai tin concentrates are high in tantalum content from which the Thaisarco smelter at Phuket produces a tantalum-bearing slag containing up to 17% tantalum oxide. However, tin mine production in Thailand has declined significantly over the past decade and Thaisarco now relies mainly on concentrates imported from Australia, Peru, Portugal, and occasionally from China. Increasing the throughput of imported concentrates likely will result in reduced tantalum content of the slags.

Outlook

Columbium.—The principal use for columbium remains as an additive in steelmaking, which annually accounts for about 80% of reported consumption in the United States. This trend is expected to continue, for there are no revolutionary market changes anticipated for the near term. 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. Also, American Metal Market reported that more columbium was being used by stainless steelmakers, with markets in the automotive emissions systems sector, to improve strength and formability. Additionally, columbium usage in 1995 was affected by increased demand for columbium-containing superalloys related to jet engine repair and maintenance work. Future growth for this end use will continue to be affected mainly by the demand for columbium-containing superalloys by the aircraft industry.

Tantalum.—In 1995, U.S. apparent consumption of tantalum totaled about 515,000 kilograms compared with about 430,000 kilograms in 1994. About 60% of the tantalum consumed was used to produce electronic components, mainly tantalum capacitors. U.S. factory sales of tantalum capacitors in 1995 continued at an alltime high, an increase of more than 30% over that in 1994. The surge in sales was driven by the accelerated usage of tantalum capacitors in electronic components such as cellular telephones and personal computers.

Industry sources indicate that the future growth of tantalum capacitors will be driven by the rapid growth of the electronics industry; the increasing functionality and speed of integrated circuits used in electronic equipment; and the changing technology in electronic circuit assembly where the usage of surface mounted tantalum capacitors are preferred. By the year 2000, worldwide consumption of tantalum capacitors is forecast to increase to about 25 billion units, a 6% annual growth rate. However, the annual per-unit requirement of tantalum powder and wire for tantalum capacitors is expected to decline at an annual rate of 6% and 5%, respectively. The forecast consumption of tantalum capacitors in the year 2000 will require about 794,000 kilograms of tantalum powder and about 159,000 kilograms of tantalum wire. Tantalum demand in the cemented carbide sector is expected to be limited by the use of coatings, which prolong tool life, and developments in processing to achieve near-to-shape form thereby minimizing any subsequent machining.[5]

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[1]Chemical Marketing Reporter. V. 248, No. 20, Nov. 13, 1995, p. 13.

Cabot Corp. 1995 Annual Report. 44 pp.

[2]Gwalia Consolidated Ltd. 1995 Annual Report, 52 pp.

[3]Teck Corp. 1995 Annual Report. 68 pp.

[4]Metal Bulletin. No. 7998, July 20, 1995, p. 5.

[5]Proceedings. International Symposium on Tantalum and Niobium, Goslar, Germany, Sept. 24-28, 1995. Tantalum-Niobium International Study Center, Brussels, Belgium, 516 pp.

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TABLE 1
SALIENT COLUMBIUM STATISTICS 1/

(Thousand kilograms of columbium content unless otherwise specified)

	1991	1992	1993	1994	1995
United States:					
Mine production of columbium-tantalum concentrates	(2/)	(2/)	--	--	--
Releases from Government excesses	--	--	--	--	--
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/	1,160	1,230	1,210	1,480	615
Columbium metal and columbium-bearing alloys e/	1	1	111	171 r/	257
Ferrocolumbium e/	2,130	2,450	2,190	2,590	3,580
Tin slag	NA	NA	NA	NA	NA
Consumption:					
Raw materials	NA	NA	NA	NA	NA
Ferrocolumbium and nickel columbium e/	2,410	2,460 r/	2,470	2,750	2,900
Apparent e/	3,310	3,500	3,500	3,700	3,800
Prices:					
Columbite, dollars per pound 3/	2.83	2.83	2.67	2.60	2.97
Pyrochlore, dollars per pound 4/	2.75	2.75	2.75	NA	NA
World: Production of columbium-tantalum concentrates e/	15,700	15,300	12,400	15,400 r/	17,800

e/ Estimated. r/ Revised. NA Not available.
1/ Data are rounded 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)

