TANTALUM PRODUCERS INTERNATIONAL STUDY CENTER

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T.I.C. Activities

The Tenth General Assembly of the T.I.C. will take place in Brussels on Friday October 13th 1978, as arranged at the Ninth General Assembly held in Rothenburg ob der Tauber on May 10th 1978. Following the official business of the meeting there will be a presentation given by a member of the staff of the European Community Liaison Committee for Non-Ferrous Metal Industries on a subject of particular interest to the tantalum industry. Afterwards drinks and luncheon will be served at about 1 p.m. in the directors' dining hall of the Bank.

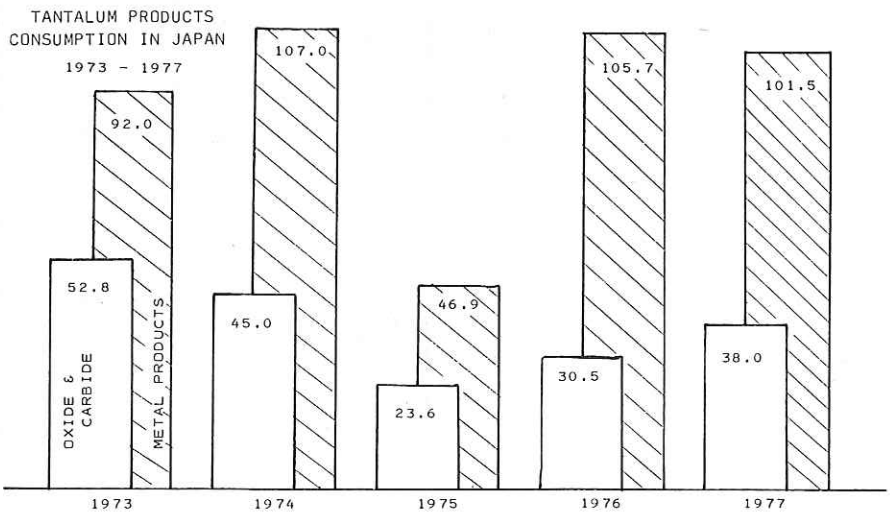
Japanese Tantalum Production 1977 data and 1978 forecast

Reports from the Japanese Association of New Metals provide statistics for the consumption of tantalum during 1977 and the source of the products used as to domestic production and imports :

PRODUCT (Unit : kg)	1976 Actual	1977 Actual	% Change
Consumption :			
Powder (Capacitor and Metallurgical)	84,538	76,300	(10)
Chemical Compounds (Carbide and oxide)	30,500	38,000	25
Mill Products (Electronic and Chemical)	23,120	25,200	9
Grand Total	138,158	139,500	1
Source of products :			
Imports	45,248	44,416	(2)
Produced	92,910	95,084	2
Grand Total	138,158	139,500	1

Although the J.A.N.M. no longer reports, as they have in past years, the consumption by end use, estimates based on past division of use by product can be made. It would appear that the electronic industry consumption in 1977 was about 90,000 kg, a decrease of almost 10 % from 1976. This decrease does not indicate a softening of the electronic market, however, but a continuation of the trend established in 1976 toward the use of higher CV capacitor powder and smaller lead wire commensurate with the smaller capacitor anodes resulting from the use of higher capacitance material. As a result, tantalum use in electronics accounted for only 65 % of total tantalum consumption, down from 72 % in 1976. The strengthening of the industrial market segment is evident by the consumption of chemical compounds (carbide and oxide). The 38,000 kg, however, is still about 19 % below the peak level of 45,048 kg, attained in 1974. This appears to be accounted for by two factors :

- The increased use of ceramic cutting tools and titanium carbide coated inserts reducing the average content of tantalum carbide in cemented carbides, and



- The development of high sensitivity film coatings for camera lenses coupled with a trend to smaller lenses reducing the consumption of tantalum oxide.

The continual trend upward of the ratio of metal products to chemical compounds has been reversed. From 1972 to 1976, the ratio increased from 3:2 to 3:1. In 1977, however, the ratio dropped to 2.67:1, shown in the chart (left).

The balance between imports of tantalum products remained essentially the same as in 1977. A slight increase in domestic production to 95,084 kg provides the highest level ever attained. 97 % of these imports were from the United States and the balance from Europe. There was a gain in the imports of mill products from 4,199 kg to 5,993 kg, but a drop in the imports of powder from 41,049 kg to 38,423 kg.

