Columbium and Tantalum

By Joseph A. Sutton [1]

The extremely high inventories of columbium ores and concentrates built up by industry during 1969 and 1970 were reduced to more reasonable levels in 1971. These high levels were responsible for the depressed market that occurred during 1971. Consumption of columbium and tantalum raw materials was 33 percent below that of 1970, while consumption of ferrocolumbium (FeCb), ferrotantalum-columbium (FeTa-Cb), and other columbium and tantalum materials increased 11 percent. The primary use of FeCb, FeTa-Cb, and other columbium and tantalum materials remained in the production of alloy steels. Tantalum continued to be primarily used in capacitors and other electronic devices for military applications and the aerospace program. A newly discovered group of organometallic superconductors, containing tantalum and columbium as base materials, hold promise for use in magnets and other electrical devices.

Legislation and Government Programs.—Public Law 92–109, signed on August 11, 1971, gave the Administrator of GSA authority to dispose of 5,010,716 pounds (Cb content) of columbium from the national and supplemental stockpile inventories. Constituent makeup of this material includes approximately 4,376,758 pounds, concentrates; 1,614 pounds, columbium carbide powder; 95,383 pounds, columbium oxide powder; and 536,916 pounds, ferrocolumbium. At yearend none of the material authorized for sale had been sold.

The quantities of columbium and tantalum materials reported in government inventories as of December 31, 1971, are listed on Table 3.

During 1971 the Office of Minerals Exploration (OME), U.S. Geological Survey, continued to offer financial assistance of 50 percent (columbium) and 75 percent (tantalum) of costs for exploration of approved columbium and tantalum resources.

[1] Physical scientist, Division of Ferrous Metals.

Table 1.—Salient columbium statistics

(Thousand pounds)

	1967	1968	1969	1970	1971
United States:					
Mine production of columbite-tantalite concentrates	W	W	W	W	W
Releases from Government stocks (Cb content) [1 2]	779	1,191	1,573	617	--
Consumption of concentrate: Columbium metal contained in all raw materials consumed (Cb content) [1]	4,519	3,997	2,918	3,289	1,991
Production of primary products:					
Columbium metal (Cb content)	W	W	W	W	W
Ferrocolumbium and ferrotantalum-columbium (Cb + Ta content)	1,960	2,380	2,554	1,430	1,020
Consumption of primary products:					
Columbium metal (Cb content)	111	92	179	261	459
Ferrocolumbium and ferrotantalum-columbium (Cb + Ta content)	3,192	3,094	3,328	2,591	2,880
Exports:					
Columbium ore and concentrate (gross weight)	NA	NA	NA	NA	NA
Columbium metal, compounds, and alloys (gross weight)	6	7	41	46	21
Imports for consumption:					
Columbium mineral concentrate (gross weight)	7,431	3,657	4,161	5,719	3,054
Columbium metal and columbium-bearing alloys (Cb content)	[3]	1	5	2	1
Ferrocolumbium (gross weight) [e]	629	1,171	NA	NA	NA
World: Production of columbium-tantalum concentrates (gross weight)	20,551	23,857	31,451	44,934	23,261

[e] Estimate. NA Not available. W Withheld to avoid disclosing individual company confidential data.

[1] Includes columbium content in raw materials from which columbium is not recovered.

[2] Includes material released as payment-in-kind for upgrading.

[3] Less than ½ unit.

Table 2.—Salient tantalum statistics

(Thousand pounds)

	1967	1968	1969	1970	1971
United States:					
Mine production of columbium-tantalum concentrates	W	W	W	W	W
Releases from Government stocks (Ta content) [1] [2]	307	163	171	100	--
Consumption of concentrate: Tantalum metal contained in all raw materials consumed (Ta content) [1]	1,730	1,060	928	1,733	1,359
Production of primary products:					
Tantalum metal (Ta content)	1,021	692	1,046	916	892
Ferrocolumbium and ferrotantalum-columbium (Cb + Ta content)	1,960	2,380	2,554	1,430	1,020
Consumption of primary products: Tantalum metal (Ta content)	443	423	751	417	649
Ferrocolumbium and ferrotantalum-columbium (Cb + Ta content)	3,192	3,094	3,328	2,591	2,880
Exports:					
Tantalum ore and concentrate (gross weight)	75	65	85	122	48
Tantalum metal, compounds, and alloys (gross weight)	59	106	124	640	194
Tantalum and tantalum alloy powder (Ta content)	51	84	100	139	85
Imports for consumption:					
Tantalum mineral concentrates (gross weight)	1,675	1,230	975	1,046	1,180
Tantalum metal and tantalum-bearing alloys (Ta content)	55	18	11	51	40
World: Production of columbium-tantalum concentrates (gross weight)	20,551	23,857	31,451	44,934	23,261

W Withheld to avoid disclosing individual company confidential data.
[1] Includes tantalum content in raw materials from which tantalum is not recovered.
[2] Includes material released as payment-in-kind for upgrading.

