TANTALUM PRODUCERS INTERNATIONAL STUDY CENTER

QUARTERLY BULLETIN BULLETIN No. 38 JUNE 1984 SECOND QUARTER

Tantalite prices compared to production costs

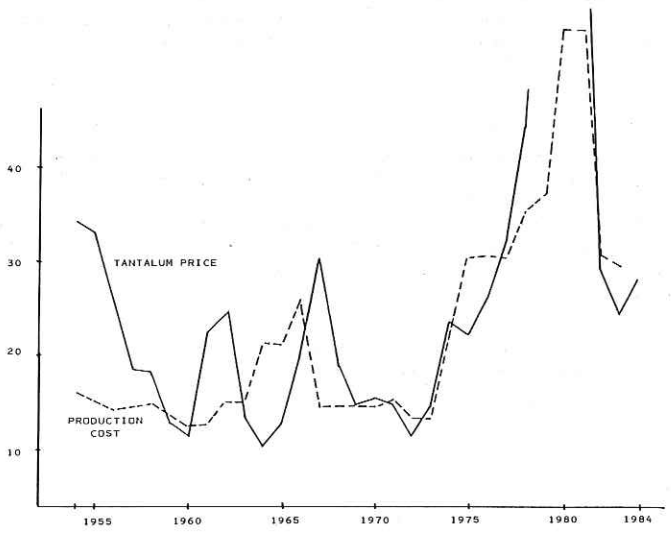
The price of tantalite today is the same as it was in 1954 on the basis of a comparison made eliminating the effects of inflation. But, because of the higher level of demand, the low production-cost operations producing tantalum source-materials as a by-product and co-product of tin production are no longer adequate. Higher cost operations for direct mining of tantalite have had to be developed. The result is that production costs today are more than twice those of the mid-1950 decade.

Although tantalite prices have cycled up and down throughout the past forty years, the greatest swing has occurred in just the past few years. In the 1940 decade, the price varied from $ 2.00 per pound of contained oxide to $ 3.50. By 1954, the price rose to almost $ 9.00 but dropped back to $ 3.50 again in 1960 and 1961. After another peak at $ 10.00 in 1962 followed by a drop to $ 3.00 in 1964, a new peak of $ 12.50 was reached in 1967. Each of the peaks was occasioned by a sudden demand for tantalum which outstripped the then currently produced supply, i.e. the U.S. Stockpile acquisitions in the 1950's and the use for missiles in the 1960's.

Each upward swing in price stimulated production. But soon, in each case, over-production continued after a cooling in the marketplace and resulted in a rapid decline in price. The higher cost operations opened to meet the extra demand again closed down and the supply sank back to the customary levels. These same market influences continued in the 1970's with new peaks in 1974 and 1981, each followed by a drop in price soon afterward.

When examining the history of production in the light of price, it is apparent that the low-cost production associated with tin production has been limited to 1.4 to 1.5 million pounds of contained oxide per year. Whenever the demand has exceeded these levels, the price has had to increase to bring the higher-cost direct operations into production. With a tin future that is not too bright and with the depletion of some of the tantalum-rich tin reserves, it is probable that the threshold for needing the higher-cost producers will lower below 1.4 million pounds per year.

Although the casual observer will proclaim that tantalum prices have been continually increasing for the past forty years, it must be recognized that most of the increase has been due to inflation. The prices for the past thirty years, when compared on the basis of 1983 dollar value, show that the price today is actually less than it was in 1954 and 1955.