T.I.C. TENTH GENERAL ASSEMBLY

The Tenth General Assembly of the T.I.C. will be convened at 10.00 a.m. on Friday October 13th 1978 in the conference rooms of the Banque Bruxelles Lambert, 2 rue de la Régence, 1000 Brussels. All members will be represented.

The Agenda for the meeting will be :

1. **Approval of Minutes.**
2. **Financial position at September 30th 1978.**
3. **Report of Executive Committee.**
4. **Symposium :**
   - **General accounts**
   - **Publication of Proceedings.**
5. **Statistics : Report on arrangements made with Price Waterhouse and Co.**
6. **Further activities of T.I.C.**
7. **Quarterly Bulletin.**
8. **Eleventh General Assembly, spring 1979 :**
   - **location**
   - **date**
   - **agenda and programme.**
9. **Statutory elections.**
10. **Other matters.**

Presentation : A presentation will then be made by a member of the staff of the European Community Liaison Committee for Non-Ferrous Metal Industries on the subject :

" Representative Sectorial Data of Non-Ferrous Metal Industries, with special reference to the Tantalum Statistical Project ".

The presentation will be followed by a discussion.

Interested prospective members wishing to attend the Tenth General Assembly should contact the Secretary of the T.I.C., 1 rue aux Laines, 1000 Brussels, Belgium; telephone 511 83 96 or 512 54 42; cable address Tictan Brussels.

The imports of source materials for 1975, 1976, and 1977 compare as follows :

SOURCE : (Unit : m.t.)	1975	1976	1977
Ore and concentrates	69	62	170
Potassium fluotantalate	22	118	138
Tantalum scrap	1	9	8
Approximate Ta content	34	87	116
% of products produced	70 %	92 %	122 %

The approximate tantalum content of the source materials, amounting to 122 % of the weight of domestically produced products, indicates a reversal of the trend of three years to reduce inventory. New imports, after making allowance for unrecoverable losses in processing, supplied only 85 % of the material needed. The consistent supply of concentrates from Australia continued actually increasing 20 % over 1976 to a total of 69 gross tonnes. For the first time, a large quantity of concentrates was imported from Malaysia, a total of 101 gross tonnes. The 1977 imports of potassium fluotantalate from the United States were almost identical to the 1976 imports, but, for the first time in recent history, 20 m.t. were imported from Belgium.

The 1978 forecast has been made at 124,400 kg, a drop of 11 % from 1977. The continued trend toward the use of higher CV-rated capacitor powder is expected to reduce consumption by 8 %. Although there will be a slight decrease in the use of mill products (3 %), the big reduction will be in the chemical compound product group, a 21 % reduction. For comparison, in 1977 the J.G.N.M. forecast consumption for 1977 at 130,000 kg and a level of 139,500 kg was attained.

Acquisition of Kawecki Berylco Industries, Inc. by Cabot Corporation

Kawecki Berylco Industries, Inc. (KBI), one of the largest processors of tantalum and niobium, has been acquired as a wholly-owned subsidiary by Cabot Corporation, a major producer of cobalt-base and nickel-base metal products as well as energy products and performance chemicals. On March 20, 1978, Cabot purchased 64 % of the issued and outstanding stock of KBI from the Union Oil Company of California and the Pacific Holding Corporation. At the same time Cabot announced the intent to make the same price paid to Union Oil and Pacific Holding available to other shareholders of KBI in a prompt consolidation proposal. A special meeting of KBI's shareholders was held on May 31 at which total acquisition was approved and effected.

Cabot's stated interest in the acquisition results from its belief that there are significant growth opportunities for KBI's specialty metals product lines and that KBI's products, markets and technology for the consumer goods areas will complement the capital goods orientation of Cabot's Stellite Division which manufactures high-performance alloys and alloy-fabricated products. Both KBI and Cabot serve the chemical processing, aerospace, and nuclear industries with their own specialty metals and Cabot expects that the combination will give them a major new industrial base in the specialty metal field. Furthermore, the combination will provide the economics of scale, common financing opportunities, and the sharing of managerial experience and expertise.

The Cabot Stellite Division is based in Kokomo, Indiana, at the plant which was formerly the Stellite Division of Union Carbide Corporation. At the time of the Cabot acquisition of this Division, the Kokomo plant was a producer of tantalum and niobium metal products. Although Cabot subsequently dropped the tantalum and niobium product lines, much of the expertise and the facilities used for processing are still in place within the Division. These facilities, which include a one megawatt electron-beam melting furnace, forging presses and rolling mills, have been used, in the intervening years, for conversion of tantalum products for most of the major tantalum processors.