Table 3.—Columbium and tantalum materials in Government inventories as of Dec. 31, 1971

(Thousand pounds, columbium and tantalum content)

Material	Objective	National (strategic) stockpile	Defense Production Act (DPA) inventory	Supplemental stockpile	Total
COLUMBIUM					
Concentrates	--	5,799	1,600	358	7,757
Carbide powder: Stockpile grade	20	21	--	--	21
Ferrocolumbium:					
Stockpile grade	930	556	--	--	556
Nonstockpile grade	--	738	--	--	738
Metal: Stockpile grade	45	45	--	--	45
Oxide powder: Stockpile	--	86	--	--	86
TANTALUM					
Tantalum minerals: Stockpile grade	2,947	3,151	756	6	3,913
Carbide powder: Stockpile grade	27	29	--	--	29
Metal: Stockpile grade	360	201	--	--	201

DOMESTIC PRODUCTION

Domestic mining activity was again insignificant. Small quantities of columbium and tantalum were produced by one company during exploration and development work in Larimer County, Colo., but none of the material was marketed.

Production of columbium metal powder increased 53 percent in 1971 while production of tantalum metal (including capacitor-grade powder) decreased 3 percent; however, data continued to be withheld to avoid disclosing individual company confidential data. There was a 66-percent increase in production of columbium metal ingots and a 19-percent decrease in production of tantalum metal ingots during the year, but production figures also cannot be revealed.

Ferrocolumbium and columbium base master alloys were produced by the thermite process by the Reading Alloys Co., Inc., and Shieldalloy Corp. Foote Mineral Co., Kawecki Division of Kawecki Berylco Industries, Inc., Molybdenum Corp. of America (Molycorp), and Union Carbide Corp. produced these alloys in electric furnaces. During 1970 and 1971 there was no production of ferrotantalum-columbium.

Table 4.—Major domestic columbium and tantalum processing and producing companies in 1971

Company	Location	Columbium	Tantalum	Tantalum carbide	Ferrocolumbium
Allegheny-Ludlum Industries, Inc	Brackenbridge, Pa, Watervliet, N.Y	X	--	--	--
Arnold Engineering	Marengo, Ill	X	--	--	--
Fansteel Inc	Muskogee, Okla	X	X	--	--
Kawecki Division, Kawecki Berylco Industries, Inc	Boyertown, Pa	X	X	X	X
Kennametal, Inc	Latrobe, Pa	X	X	X	--
Mallinckrodt Chemical Works	St. Louis, Mo	X	X	--	--
Mining and Metals Division, Union Carbide Corp	Niagara Falls, N.Y, Marietta, Ohio, Greenville, S.C	X	X	--	X
Molybdenum Corp. of America	Washington, Pa	--	--	--	X
Metals Division, Norton Co	Newton, Mass	--	X	--	--
Newcomer Products, Inc	Latrobe, Pa	X	--	X	--
Reading Alloys, Co., Inc	Robesonia, Pa	--	--	--	X
Shieldalloy Corp	Newfield, N.J	X	--	--	X
Metallurgical Products Division, Foote Mineral Co.	Cambridge, Ohio	--	--	--	X
Wah Chang Albany (A Teledyne Company)	Albany, Oreg	X	X	X	--

CONSUMPTION AND USES

Columbium consumed in the form of high-purity metal totaled 458,986 pounds, an increase of 76 percent over the total for 1970. Tantalum metal (including capacitor-grade powder) consumed during the year increased from the 416,620 pounds reported in 1970 to 648,656 pounds. Tantalum metal continued to be used primarily in powder or ingot form in the manufacture of capacitors, other electronic equipment, and corrosion-resistant chemical equipment.

Consumption of ferrocolumbium (FeCb), ferrotantalum-columbium (FeTa–Cb), and other columbium and tantalum materials increased in all end-use categories except alloys steels (excluding stainless and heat-resisting steels). The greatest single volume increase occurred in carbon steels. Total consumption of columbium plus tantalum in these forms increased 11 percent to nearly 2.9 million pounds in 1971. Domestic consumption of FeCb, FeTa-Cb, and other columbium and tantalum materials, by major end-use categories was as follows: Carbon steel (29 percent), alloy steel other than stainless and heat-resisting steel (27 percent), superalloys (21 percent), stainless and heat-resisting steel (20 percent), miscellaneous and unspecified (2 percent), and alloy other than alloy steels and superalloys (1 percent).

Use of columbium and tantalum in ferroalloys for additions to steels to control grain size accounted for approximately 76 percent of the FeCb, FeTa-Cb, and other columbium and tantalum materials consumed. Total quantity of ferrocolumbium consumed in alloy steelmaking was over 2.2 million pounds, an increase of 7 percent over the total for 1970.

Consumption of ferrotantalum-columbium continued to be small and amounted to about 1 percent of the FeCb, FeTa-Cb, and other columbium and tantalum materials consumed. Carbon and stainless and heat-resisting steels continued to be the major end-use categories for FeTa-Cb. Consumption of FeTa-Cb in making carbon steel was 11 percent below that recorded for 1970 and consumption of FeTa-Cb in making stainless and heat-resisting steel declined 73 percent.