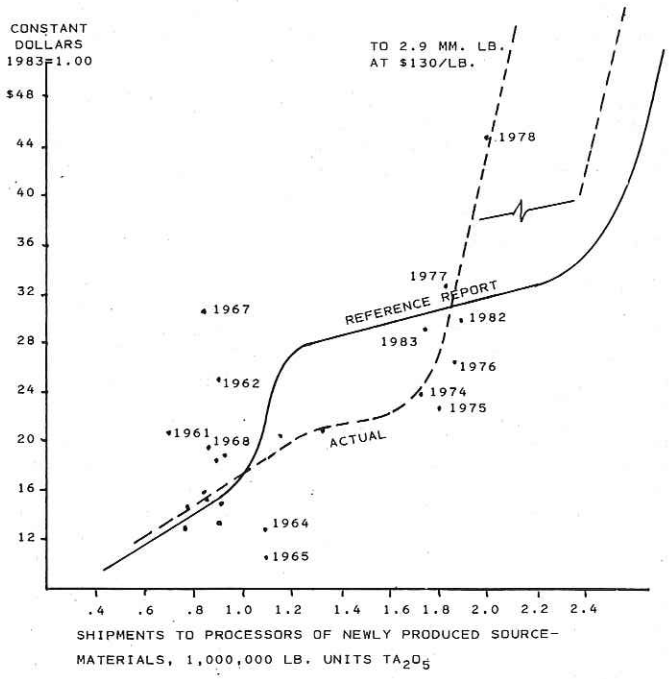
On this chart, the production cost is also shown as determined by the production level of tantalite and currently usable tin slag for each year (Ref. : T.I.C. « Bulletin », Issue no. 34, « President's Address », pp. 2-5). The comparison with average prices for each year shows that there have been a number of years in which the price of tantalite has been less than the cost of producing. There have been favorable years as well but, from 1958 to 1978, the favorable years have only offset the unfavorable years. Obviously, during these years there was little capital accumulation available for exploration and mine development which could have provided the extra material to meet the demand of the 1979 to 1981 period.

Even though the recurring peak prices have caused short-term concerns within the tantalum community, it must be recognized that there have also been important beneficial effects from the short periods of high prices.

- New sources have been developed, such as the Bernic Lake mine, the underground mine at Greenbushes, the direct use of high-grade slags from Thailand, etc.
- World production has greatly increased from less than 200,000 lb. in 1950 to over 2,500,000 lb. in 1980.
- Product technology has been developed to offset the higher prices particularly in the quality and application of capacitor powder, in the application of tantalum carbide for cutting tools and in the application of tantalum mill products in chemical equipment.
- A recycling industry has evolved to conserve tantalum which had previously been lost after initial use.

Without the periodic price increases providing the motivation for such developments, the tantalum industry would not have evolved to its present importance and size.

The price history can be applied to verify the cost-of-production data used above by comparing the actual annual average prices (in 1983 dollars) against the volume produced each year with the production-cost curve from the reference article.



Although there is not a perfect one-to-one correspondence, it is apparent that larger volumes of source-materials will be available only with higher prices. The correspondence becomes better when it is considered that the Greenbushes Tin underground mine would

probably begin to produce as much as 400,000 lb. per year if the demand became sufficient to raise the price above the projected production cost of $ 34 to $ 36 per pound. (Ref. : Issue no. 34, ibid. p. 3).

The conclusion which can be reached is that the increased demand of the 1970's and the 1980's cannot be totally supplied from the lowest-cost sources associated with the tin industry. The increased volume of source-material which must be produced has increased the incremental volume production cost from about $ 15 per pound (1983 constant dollars) during the period from 1954 through 1974 to over $ 30 per pound at present. But, for other than the short period from 1978 through 1981, the price of tantalite has not increased proportionately. Price below production-cost, since 1981, has already led to the curtailment of production and the actual shut-down of some operations. The stage could be in the process of being set for a repetition of conditions which existed from 1969 to 1977 when production was very low in relation to demand and the only stabilizing factor was the accumulation of Thai slags and disposals from the U.S. National Stockpile.