As a result of the merger, Mr. Joseph Abeles, a leading figure in the tantalum community for over twenty years, has become a vice-president and director of Cabot as well as chairman of KBI. Mr. Larry O'Rourke has been employed to be president of KBI. Mr. O'Rourke, formerly president of the New Jersey Zinc Co., is well known in the tantalum business as he was general manager of the Capacitor Division of Union Carbide prior to his association with New Jersey Zinc. He is experienced in all facets of tantalum from raw materials to end-product manufacture and use.

World Tantalite/Columbite Reserves

Current sources of information concerning world reserves of source materials for tantalum provide varying, non-consistent information. In view of the present concern about future tantalum supply, data has been accumulated from various sources, including direct conversations with producers, and evaluated in order to develop a reasonable summary of known reserves available to meet market demand. The results are not absolute in their accuracy, but present the best consensus available at the present time. The errors on the low-side are probably off-set by similar errors on the high-side so that the totals are reasonably good.

The following table presents the results of the evaluation in metric tons of Ta_2O_5 as usable production, not of the quantity available in the mineral state. Although such introduces another variable in the form of recovery ratio, it has been assumed that future recovery rates in each country will be similar to those now being realized. To indicate the source of undeveloped reserves, abbreviations have been used : S for tin mine tailings, T for tantalite or columbite independent of tin sources, and TS for tantalum in tin ores.

WORLD TANTALUM SOURCE RESERVES ESTIMATED AT THE END OF 1977
(Metric tons of contained Ta_2O_5 recoverable)

LOCATION	CURRENT WORKING SOURCES				UNDEVELOPED		TOTAL
	In Tin Ores	Independent of Tin Ore	Total	Yrs Supply *	Type	Estimate	
Australia	160	—	160	2	S T	130 220	510
Malaysia	2,250	1,100	3,350	21	—	—	3,350
Thailand	4,500	—	4,500	15	S	450	4,950
Nigeria	500	100	600	9	—	—	600
Zaire	1,800	—	1,800	40	TS	500e	2,300
Rwanda	50	—	50	11	—	—	50
Mozambique	—	500	500	7	—	—	500
Rhodesia	n.a.	n.a.	n.a.	—	—	—	n.a.
Union of South Africa	—	20	20	10	T	200	220
Namibia	400	—	400		—	—	400
Brazil	450	—	450	4	S T TS	220 450e 450e	1,570
Canada	—	550	550	4	S T	540 Unknown	1,090
Spain & Portugal	500	—	500	11	—	—	500
Egypt	—	—	—	—	T	5,600	5,600
TOTAL	10,610	2,270	12,880	12		8,760	21,640

Note : * At present (1977) production rates.

A brief run-down of the more important reserves follows by source country :

— Australia : Although the reserves in Southwestern Australia are being rapidly depleted, recoverable material and known deposits in the Pilbara region will provide continuing supply.

— Malaysia : Tantalum in tin reserves and struverite in tin mine dumps assures continuing supply mostly in tin slags from the Penang smelters.

— Thailand : The real extent of recovery from tin mine tailings is unknown. The stated tin reserves assure a continuing supply of typical high-grade tin slags and tantalite gleaned during the tin ore concentration process.

— Nigeria : The reserves of rich tin placer deposits have been depleted, but the extent of primary pegmatite deposits, now being developed, are unknown. Reserves could be increased significantly in coming years.

— Zaire : Although Zaire reserves have been reported as high as 10,000 m.t. recoverable, mining sources in the country consider such an overstatement by a factor of five. These are extensive scattered pegmatites which have not yet been developed. However, because of the economic and political condition of the country, development cannot be presently anticipated. With stability, Zaire could become the world's principal source of tantalum raw materials.

— Mozambique : To date, the richest known deposits have been the source of most tantalite and microlite produced. Less favorable reserves are extensive and will be developed.

— Brazil : The potential of Brazil is still to be developed. The reserves in Minas Gerais are diminished to low levels, but other areas are virtually untapped (Issue No. 9, T.I.C. " Bulletin ").

— Canada : The Bernic Lake deposit is approaching depletion unless new reserves are located in the same area. The tailings at the mine offer continued supply for a few more years. There are tantalum-containing pegmatites known in several other locations in Canada, but they are of unknown extent and not considered workable at present.