Consumption of other tantalum and columbium materials was equal to about 4 percent of the total FeCb, FeTa-Cb, and

other columbium and tantalum materials consumed. Superalloys remained as the major end-use category and consumption was increased by 20 percent in 1971.

The metals division of the Norton Co. introduced a new capacitor-grade tantalum wire (SGSR), used in the manufacturing of capacitors. The tantalum wire was to be used as the contact between the sintered powder electrode and the outside circuitry.

Table 5.—Reported shipments of columbium and tantalum materials

(Pounds of metal content)

Material	1970	1971	Percent change
Columbium products:			
Compounds including alloys	1,098,600	689,550	−37.2
Metal including worked products	203,600	270,500	+32.9
All other	15,600	6,800	−56.4
Total Cb	1,317,800	966,850	−26.6
Tantalum products:			
Oxides and salts	90,200	60,900	−32.5
Alloy additive	28,200	48,800	+73.0
Carbide	145,600	135,000	−7.3
Powder and anodes	498,700	398,700	−20.1
Ingot (unworked consolidated metal)	54,400	42,400	−22.1
Mill products	213,300	223,300	+4.7
Scrap	78,600	52,400	−33.3
Other	9,200	--	--
Total Ta	1,118,200	961,500	−14.0

Table 6.—Consumption of ferrocolumbium, ferrotantalum-columbium, and other columbium and tantalum materials in the United States in 1971, by end use

End use	Pounds of contained columbium plus tantalum
Steel:	
Carbon	821,668
Stainless and heat-resisting	588,411
Alloy (excludes stainless and heat-resisting)	789,507
Superalloys	591,063
Alloys (excludes alloy steels and superalloys)	37,665
Miscellaneous and unspecified [1]	51,523
Total	2,879,837

[1] Includes tool steel.

STOCKS

The following yearend columbium and tantalum materials (given in pounds) were reported in inventories:

Material	Dec. 31, 1970	Dec. 31, 1971
COLUMBIUM		
Primary metal	71,200	60,303
Ingot	34,581	45,324
Scrap	r 74,711	67,503
Oxide	r 1,228,522	1,051,357
Other compounds	r 222,063	353,776
TANTALUM		
Primary metal	r 250,122	269,249
Capacitor-grade powder	r 216,702	163,320
Ingot	114,279	86,452
Scrap	r 257,704	271,663
Oxide	168,895	114,713
Potassium tantalum fluoride (K_2TaF_7)	r 114,927	211,248
Other compounds	r 44,652	--

r Revised.

Stocks of columbium and tantalum raw materials, as reported by consumers and dealers at yearend 1971, were as follows (in short tons—1970 figures in parentheses): Columbite, 521 (714); tantalite, 1,322 (1,461); pyrochlore, 595 (767); tin slag, 35,787 (31,055); and other, none (172).

Consumers inventories of ferrocolumbium and ferro-tantalum-columbium as of December 31, 1971, were as follows (with 1970 yearend stocks in parentheses): Ferrocolumbium, 758,828 pounds contained columbium plus tantalum (820,458); ferrotantalum-columbium, 34,737 pounds contained columbium plus tantalum (17,108); and other Cb and Ta materials,

31,818 pounds contained columbium plus tantalum (41,230). Producer stocks of ferrocolumbium at yearend 1971 were 534,000 pounds contained Cb (852,000).

PRICES

Spot prices for columbite ore, c.i.f. U.S. ports, as reported by Metals Week decreased from $1.00–$1.05 per pound of contained pentoxides for material having a Cb_2O_5 to Ta_2O_5 ratio of 10 to 1 at the beginning of 1971 to $0.75–$0.80 per pound at yearend. Under long-term contracts columbite reportedly sold at discounts from the spot quotations, but prices were subject to negotiation and no quotations were published. The quoted prices for Brazilian and Canadian pyrochlore concentrates remained constant during the year. Brazilian concentrate, f.o.b. shipping point, was quoted at $1.15 per pound of Cb_2O_5; and Canadian pyrochlore concentrate, f.o.b. mine or mill, was quoted at $1.15–$1.20 per pound of Cb_2O_5. The yearend price for tantalite ore and concentrate, 60-percent basis, was $6.25–$6.75 per pound Ta_2O_5, c.i.f. U.S. ports, as compared to $6.75–$7.50 at the beginning of the year.

The quoted prices for various grades of ferrocolumbium per pound of columbium content, ton lots, f.o.b. shipping points, at the beginning of the year were as follows: Low alloy, standard grades, $2.65 to $4.12; and high-purity grades, $5.38 to $6.81. From late in May until yearend, quotations fell to $2.45–$2.65 for the low-alloy grades and to $4.12–$6.81 for the high-purity grades.

The quoted price of tantalum metal remained constant during 1971 and was $28.50 to $38.50 per pound of powder, $36 to $60 per pound for sheet, and $36 to $50 for rod.

The price of columbium metal remained unchanged during the year. Columbium-powder roundels, 99.5 to 99.8 percent purity, were quoted at $11 to $22 per pound for metallurgical-grade material, and $17.50 to $28 per pound for reactor-grade material.