PLENTY OF TANTALUM

Fortunately, there is plenty of tantalum. Inventories are adequate, along with the production capability of new resources developed during the 1978-1981 period, to more than meet the most optimistic forecast needs for at least fifteen to twenty years. It must be recognized, however, that the same economic and market factors that have caused the ups and downs of tantalite prices are still in force. With only a 5 % average annual inflation effect, today's price of tantalite would be $ 65 per pound by the year 2000. Superimpose upon that an increase in demand of 3 % per year average from 1983 and the price may well be $ 95 per pound without any peaks.

Letter from the President

Starting with this issue statistics on tantalum capacitor sales in the U.S.A. and Japan will be included regularly in the quarterly Bulletin.

It is hoped that eventually we will be able to publish European sales too, to provide a more complete coverage of the main production areas. The statistics will cover numbers of units sold. However it must be recognised that the tantalum content per capacitor is not a constant : different styles have different CV's (the product of capacitance and voltage; the CV is an indication of the tantalum surface area) and also over a period of time the tantalum required for a given CV decreases due to technological improvements. Within these limitations the movement in the total gives an indication of the changes in demand for tantalum.

Further advances are being made in the presentation of Producer and Processor statistics. The total Production and Shipments have been included in the quarterly Bulletins for some time but now agreement has been reached with the reporting companies for the presentation of the quantities split into additional categories. This move is being taken cautiously to ensure that information on individual companies' outputs is not divulged.

The publication of the next quarterly Bulletin is being advanced one month, from September to August and the December Bulletin is to advance two months to October. The first Bulletin in 1985 will then be published in January. The reason for this change is that the original dates for the Bulletin were set so that they matched up with General Assemblies in May and October. One Bulletin gave details of the forthcoming G.A. and the next reported the proceedings. As the dates of the assemblies moved to June and November this has created a mismatch. Also when the Bulletin was only four pages the preparation and printing time was relatively short. As the size has increased there is substantially more work involved in its presentation. Consequently this year's June G.A. could not be reported in this present June Bulletin and it would be too long to wait until September before covering the meeting. The August issue will now include a report of the 21st G.A. and details of the following 22nd G.A. in Brussels. The October issue will include a number of papers on tantalum and niobium/columbium topics and the January Bulletin will report the 22nd G.A. Advancing the dates in effect slips in an additional issue and that will also help by allowing publication of all the presented papers without increasing the size of each Bulletin too much.

R.W. FRANKLIN
President

U.S.Bureau of Mines - Tantalum 1982

During late 1983, the U.S. Bureau of Mines released two publications updating their tantalum information through 1982 : « Columbium and Tantalum, Bureau of Mines Yearbook » and « Tantalum, Mineral Commodity Profiles, 1983 ». Both publications were authored by Larry D. Cunningham, Physical Scientist in the Division of Ferrous Metals. This article has been extracted from both reports to show the status of the tantalum industry in the United States through the end of 1982.

A summary of the salient statistics for 1982 compared to 1980 and 1981 follows :

(1,000 lb. Ta content)	*1980*	*1981*	*1982*
UNITED STATES			
Mine production of Cb-Ta concentrates	—	—	—
Releases from Government excesses	0	0	0
Consumption of raw materials	1863	1269	800
Exports :			
Ta ore and concentrate (gr. wt.)	468	99	235
Ta metal, compounds, alloys (gr. wt.)	524	205	382
Ta and Ta-alloy powder (gr. wt.)	251	97	115
Imports for consumption :			
Mineral concentrate	860	650	440
Ta metal and Ta-bearing alloys	140	32	69
Tin slags	1327	930	na

Although no domestic production is shown, small quantities of tantalum-bearing concentrates were again produced from operations in South Dakota. There was also an increase in exploration activity for columbium and tantalum in Wyoming.

U.S.NATIONAL STOCKPILE

The goal for mineral concentrates in the National Stockpile continues to be 8,400,000 lb. tantalum content (10,250,000 lb. contained Ta_2O_5). The inventory of stockpile-grade concentrates increased during the year to 1,432,000 lb. (Ta content) as a result of delivery during June 1982 of 33,000 lb. of contracted materials by Norore Corp. of New York City. The Stockpile continues to include 1,152,000 lb. Ta in non-stockpile grade concentrates, 29,000 lb. (Ta content) in carbide powder and 201,000 lb. of tantalum metal. There were no disbursements from the Stockpile during 1982.