— Egypt : It is unlikely that the very large deposit of tantalum bearing granite in Egypt will be developed in the near future (Issue No. 10, T.I.C. " Bulletin ").

No worthwhile information has been found concerning tantalum deposits in China and the U.S.S.R.

The data developed shows that an average supply at the 1977 level could exist for at least twelve years from current working sources. However, some of the major sources appear to be reaching the depletion level in two to four years. But reserves seem always to have a way of increasing as they approach depletion. This factor along with the 3,000 tons of producible tantalum oxide in undeveloped reserves (excluding Egypt) seems to assure a continuing supply of tantalum raw material adequate to meet world demand at currently projected levels for many years to come. The present price level is also known to have already stimulated further exploration in Australia, Canada, and Brazil. It has also led to the beginning of tailing processing in Thailand, Malaysia, and Australia. There are other tailing sources not yet being processed. A reappraisal of reserves five years from now will probably show little deterioration of the total although some dislocations might be evident. The history of the mineral industry, in general, is rife with examples of forecasts of short-supply stimulating the exploration and development of new sources which always keep the reserve totals well in front of immediate needs.

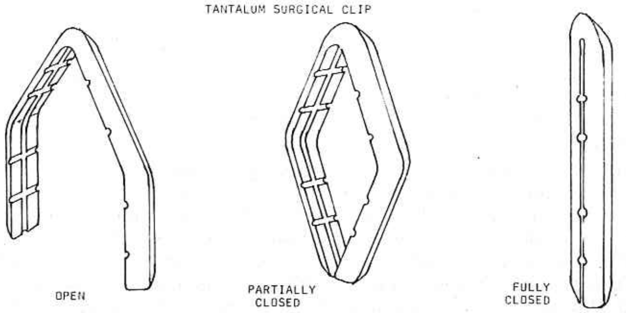
Tantalum in Surgical Clips

During the first decade of the twentieth century, metal clips were introduced to be used in place of sutures in surgical procedures. A hemostatic clip made of silver was introduced in 1911 by Dr. Harvey Cushing, an eminent surgeon. Although at that time wide-spread general surgical use was predicted, clips did not find favor with surgeons. The advantages of clips for many procedures are generally conceded, but many surgeons balk at the idea of having a metallic foreign body in tissue because of the severe results of corrosion of the metal. The discharge of metallic ions from a corroding metal into surrounding tissues may either destroy tissue directly or through the disturbance of pH balance on other parameters.

By 1940, however, the biological inertness of tantalum in living tissue was recognized and confirmed conclusively by 1942. An immediate consideration was the use in surgical clips. Beyond this property of tantalum, strength equal to stainless steel and malleability which allows easy closure when applied makes tantalum the ideal material for use in this application. Because tantalum is biologically inert and not affected by the oxidizing agents in living tissue, clips can be left in patients permanently without harmful effects. Thus the application of tantalum has opened up entire new procedures in surgery, improving many techniques which reduce the complications of operations with less strain on the patient.

The clips are made from various lengths of a special tantalum wire with a heart-shaped cross-section. The wire is bent in three places to form a U-shape resembling a diamond with one apex open. The inner flat surface of the wire has a longitudinal channel and regularly spaced transverse notches impressed on the surface to aid in gripping the vessel to be clamped off. Each end of the clip and all edges are carefully rounded to avoid cutting the tissue clamped. These design features affect the ease of loading and the efficiency of applying forceps and, most important, the security of the clip when in place.

TANTALUM SURGICAL CLIP



Clips are loaded into high temperature plastic racks so that they can be sterilized. These racks are designed so that the clips can be extracted conveniently with a forcep but will not fall out if the rack is turned upside down. Although the forceps are of conventional design, the inner surface of each jaw is channelled by a triangular depression running the length of the jaw. This depression fits the triangular outer surface of the clip exactly. The clip, when picked up, fits tightly into the forcep and cannot fall out due to a spring between the shafts of the forcep applying a clamping force.

In application, partial closing of the forceps bonds the clip into a closed diamond-shape about the structure being occluded. As the forceps are further closed, the clip closes tight completely clamping the tissue. The clips have been tested on rubber tubing and have withstood pressures of 15 pounds per square inch, far beyond any pressure encountered physiologically.

Even though this application at present represents only a small usage of tantalum, it is an excellent example of utilization of a unique property of tantalum. Although surgeons still rely heavily on the conventional needle-and-thread sutures to close wounds, more and more of them are switching to clips in many procedures. It is estimated that more than half of the 18 million surgical procedures performed in the U.S. annually have some application for surgical clips. Thus, the market for the special tantalum wire, from which the clips are made, will continue to grow.