Table 7.—Average grade of concentrate received by U.S. consumers and dealers in 1971, by country of origin

(Percent of contained pentoxides)

	Columbite		Tantalite	
	Cb_2O_5	Ta_2O_5	Ta_2O_5	Cb_2O_5
Argentina	--	--	28	32
Australia	41	21	44	25
Belgium	--	--	43	38
Brazil [1] [2]	57	--	40	27
Canada [2]	51	--	50	4
French Guiana	--	--	54	28
Germany, West	31	32	--	--
Kenya	69	41	7	34
Malaysia [1]	69	19	17	55
Mozambique	--	--	39	21
Nigeria [1]	42	5	28	39
Portugal	--	--	33	35
Rwanda	--	--	26	41
South Africa, Republic of	--	--	33	44
Spain	--	--	31	36
Thailand [1]	--	--	30	32
Uganda	56	18	--	--

[1] Excludes tin slag.
[2] Material reported from Brazil or Canada as columbite represents primarily pyrochlore.

FOREIGN TRADE

West Germany, Japan, France, Canada and the United Kingdom received the majority of the columbium and tantalum exports during the year. Unwrought tantalum alloys in crude form and scrap, the largest export item by volume, were shipped to West Germany (64 percent), the United Kingdom (12 percent), Canada (8 percent), Japan (8 percent), and other Western Europe countries (8 percent). Tantalum and tantalum alloy powder, the largest value item, were destined for West

Table 8.—U.S. exports of columbium and tantalum, by class

(Thousand pounds, gross weight, and thousand dollars)

Class	1970		1971	
	Quantity	Value	Quantity	Value
Columbium and columbium alloys, unwrought, and waste and scrap	38	$153	3	$63
Columbium and columbium alloys, wrought	8	409	18	525
Tantalum ores and concentrates	122	422	48	146
Tantalum and tantalum alloys, wrought	31	1,461	26	1,175
Tantalum metals and alloys in crude form and scrap	609	2,001	168	1,290
Tantalum and tantalum alloy powder	139	4,367	85	2,519

Germany (29 percent), Japan (21 percent), the United Kingdom (18 percent), France (13 percent), the Netherlands (6 percent), Italy (6 percent), and Canada (4 percent). The remainder of the tantalum powder exported (3 percent of the total) was destined for Switzerland, Austria, India, and Brazil. Wrought tantalum and tantalum alloys, the smallest tantalum item by volume, were exported to West Germany (19 percent), Belgium-Luxembourg (18 percent), Japan (16 percent), France (12 percent), the United Kingdom (10 percent), the Netherlands (10 percent), and Canada (6 percent). The remainder of the tantalum material (9 percent of the total) was exported to Italy, India, Austria, Switzerland, Argentina, Australia, Chile, Mexico, and Ireland. Tantalum ore and concentrate, believed not to be of domestic origin, was shipped to Japan. Wrought columbium and columbium alloys were mostly exported to France (37 percent), Canada (28 percent), Japan (14 percent), West Germany (12 percent), and the United Kingdom (8 percent). Unwrought columbium alloys in crude form and scrap were shipped to Japan (78 percent), West Germany (18 percent), and Canada (4 percent).

Imports for consumption of unwrought columbium metal and waste and scrap decreased sharply in terms of volume received, while value remained close to that reported in 1970. West Germany supplied 450 pounds of unwrought columbium metal, waste, and scrap valued at $7,227. Imports of wrought columbium metal alloys shipped entirely from West Germany were reported to total 30 pounds valued at $1,493. A small quantity of wrought columbium, totaling 76 pounds and valued at $16,526, was received from France (95 percent) and the United Kingdom (5 percent). Imports for consumption of unwrought tantalum metal, including waste and scrap, decreased approximately 28 percent during the year to 40,091 pounds tantalum content, valued at $278,799. The material was imported from Mexico (56 percent), United Kingdom (40 percent), and Japan, Canada, and West Germany (4 percent). Imports of wrought tantalum, primarily from West Germany, increased by a factor of little more than 5 during the year to 111 pounds tantalum content, valued at $5,214. A small quantity of unwrought tantalum alloy, totaling 7 pounds and valued at $279, was received from West Germany.

In 1971 imports of columbium-mineral concentrates were 47 percent below those of 1970, while tantalum-mineral concentrates imported in 1971 remained about equal to those of 1970.

Receipts of tin slags came primarily from Malaysia and Thailand.