CONSUMPTION, USES AND STOCKS

Tantalum consumption was down for the third consecutive year as reflected by the 11 % decrease in shipments reported by the Tantalum Producers Association (see issue no. 35, T.I.C. « Bulletin »), nearly 50 % below the peak year of 1979. Data covering aggregate stocks at the end of 1982 were not available at time of publication, but they were reported to be at 3,452,000 lb. of tantalum at the end of 1982. (Editor's note : Estimates from available data indicate that stocks probably increased by about 250,000 lb. contained tantalum during 1983 resulting in a total of almost 3,700,000 lb.)

DOMESTIC PRODUCTION

There were no changes in the structure of the tantalum processing industry in the U.S. during 1982 although the tantalum processing plant of Lien Metals, Inc. in Rapid City, South Dakota is planned to be in operation in early 1983. Using a newly developed process for extracting tantalum oxide from tantalum ore, the production of oxide and metal powder is expected to be approximately 100,000 lb. per year.

Mallinckrodt, Inc. was merged into Avon Products as a wholly-owned subsidiary in March. Shieldalloy Corp. completed the modernization of its manufacturing facilities in Newfield, New Jersey. NRC Inc. installed a 1,400 kw. electron beam furnace and new rolling mills in its plant in Newton, Massachusetts.

FOREIGN TRADE

The exports and imports for tantalum, compared to 1981, were reported as follows :

(1,000 lb. gross weight)	*1981*	*1982*
EXPORTS		
Powder	97	115
Unwrought and waste and scrap	164	330
Wrought	41	52
IMPORTS FOR CONSUMPTION		
Waste and scrap	116	97
Unwrought metal	31	67
Unwrought alloys	—	1
Wrought	—	2

Imports of columbium mineral concentrates were 910,000 lb. gross weight which, at a reported tantalum content of 4 %, could have provided a supply of about 30,000 lb. for processing. Natural tantalum mineral concentrate imports were 1,297,000 lb. gross weight containing about 113,000 lb. tantalum (505,000 lb. Ta_2O_5).

(1,000 lb. gross weight)	*1981*	*1982*
COUNTRY		
Australia	268	161
Brazil	540	260
Canada	628	373
Cayman Islands (1)	2	—
China	20	14
Germany, Federal Republic of	4	—
Malaysia	—	12
Mozambique	—	32
Nigeria	—	12
Portugal	—	11
Rwanda	62	—
Singapore (1)	7	—
South Africa, Republic of	4	19
Spain	92	7
Thailand	157	328
Zaire	127	63
Zimbabwe	42	6
Total (2)	1952	1297

(1) Presumably country of trans-shipment
(2) Data may not add to totals shown because of independent rounding.

Synthetic tantalum concentrate imports totalled 2.7 million lb. gross weight, probably containing from 440,000 to 550,000 lb. tantalum, a reduction of about 27 % from 1981. Imports for consumption from China included 5,000 lb. of potassium tantalum fluoride, down substantially from 1982.

WORLD REVIEW

The world production of mineral concentrates reported is given as follows, not including tantalum recovered from contemporary or old tin slags or in struverite.