Teledyne Wah Chang Albany

Although noted today as the world's principal source of zirconium, Teledyne Wah Chang Albany has also been known for many years as the largest producer of niobium metal. Responding to the real demand for niobium metal and the forecast future demand made by independent sources in the last 1950's, Wah Chang immediately developed a capability to produce niobium metal in large quantities and a full range of products. Several other companies who also moved into niobium metal production at that time have long since dropped out as the very large forecasts never materialized. Wah Chang, however, continued to develop its capability and has survived as the major producer.

HISTORY

The original Wah Chang, meaning " Great Development " in Chinese, was incorporated in 1916 by the late Dr. K.C. Li as a trading corporation for the import and export of tungsten ores. During the 1920 and 1930 decades, Wah Chang increased the scope of its operations and became known as an international engineering firm. With the advent of World War II, the corporation became the primary source of tungsten, antimony, and other strategic raw materials for the American war efforts. For the first time, Wah Chang set up manufacturing operations to refine and reduce tungsten ores and to produce tungsten and molybdenum mill products.

As a part of its contract engineering activity in the mid 1950's, Wah Chang managed a pilot titanium sponge production facility for the U.S. Bureau of Mines at its station in Boulder City, Nevada. With this experience Wah Chang then became the successful bidder in 1956 to the U.S. Atomic Energy Commission to operate the zirconium metal facility which had been developed at the U.S. Bureau of Mines Station in Albany, Oregon.

With the contract to supply the A.E.C.'s needs in zirconium for two years, Wah Chang quickly became expert in this field. Foreseeing the future potential in the private public-power sector, as well as in the building of ship-propulsion reactors for the U.S. Navy, Wah Chang quickly purchased a forty-five acre site in Albany and constructed its own production facility. The plant attained full production in 1957.

When the aircraft nuclear-propulsion programme generated, in 1958, a requirement for large quantities of high-purity columbium (niobium) ingot, Wah Chang again responded with speed. With most of the facilities and technology required in place as a result of its zirconium production, Wah Chang introduced the first commercial application of the electron-beam melting furnace as the processing which could produce the very high purity required to produce columbium which would meet the needed properties. This established its position as the only large-scale producer of columbium metal products, a position maintained for at least five years until another basic tantalum producer installed electron-beam melting capacity.

Although columbium was Wah Chang's principal interest, tantalum became a natural by-product as the columbite ores being processed contained sizeable amounts of tantalite. Wah Chang became, therefore, an early tantalum processor although not in the volume of the other processors. It developed a capability to produce very thin tantalum foil and became a major supplier to the electronic capacitor industry as most capacitors were then of the foil-type rather than the sintered-anode type which now dominates the market. Electing not to become a capacitor-powder producer, Wah Chang did not grow in the tantalum capacitor market as it developed, but strengthened its position as a major supplier of mill products for the chemical equipment, aerospace, and military markets.

In 1967, Wah Chang was purchased from the Li family by Teledyne, Inc. of Los Angeles, a large diversified conglomerate. Various parts of the Wah Chang complex, primarily the tungsten operations not located in Albany, Oregon, were absorbed into other operations of Teledyne. The metal producing facilities in Albany were set up as a wholly-owned subsidiary designated as " Teledyne Wah Chang Albany ".

Today TWCA is the only basic producer of zirconium in the free world. Other zirconium product plants obtain their basic material in one form or another from TWCA. Zirconium accounts for about 80 % of all sales. Although not comparable in volume to zirconium, columbium sales are of major importance to the users of this metal and will be of even more importance as the market attains its expected growth. The support of the tremendous facility to produce the large volume of zirconium product places TWCA in a good position to continue to be the leading columbium metal producer in the world.

COLUMBIUM

For at least a decade and a half, TWCA processed columbite and tantalite ores at the Albany plant. A sizeable facility utilized the conventional hydrofluoric-acid digestion followed by liquid-liquid separation. High-quality columbium oxide and potassium fluotantalate were produced for reduction to metal. In recent years, however, TWCA has found it more economic at their volume to have the basic chemical processing done for it by Mallinckrodt Chemical Company. Therefore, TWCA is no longer active in basic chemical processing but has retained its facility on a stand-by basis to be ready for volume production when the columbium market develops large enough volume to require additional capacity.