Table 9.—Receipts of tin slags reported by consumers

(Thousand pounds)

Year	Gross weight	Cb_2O_5 content	Ta_2O_5 content
1968	8,709	541	510
1969	8,327	649	453
1970	10,275	713	573
1971	9,064	753	596

Table 10.—U.S. imports for consumption of columbium-mineral concentrates, by country

(Thousand pounds and thousand dollars)

Country	1969		1970		1971	
	Quantity	Value	Quantity	Value	Quantity	Value
Angola	22	$42	19	$47	22	$52
Argentina	--	--	8	14	--	--
Belgium-Luxembourg [1]	41	72	37	68	32	60
Brazil	2,462	1,440	3,312	2,430	1,927	1,222
Burundi-Rwanda	48	62	21	38	[2] 18	[2] 24
Canada	920	473	1,271	669	341	267
Congo (Brazzaville)	--	--	--	--	11	23
Germany, West	--	--	7	23	11	3
Malaysia	59	49	104	103	60	44
Mozambique	4	7	10	19	12	18
Netherlands [1]	69	48	--	--	--	--
Nigeria	423	267	682	478	483	307
Portugal	--	--	32	75	14	26
Singapore	--	--	19	21	31	31
Spain	20	37	--	--	11	21
Uganda	3	2	4	3	--	--
United Kingdom	--	--	50	75	--	--
Zaire (formerly Congo Kinshasa)	90	182	143	282	81	124
Total	4,161	2,681	5,719	4,345	3,054	2,222

[1] Presumably country of transshipment rather than original source.
[2] Rwanda separately classified Jan. 1, 1971.

Table 11. U.S. imports for consumption of tantalum-mineral concentrates, by country

(Thousand pounds and thousand dollars)

Country	1969		1970		1971	
	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	--	--	2	$10	2	$8
Australia	75	$170	13	31	62	174
Belgium-Luxembourg [1]	30	97	17	42	14	35
Brazil	253	767	178	624	159	549
Burundi-Rwanda	31	47	31	58	[2] 31	[2] 55
Cameroon	--	--	4	12	--	--
Canada	220	1,195	477	1,724	522	1,818
French Guiana	--	--	2	6	2	8
Germany, West	--	--	--	--	31	62
Japan	25	15	5	8	--	--
Malaysia	77	350	--	--	16	10
Mozambique	8	23	4	10	47	108
Nigeria	--	--	10	22	50	33
Portugal	19	36	--	--	7	11
South Africa, Republic of	27	40	52	105	20	29
Spain	9	22	--	--	35	69
Tanzania	22	40	--	--	--	--
Thailand	--	--	--	--	26	52
Uganda	--	--	22	45	4	4
United Kingdom	--	--	7	13	--	--
Western Africa, n.e.c	179	394	222	521	152	307
Zaire (formerly Congo Kinshasa)						
Total	975	3,196	1,046	3,231	1,180	3,332

[1] Presumably country of transhipment rather than country of origin.
[2] Rwanda separately classified Jan. 1, 1971.

Table 12.—U.S. import duties

Tariff classification number	Article	Rate of duty per pound [1]	
		Effective Jan. 1, 1971	Effective Jan. 1, 1972
601.21	Columbium concentrate	Free	Free.
601.42	Tantalum concentrate	do	Do.
607.80	Ferrocolumbium and ferro-tantalum-columbium.	6 percent ad valorem	5 percent ad valorem.
	Columbium:		
628.15	Unwrought, waste, scrap	do	Do.
628.20	Wrought	10.5 percent ad valorem	9 percent ad valorem.
628.17	Unwrought Cb alloys	9 percent ad valorem	7.5 percent ad valorem.
	Tantalum:		
629.05	Unwrought, waste, scrap	6 percent ad valorem	5 percent ad valorem.
629.10	Wrought	10.5 percent ad valorem	9 percent ad valorem.
629.07	Unwrought Ta alloys	9 percent ad valorem	7.5 percent ad valorem.
423.00	Columbium and tantalum chemicals.	6 percent ad valorem	5 percent ad valorem.

[1] Not applicable to Communist countries.

WORLD REVIEW

Arab Republic of Egypt.—Tantalum and columbium deposits in an area 25 miles west of Marsa Alam on the Red Sea coast was discovered by the Egyptian Geological Survey and Mining Authority.[2] The deposits were reported to be located at Abu Dabbad and Nuweibi. Preliminary surveys by Russian and Egyptian experts indicate that there were 10 million tons of tantalum bearing material in the Abu Dabbad deposit and approximately 45 million tons in the Nuweibi deposit.

Australia.—Exploration on the Wodgina, Strelley, and Tabba properties of Goldrim Australia, continued during the year. Samples taken from the Strelley property were reported to average 3 pounds Ta_2O_5 per ton representing a zone approximately 1,030 feet in length and 100 feet in width.[3]

Brazil.—As a result of the decreased demand for columbium, Brazilian columbium production in 1971 was about half of that produced in 1970. Companhia Brasileira de Metalúrgia e Mineração (CBMM), the country's leading producer, continued to recover columbium concentrate from rich pyrochlore ores at the Araxa company mine and mill operations and to produce ferrocolumbium (FeCb) at its pyrometallurgical plant by a thermite-type batch process. In 1970, approximately 4.2 million pounds of FeCb were produced from 6.6 million pounds of pyrochlore concentrate. With the exception of approximately 0.8 million pounds sold domestically, all of the FeCb was exported to the United States, Japan, and European countries. In 1971, FeCb production was approximately 26 percent below that reported in 1970.