	1991	1992	1993	1994	1995
United States:					
Mine production of columbium-tantalum concentrates	(1/)	(1/)	--	--	--
Releases from Government excesses	--	--	--	--	--
Exports:					
Tantalum ores and concentrates (gross weight) 2/	11	17	11	23	1
Tantalum metal, compounds, alloys (gross weight)	219	136	235	242	281
Tantalum and tantalum alloy powder (gross weight)	66	61	57	46	41
Imports for consumption:					
Mineral concentrates e/	340	420	390	310	300
Tantalum metal and tantalum-bearing alloys 3/	19	14	67	73	181
Tin slag	NA	NA	NA	NA	NA
Consumption:					
Raw materials	NA	NA	NA	NA	NA
Apparent e/	370	375	410	430	515
Prices:					
Tantalite, dollars per pound 4/	30.06	28.19	26.41	26.24	26.98
World: Production of columbium-tantalum concentrates e/	477	399	310	333 r/	356

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, 1995 1/

(Thousand kilograms of columbium or tantalum content)

Material	Stockpile goals	Disposal authority	National Defense Stockpile inventory			
			Uncommitted 2/			
			Stockpile-grade	Nonstockpile-grade	Total	Committed
Columbium:						
Concentrates	--	--	427	341	768	--
Carbide powder	--	--	10	--	10	--
Ferrocolumbium	--	--	385	151	536	--
Metal ingots	--	--	20	--	20	--
Total	5,050 3/	--	842	492	1,330	--
Tantalum:						
Minerals	--	--	646	456	1,100	--
Carbide powder	--	--	13	--	13	--
Metal:						
Capacitor grade	--	--	73	(4/)	73	--
Ingots	--	--	46	--	46	--
Oxide	--	--	74	--	74	--
Total	3,960 3/	--	852	456	1,310	--

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ The stockpile also contained uncommitted inventories of 50,000 kilograms in columbium concentrates, 51,000 kilograms in columbium metal ingots, 74,000 kilograms in tantalum minerals, and 58,000 kilograms in tantalum metal ingots with status (inventory) not yet determined.
3/ Overall goals for the columbium and tantalum groups as of Sept. 30, 1995.
4/ 45 kilograms.

Source: Defense Logistics Agency, Defense National Stockpile Center.

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

(Kilograms of contained columbium 2/)

End use	1994	1995
Steel:		
Carbon	920,000	917,000
Stainless and heat-resisting	350,000	408,000
Full alloy	(3/)	(3/)
High-strength low-alloy	1,050,000	1,050,000
Electric	--	--
Tool	(4/)	(4/)
Unspecified	9,450	5,060
Total	2,330,000	2,380,000
Superalloys	411,000	506,000
Alloys (excluding alloy steels and superalloys)	(5/)	(5/)
Miscellaneous and unspecified	8,840	9,820
Total consumption	2,750,000	2,900,000
Stocks, Dec. 31:		
Consumer	NA	NA
Producer 6/	NA	NA
Total stocks	NA	NA

NA Not available.