The refined columbium oxide is reduced to metal at TWCA by the exothermic process which displaces the columbium in the oxide with aluminium resulting in pure columbium metal. Since the directly reduced metal is not pure enough for fabrication, containing residual oxides and slag as well as some aluminium, several remelts are made in the high-vacuum electron-beam furnaces. The resulting high-purity ingots can be made as large as 12" diameter. To obtain larger ingots or to make alloys, however, the electron-beam melted ingots are used as electrodes for remelting in consumable-electrode vacuum arc-melt furnaces. Ingots as large as 16" diameter weighing over 3,000 lbs. are produced.

The excellent facilities for further processing at the Albany plant include forging, extruding, rolling (bar and flat products), swaging, and tube reduction. Any needed wrought product form can be produced, from large forged or extruded shapes to fine foil, wire, and tubing. TWCA has the most complete metal-working facilities available today used exclusively for the production of special metals. The plant is able to produce well over 400,000 lbs. of columbium metal products per year, far in excess of the current domestic demand. With the expected future increased use of columbium in superconductor applications and fusion reactors, TWCA is prepared to supply the growing market needs.

U.S. Shipments of Tantalum and Columbium Products

The Bureau of Mines, U.S. Department of Interior, annually reports the " U.S. shipments of tantalum and columbium products by U.S. processors ". The data for 1973 through 1977 is as follows (1,000 lb. units) :

PRODUCT	1973	1974	1975	1976	1977
Tantalum					
Oxides & Salts	142.3	226.1	127.4	55.4	62.8
Alloy Additive	17.3	24.8	8.5	13.2	12.2
Carbide	173.4	163.4	106.5	93.3	113.5
Powder & Anodes	790.5	929.4	436.6	759.0	759.2
Ingot	16.0	1.7	1.0	7.7	8.0
Mill Products	321.2	288.8	172.2	238.5	292.4
Scrap	40.5	45.6	13.0	130.7	168.3
Other	1.3	1.3	—	—	2.0
Total	1,502.4	1,681.1	865.2	1,297.8	1,418.4
% Change	38.0	11.9	(48.5)	50.0	9.3
Columbium					
Compounds	1,276.8	1,520.5	930.8	791.3	n.a.
Metal	143.0	133.4	112.7	101.6	n.a.
Miscellaneous	.3	34.0	21.2	41.0	n.a.
Total	1,420.1	1,687.9	1,064.7	933.9	n.a.
% Change	24.8	24.1	(36.9)	(12.3)	n.a.

The data demonstrates the drastic effect of the 1975 recession on consumption, particularly in the use of tantalum carbide and tantalum powder for capacitors. The recovery in the use of tantalum carbide by the cemented carbide industry has been slow, reaching in 1977 only 68 % of the peak level attained in 1973. Such is not necessarily indicative, however, of the overall condition of the cemented-carbide market as technological progress in the development and use of tantalum carbide solid and coated tools has probably had an effect decreasing the proportionate need for tantalum carbide. The peak use of capacitor powder in 1974 does not represent total use in capacitors as there was some inventory building in that year. Consumption of some inventory during 1975 depressed shipments of powder in that year. The trend of less powder required per capacitor due to improvement in the capacitance rating of powder is evident, however, by the fact that the average consumption in 1973 was 1.46 lb. per 1,000 units (540 million units), and only 1.34 in 1977 (600 million units). These average numbers indicate only a trend as the effect of imports and exports has not been considered. The continuing depressed shipments of the " oxides and salts " category probably reflects further decline in the use of oxide by the cemented-carbide producers who make their own carbide.

From the reported shipments of products, an estimate can be made of source material requirements. By allowing for unrecoverable losses in processing and for scrap purchased by the processors for recycling, calculation provides the following estimates of the tantalum and columbium content of ores and slag consumed each year by U.S. processors (1,000 lb. units).

Year	lb. Ta_2O_5	lb. Cb_2O_5
1973	2,000	2,090
1974	2,250	2,700
1975	1,160	1,700
1976	1,740	1,490
1977	1,910	n.a.

Since tantalite and tin slag production did not decrease substantially during 1975, it can be concluded that inventories of source materials in the hands of merchants and processors probably increased. This is substantiated by additional Bureau of Mines data which shows an increase of about 800,000 lb. Ta_2O_5 from 2,872,000 lb. at the end of 1975. Increased consumption in 1976 and 1977 is depleting those inventories, again dropping them back below the 1974 level.

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