During 1970 CBMM's flotation plant was expanded by the addition of a new 8- by 14-foot Marcy mill and complementary magnetic separators, pulp distributors, and flotation cells, which brought production capacity to the present level of 25 million pounds of Cb_2O_5 per year.

During the year CBMM built a new plant for producing high-purity columbium oxide from a process developed by the Molybdenum Corp. of America. The new plant has an annual capacity of 1 million pounds, but no columbium oxide was produced in 1971.

Canada.—Production of pyrochlore concentrate by St. Lawrence Columbium and Metals Corp., Canada's only producer, decreased during 1971 from the peak reached in 1970. The milling operation in fiscal 1971 (ended September 30, 1971) produced 408,500 tons of ore, a decrease of 44 percent from the 724,345 tons produced in fiscal 1970. The general slowdown in the steel industry, a major outlet for the company's product, caused the company to shutdown its mining and milling operations for a 6-week period in 1971.[4]

The development of a second major columbium mine in Canada was continued as a joint undertaking by the Keevil Mining Group of Toronto and the Quebec Government exploration company, SOQUEM. The deposit located at St. Honore, near

[2] Mining Journal (London). Phosphates and Tantalum. V. 277, No. 7102, Oct. 1, 1971, p. 295.
[3] Tron, A. R. Columbium (Niobium) and Tantalum. Min. Ann. Rev., June 1971, p. 74.
[4] The Northern Miner. Production Resumed by St. Lawrence at Columbium Mine. V. 57, No. 24, Sept. 2, 1971, p. 19.

Chicoutimi, Quebec, was discovered in 1967 by SOQUEM. The Copperfields Mining Corp. Ltd. secured participation rights in 1968, after submitting a successful bid in response to SOQUEM's tender.[5] Development work was first proved up by SOQUEM, after which a joint development arrangement was made with Keevil interests through Copperfields Mining Corp.

Results of metallurgical work conducted at the SOQUEM research laboratories indicate that a salable pyrochlore concentrate can be produced with acceptable recoveries according to N. B. Keevil, President of the Keevil group.[6]

Present ore reserves of the columbium deposit were estimated to be approximately 60 million tons averaging 0.65 percent Cb_2O_5 to a vertical depth of about 850 feet, proven by over 70,000 feet of diamond drilling in an area 1,800 feet long and 2,400 feet wide. According to the Copperfields Mining Corp. either an underground or an open pit mine facility will probably become operational at St. Honore in 1973.

Chemalloy Minerals Ltd., Toronto, Ontario, which now has 100-percent control of Tantalum Mining Corporation of Canada Ltd. (TANCC), was planning a $3.5 million expansion at its Bernic Lake, Manitoba, tantalum mine. The expansion project includes the provision of a lithium mill and concentrator, but construction will not begin until the company completes financing arrangements and negotiations for the sale of lithium. In 1970 TANCC produced about 315,000 pounds of Ta_2O_5 at Bernic Lake.[7]

A new tantalum deposit was discovered beneath the existing one at Bernic Lake, and TANCC started a new drilling and development program to determine the extent and grade of the new discovery.[8]

Nord Interex Ltd. and Armco Steel Corp. discovered deposits of columbium and uranium at the Nova Meaucage property at North Bay, Ontario.[9] Extensive drilling indicated that the deposits contain approximately 3.6 million tons of mineralization averaging 0.63 percent columbium and 0.032 percent uranium oxide per ton. Further exploratory drilling was planned.

Canada's first ferroalloy plant in the western provinces was opened in the Roberts Bank area at Surrey, British Columbia in October by Fundy Chemical Corp.[10] The new facility has an overall annual capacity of approximately 6.4 million pounds to produce such alloys as ferrocolumbium, ferrotantalum, ferromolybdenum, and ferrotungsten by the thermite process.

Japan.—A new tantalum refining company was formed in Japan.[11] The new company, Showa-KBI, was founded with capital supplied by the Japanese company Showa Denko K. K. and the American company Kawecki Berylco Industries, Inc. The new company was to produce high-quality tantalum powder, wire, sheet, and other tantalum mill products.

Nigeria.—Nigeria continued to rank third (behind Brazil and Canada) in production of columbium raw material. The largest suppliers of columbite concentrates, a coproduct of the tin industry, were Amalgamated Tin Mines of Nigeria, Ltd. (ATMM), Bisichi Tin Co. Ltd., Jantor Ltd., and Tin and Associated Minerals Ltd.