1/ Data are rounded 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	1994 Quantity	1994 Value	1995 Quantity	1995 Value	Principal destinations and sources, 1995
Exports: 2/					
Columbium:					
Ores and concentrates	489	$4,500	96	$869	Netherlands 90, $779; Japan 1, $36; Korea, Republic of 1, $25; Germany 2, $17; Brazil 2, $12.
Ferrocolumbium	234	2,080	529	4,450	Mexico 233, $2,170; Canada 95, $861; Australia 73, $677; Netherlands 113, $364; South Africa 6, $70; Korea, Republic of 6, $24.
Tantalum:					
Synthetic concentrates	2	9	1	19	Thailand 1, $10; Taiwan (3/), $9.
Ores and concentrates	23	319	1	36	United Kingdom 1, $15; France 1, $13; Switzerland (3/), $7.
Unwrought and waste and scrap	146	6,610	143	5,990	Germany 39, $2,940; China 67, $1,090; United Kingdom 7, $694; Hong Kong 18, $294; Canada 3, $277; Japan 1, $171.
Unwrought powders	46	12,800	41	11,000	Germany 14, $3,880; France 13, $3,160; United Kingdom 6, $2,080; Japan 5, $1,420; Austria 3, $284; Taiwan 1, $185.
Unwrought alloys and metal	8	1,670	27	8,790	France 10, $3,070; United Kingdom 8, $2,620; Canada 5, $1,390; Barbados 1, $605; Germany 2, $580; Austria 1, $243.
Wrought	88	25,600	111	33,000	Japan 40, $15,700; United Kingdom 13, $4,690; Germany 17, $4,240; Canada 25, $2,870; Ireland 1, $446.
Total	XX	53,600	XX	64,200	Japan $17,400; Germany $11,700; United Kingdom $10,100; France $9,510; Canada $5,400; Mexico $2,180.
Imports for consumption:					
Columbium:					
Ores and concentrates	3,080	11,400	1,040	6,580	Canada 851, $5,400; Nigeria 117, $618; Russia 41, $355; Brazil 27, $130; Estonia 1, $53; Germany (3/), $13.
Oxide	757	11,600	1,320	20,200	Brazil 897, $13,000; Germany 153, $5,150; Russia 242, $1,430; Thailand 28, $434; China 2, $59; Belgium 1, $16.
Ferrocolumbium	3,980	34,000	5,510	45,000	Brazil 4,910, $39,100; Canada 601, $5,840; France 6, $63.
Unwrought alloys, metal, and powder	171	3,770	257	5,380	Brazil 156, $3,140; Germany 49, $924; Kazakstan 20, $605; Cyprus 14, $2 Russia 7, $164; United Kingdom 7, $129.
Tantalum:					
Synthetic concentrates	25	160	100	872	China 12, $626; Nigeria 31, $120; South Africa 13, $120; Australia 43, $6.
Ores and concentrates	1,090	25,400	1,020	23,400	Australia 323, $10,700; Brazil 170, $3,390; Burundi 123, $2,260; Nigeria 4 $1,510; China 69, $1,270; Thailand 127, $988.
Unwrought waste and scrap	268	13,600	364	28,500	Kazakstan 107, $13,300; Germany 77, $5,180; Japan 38, $2,920; Russia 21, $1,540; United Kingdom 18, $1,330; Hong Kong 12, $799.
Unwrought powders	60	10,700	101	21,600	Thailand 65, $13,700; Japan 17, $4,320; China 13, $2,850; Germany 2, $361; Kazakstan 2, $219; France 1, $109.
Unwrought alloys and metal	12	1,790	75	9,590	Germany 58, $7,170; Russia 7, $873; Kazakstan 6, $606; France 2, $415; Japan 1, $321; China 1, $198.
Wrought	1	368	5	1,500	Austria 1, $438; United Kingdom 1, $314; China 1, $218; Japan 1, $195; Switzerland (3/), $109; Korea, Republic of (3/), $72.
Total	XX	113,000	XX	162,000	Brazil $58,800; Germany $19,300; Thailand $15,200; Kazakstan $14,900; Canada $11,300; Australia $10,700.

XX Not applicable.

1/ Data are rounded 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/ Less than 1/2 unit.

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

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

(Thousand kilograms and thousand dollars)

Country	1994		1995	
	Gross weight	Value	Gross weight	Value
Brazil	--	--	27	130
Canada	3,070	11,300	851	5,400
Estonia	--	--	1	53
Germany 2/	--	--	(3/)	13
Nigeria	--	--	117	618
Russia	--	--	41	355
Thailand	9	136	--	--
United Kingdom 2/	--	--	2	10
Total	3,080	11,400	1,040	6,580

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Presumably country of transshipment rather than original source.
3/ Less than ½ unit.

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

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

(Thousand kilograms and thousand dollars)

Country	1994		1995	
	Gross weight	Value	Gross weight	Value
Australia	410	12,500	323	10,700
Belgium 2/	26	727	20	403
Brazil	162	3,340	170	3,390
Burundi	122	2,690	123	2,260
Canada	19	420	--	--
China	116	2,080	69	1,270
Ethiopia	--	--	7	263
Germany 2/	--	--	22	423
Japan 2/	--	--	(3/)	12
Kazakstan	17	182	18	174
Malaysia	--	--	10	154
Nigeria	5	142	40	1,510
Rwanda	72	1,400	31	598
Singapore 2/	6	99	--	--
South Africa	--	--	1	37
Spain	9	162	25	459
Thailand	100	1,100	127	988
Zaire	10	181	32	677
Zimbabwe	15	322	--	--
Total	1,090	25,400	1,020	23,400

1/ Data are rounded to three significant digits; may not add totals shown.
2/ Presumably country of transshipment rather than original source.
3/ Less than ½ unit.