Nigeria's National Development Plan, covering the years 1970–74, was launched by General Gowon, Nigerian Head of State.[12] The aim of the plan was to make Nigeria a united, strong, and self-reliant nation. It was proposed that the country be divided into seven zones and that the mineral resources be investigated in detail in collaboration with selected overseas organizations, under arrangements which will ensure that the results of such investigations remain the property of the appropriate agency of the Federal Government. It was noted that foreign interests will be encouraged by the offering of incentives in the way of concessions or financial reward. The seven zones were outlined as: Area I —North-Western and Kwara States; Area

---

[5] Mining Magazine. St. Honore Columbium Development. V. 125, No. 6, December 1971, p. 521.
[6] The Northern Miner. Copperfields, SOQUEM Plan Production of Columbium. V. 56, No. 43, Jan. 14, 1971, pp. 1 and 13.
[7] World Minerals and Metals. Chemalloy to Expand Tantalum Mine. No. 3, September–October 1971, p. 22.
[8] Wall Street Journal. Chemalloy Minerals Reports Possible New Tantalite Zone. V. 181, No. 46, Mar. 7, 1972, p. 16.
[9] Metal Bulletin. Nord Venture Mineral Find. No. 5652, Nov. 23, 1971, p. 7.
[10] Metals Week. Canada's New Ferroalloy Production. V. 42, No. 50, Dec. 13, 1971, p. 5.
[11] American Metal Market. Japanese Report Kawecki Berylco Ready to Establish Joint Tantalum Venture. V. 78, No. 247, Dec. 28, 1971, p. 16.
[12] Mining Journal (London). National Plan Launched. V. 275, No. 7057, Nov. 20, 1970, pp. 452–453.

II—Kano and North-Central States; Area III—Benae-Plateau State; Area IV—North-Eastern States; Area V—Western and Lagos States; Area VI—East-Central, Rivers and South-Eastern States; Area VII—Mid-West States. Of these seven zones, Area III accounts for more than 90 percent of Nigeria's production of columbite.

Zaire (formerly Congo Kinshasa).—Congo-Etain, a Congolese company owned 50 percent by the Congolese Government and 50 percent by the Belgian company Compagnie Géologique et Minière des Ingénieurs et Industriels Belges (GÉOMINES), produced approximately 178,000 pounds of columbite-tantalite concentrate in 1970, which was equal to a little more than half of Zaire's 1970 columbite-tantalite production.

Somikubi-Union Carbide (SOMUCAR), owned 53 percent by Union Carbide Corp., holds a 741,300-acre concession on which it plans to begin pyrochlore production. Production was originally to have started in 1970, but was delayed in 1970 and 1971 owing to technical difficulties.

The Congolese company KIVUMINES, owned by the Belgian company SOBAKI (75 percent) and the American group Engelhard Minerals and Chemicals Corp. Philipp Brothers (25 percent), continued to produce mixed cassiterite/columbite-tantalite ore from deposits at Kabili, 262 kilometers from Bukavu.

Table 13.—Columbium and Tantalum: World production of mineral concentrates by country [1]

(Pounds, gross weight)

Country [2]	1969	1970	1971 [p]
Argentina: Columbite-tantalite	[r] 3,560	9,899	[e] 9,900
Australia: Columbite-tantalite	340,631	121,543	107,000
Brazil:			
Columbite-tantalite:			
Columbite concentrate [3]	152,119	90,000	[e] 90,000
Tantalite concentrate [3]	[r] 447,538	461,000	[e] 463,000
Pyrochlore	19,098,623	29,288,000	13,435,000
Canada:			
Pyrochlore [e]	6,829,000	9,838,000	4,560,000
Tantalite [e]	245,850	594,300	845,000
Ivory Coast: Columbite-tantalite	465		
Malaysia: Columbite-tantalite	141,120	134,400	53,760
Mozambique:			
Columbite-tantalite	141,120	214,256	[e] 141,000
Microlite (tantalum concentrate)	181,440	140,161	[e] 120,000
Nigeria: Columbite-tantalite:			
Columbite concentrate	[r] 3,339,840	3,562,666	3,039,680
Tantalite concentrate	[r] 13,440	9,700	9,296
Portugal: Tantalite	13,440	8,818	24,251
Rwanda: Columbite-tantalite	48,502	NA	73
South Africa, Republic of: Tantalite	8,818	6,614	2,205
Thailand: Columbite-tantalite	57,320	125,663	92,594
Uganda: Columbite-tantalite	4,189	6,614	17,416
Zaire (formerly Congo Kinshasa)	[r] 383,604	321,875	251,324
Total	[r] 31,450,619	44,933,509	23,261,499

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.

[1] Data generally has been presented as reported in sources, divided into columbite concentrates and tantalite concentrates where information is available to do so, and reported as columbite-tantalite where it is not. Data in table excludes columbium and tantalum-bearing tin concentrates and slags.

[2] In addition to the countries listed, Spain, South-West Africa, Southern Rhodesia, and the U.S.S.R. also produce columbium and tantalum mineral concentrates, but available information is inadequate to make reliable estimates of output levels.

[3] Exports.

TECHNOLOGY

Kawecki Berylco Industries developed a four-step process for upgrading low-grade tin slags to a 40- to 50-percent combined tantalum plus columbium oxides concentrate.[13] The tin slags were smelted with coke to produce a carbidic hearth concentrate of 20 to 25 percent $(Ta,Cb)_2O_5$; the concentrate was then exothermically fused with sodium nitrate and finely divided carbon to form a fusion

[13] American Metal Market. Tin Slag Called Good Source For Tantalum, Columbium. V. 78, No. 44, Mar. 5, 1971, pp. 1 and 10.

Gustison, R. A., J. A. Generazzo. Exothermic Fusion of Eastern Tin Slag Carbides to a Tantalum-Columbium Concentrate. J. Metals, v. 23, No. 8, August 1971, pp. 45–48.

mass which was then water-leached and acid-leached to remove silica, titanium, alumina, tungsten, iron and caustic.

A new cladding process was developed by Fansteel Inc., North Chicago, Ill., for lining process equipment with a thin film of tantalum about 10 mils thick which could make tantalum competitive with glass as a lining for processing equipment.[14] The Eco Pump Corp., South Plainfield, N.J., signed an agreement with Fansteel Inc., to use the Fanclad process to produce small, corrosion-resistant, heavy-duty pumps, and Fansteel Inc. was in the process of installing new facilities at its Torrance, Calif., plant for coating large pieces of equipment.

A new alloy steel was developed by St. Lawrence Columbium and Metals Corporation of Montreal, Canada. The alloy was described as a deep-drawing, conventional low-carbon steel with columbium added at a level of 0.06 to 0.25 weight-percent. The new columbium-bearing steel was reported to have better drawability and lower fabricating costs.[15]

Researchers at Hiroshima Technical Institute developed a weldable tantalum-clad steel featuring titanium as an intermediate metal.[16]

A group of organometallic tantalum and columbium materials were discovered and described as being the most efficient superconductors yet developed.[17] If further research confirms their practical application, this new group of organometallic superconductors could prove useful for magnets, electrical devices, and high-energy physics apparatus, and possibly for advanced electric power transmission systems.

The Martin-Marietta Corp. evaluated TP Nickel-Chromium and coated T–222 Tantalum as primary materials for structural elements in hypersonic aerospace vehicles.[18] In a coating investigation for protecting T–222 tantalum above 3000° F, the Sylvania coating (R512C) was found to give better oxidation protection from quartz-lamp radiant heating in air than the other materials tested. T–222 Tantalum bolted joints, TD Nickel-Chromium riveted joints, and honeycomb panels of both materials were used as structural test specimens. Stress distribution was conducted up to 2100° F for TD Nickel-Chromium and 3200° F for T–222 Tantalum. Ultimate strength trends were defined for tension, compression, shear, and biaxial tension in the honeycomb panel specimens.

A feasibility study of clad-core columbium alloy combinations for turbine blades was completed by TRW, Inc.[19] Test results indicated that the cladding concept of using an oxidation-resistant coated cladding alloy to prevent catastrophic oxidation of a high-strength but more oxidized core alloy was feasible.

A research program was concluded at Nuclear Metals Division of the Whittaker Corp. which demonstrated that high-quality tantalum-stainless steel sleeves and tandem joints could be produced by coextrusion techniques.[20]

The continuing interest in methods of extraction and beneficiation of columbium and tantalum ores was reflected by some of the patents issued during the year.[21]

---

[14] Chemical and Engineering News. Process Lowers Cost of Tantalum Linings. V. 49, No. 49, Nov. 29, 1971, p. 18.

[15] Mining and Minerals Engineering. Potential for Columbium. V. 7, July 1971, p. 32.

[16] Iron Age. Solve Problems of Welding Tantalum-Clad Steel. V. 208, No. 24, Dec. 9, 1971, p. 27.

[17] Gamble, F. R., J. H. Osiecki, M. Cais, and R. Pisharody. Intercalation Complexes of Lewis Bases and Lavered Sulfides: A Large Class of New Superconductors. Science, v. 174, No. 4008, Oct. 29, 1971, pp. 493–497.

[18] Norton, A. M. Hypersonic Aerospace-Vehicle Structures Program. Martin Marietta Corp. (Denver, Colo.), AFFDL-Tech. Rept. 68–129, v. 5, March 1970, 324 pp. Available from Defense Documentation Center, Alexandria, Va. to registered users. AD 866190.

[19] Scheirer, S. T.. Development of Columbium Alloy Combinations for Gas Turbine Blade Applications. TRW, Incorp. (Cleveland, Ohio), AFML-Tech. Rept. 70–187, October 1970, 167 pp.; Available from Defense Documentation Center, Alexandria, Va. to registered users. AD 876475.

[20] Friedman, G. I., "Coextruded Tantalum-316 Stainless Bimetallic Joints and Tubing." Nuclear Metals Division, Whittaker Corp. (Concord, Mass.), NASA CR–72761, October 1970, 61 pp.; Available from National Technical Information Service, Springfield, Va. N71–12419.

[21] Cenerazzo, C. E., E. E. Mosheim, and C. E. Marvasi (assigned to Kawecki Berylco Industries, Inc.). Upgrading the Tantalum and Columbium Content of Tin Slags. U.S. Pat. 3,585,024, June 15, 1917.

Erhard, A. E. and J. B. Allison (assigned to Molybdenum Corp. of America). Process for Recovery of Columbium. U.S. Pat. 3,640,679, Feb. 8, 1972.

Robert, D. (assigned to Ste. de Produits Chimiques d'Auby). Method of Selectively Separating Solid Particles by Electrostatic Sorting in Fluid-Bed. U.S. Pat. 3,563,375, Feb. 16, 1971.