Sources: Bureau of the Census 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	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.
	Mineracoa Catalao de Goias 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/	
	H. C. Starck GmbH & Co. KG.	

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

TABLE 9
PRINCIPAL WORLD PRODUCERS OF COLUMBIUM AND TANTALUM PRODUCTS

Country		Products1/
Austria	Treibacher Chemische Werke 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,Ta carbide.
	Mineracao Catalao de Goias S.A. (Catalao)	FeNb.
Estonia	Silmet	Nb oxide.
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	Japan Metals & Chemicals Co. Ltd.	FeNb.
	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.
Kazakstan	Ulba Metallurgical	Ta oxide/metal.
Russia	Solikamsk Magnesium Works	Nb and Ta oxide/metal, K-salt.
Thailand	Thai Tantalum Inc.	K-salt, Ta metal.
United Kingdom	London & Scadinavian Metallurgical Co. Ltd. 2/	Nb and Ta carbide.
United States	Cabot Corp.	Nb and Ta oxide/metal, K-Salt, FeNb, NiNb, Ta capacitor powder.
	H. C. Starck Inc. 5/	Nb and Ta metal, Ta capacitor powder.
	Kennametal, Inc.	Nb and Ta carbide.
	Reading Alloys, Inc.	FeNb, NiNb.
	Shieldalloy Metallurgical Corp. 2/	FeNb, NiNb.
	Teledyne Wah Chang Albany	Nb oxide/metal, FeNb, NiNb.
	Thai Tantalum Inc.	Ta capacitor powder.

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 USA and H. C. Starck GmbH & Co. KG.

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/				
	1991	1992	1993	1994	1995 e/	1991	1992	1993	1994	1995	1991	1992	1993	1994	1995
Australia: Columbite-tantalite e/	703	656	495	700	900	94	69	50	81	109	218	224	170	238	274
Brazil: e/															
Columbite-tantalite	290	200	175	175	175	66	45	40	40	40	84	60	50	50	50
Pyrochlore	30,500	29,600	22,700	30,700 r/	36,400	12,800	12,500	9,540	12,900 r/	15,300	--	--	--	--	--
Canada:															
Pyrochlore e/	5,230	5,100	5,320	5,130	5,230	2,350	2,300	2,390	2,310	2,350	--	--	--	--	--
Tantalite e/	380	200	100	144 r/	105	15	8	5	7 r/	5	93	48	25	36 r/	26
Nambia: Tantalite	(6/)	(6/)	--	--	(6/) 7/	(6/)	(6/)	--	--	NA	(6/)	(6/)	--	--	(6/) 7/
Nigeria: Columbite e/	36	40	40	30 r/	30	15	17	17	13 r/	13	2	2	2	2	2
Rwanda: Columbite-tantalite e/	100	100	100	10	--	30	30	30	3	--	22	22	22	2	--
South Africa: Columbite-tantalite e/	(6/)	(6/)	(6/)	--	-- 7/	(6/)	(6/)	(6/)	--	-- 7/	(6/)	(6/)	(6/)	--	-- 7/
Spain: e/ Tantalite	8	8	6	6	5	NA	NA	NA	NA	NA	2	2	2	2	1
Thailand: Columbite-tantalite	3	--	--	--	--	1	--	--	--	--	1	--	--	--	--
Zaire: Columbite-tantalite	57	29	20	4	4	15	8	5	1	1	16	8	6	1	1
Pyrochlore e/	780	780	780	--	--	350	350	350	--	--	--	--	--	--	--
Zimbabwe: Columbite-tantalite e/	111	94	94	7	7	17	14	14	1	1	39	33	33	2	2
Total	38,100	36,800	29,800	36,900 r/	42,900	15,700	15,300	12,400	15,400 r/	17,800	477	399	310	333 r/	356

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

1/ Data are rounded 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: 1991--244; 1992--160; 1993--132; 1994--NA; and 1995--NA according to data from the Tantalum-Niobium International Study Center. Table includes data available through Aug. 1, 1996.

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 concentratres 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 estimates based on, in most part, reported gross weight and/or pentoxide content.

6/ Less than 1/2 unit.

7/ Reported figure.