Country, type of ore	*gross weight*			*tantalum content*		
(1,000 lb. units)	*1980*	*1981*	*1982*	*1980*	*1981*	*1982*
Australia, columbite-tantalite	351	657	660	116	230	230
Brazil, columbite-tantalite	1186	659	606	380	178	170
Canada, tantalite	620	640	590	208	188	170
Malaysia, columbite-tantalite	73	51	32	8	4	2
Mozambique	na	na	na	na	na	na
Nigeria, columbite	1221	831	400	73	48	24
tantalite	2	2	2	1	1	1
Portugal, tantalite	9	20	22	2	5	6
Rwanda, columbite-tantalite	132	126	137	24	28	30
Spain, tantalite	112	129	130	28	33	33
Thailand, columbite-tantalite	785	106	86	259	23	20
Zaire, columbite-tantalite	203	165	70	43	46	20
Zimbabwe, columbite-tantalite	90	100	90	23	35	32
Total				1165	819	738

The only data available regarding the shipment of old tin slags are those from Thailand indicating that 109 short tons were exported in 1981 and only 36 short tons in 1982 (probably about 10,000 lb. and 3,000 lb. Ta_2O_5, respectively) as compared to 10,387 short tons in 1980.

Country by country reporting is also included in the report :

Australia — Tin-tantalite mine operations at Greenbushes Tin were reported to have produced a record quantity of Ta_2O_5, more than 240,000 lb. contained in all products, resulting from increased production, higher grades of ore being mined and the treatment of tailings. For the fiscal year ending June 30, 1982, production of tantalite concentrates was 206 tons compared to 163 tons in fiscal year 1981 and 826,000 cubic meters of ore were treated compared to 1.5 million in 1981. Additionally, 391,000 cubic meters of tailings were produced in 1982 as were 134,000 tons of tantalum « glass » slag. Approximately 15,000 lb. Ta_2O_5 was separated in the pilot extraction plant. The plant was closed in September 1981 and then recommissioned in May 1982 with production since averaging 3,300 lb. Ta_2O_5 per month from leached cassiterite and stibio-tantalite ores.
Pilot plant production tests from underground ore showed gravity-circuit recoveries in excess of 75 % for tin and 70 % for tantalum with overall recoveries expected to be increased to at least 85 % with the inclusion of a flotation circuit.
The new tailings treatment plant was closed down in January and placed on a standby basis owing to the declining tantalum market. In February, the main ore treatment plant was reduced to one shift per day treating only nearby high-grade ore. A new demountable treatment plant was commissioned to treat highgrade alluvial ore remote from the main treatment plant.

Canada — Tanco suspended mining and milling operations at its Bernic Lake mine in Manitoba for about one month during the summer. Later in the year, Tanco announced that operations at the mine would be suspended at year end for an indefinite period, attributing the suspension to a weak tantalum market and high tantalum inventories. In 1982, 142,000 tons of ore at a Ta_2O_5 grade of 0.125 % and 38,000 tons of tailings at 0.065 % were milled, compared with 152,000 tons at 0.122 % and 55,000 tons at 0.059 %, respectively, milled in 1981. Total production of Ta_2O_5 in concentrates declined to about 272,000 lb. in 1982 from 279,000 lb. in 1981. Overall recovery in 1982 was down slightly to about 67 %. Reported mine reserves at year end decreased about 11 % from 2.7 million lb. to 2.4 million lb. of contained tantalum and the tantalum contained in stored tailings dropped to 747,000 lb. from 790,000 lb.
Placer Development Ltd. relinquished its option on the columbium-tantalum rare-earths properties of Highwood Resources Ltd. in the Northwest Territories owing to uneconomic recovery of ore. Plans for further testing and exploration were indicated by Highwood.

Thailand — Again, in 1982, tantalum-bearing tin slags were second only to tin in value of exports of metals and minerals. Production of struverite declined to 11 tons in 1982, down from over 330 tons in 1980.
The proposed plan of the Thailand Tantalum Industry Co., Ltd. (T.T.I.C.) to set up an extraction plant at Phuket was slowed. However, T.T.I.C. was reported to have signed a contract for design, construction management of the project.

U.S. Tantalum Industry Profile

The second report provides a profile of the U.S. tantalum industry for the years 1979 through 1981 :

(1,000 lb. tantalum content units)	*1979*	*1980*	*1981*
WORLD PRODUCTION :			
mine production	2540	2780	2480
COMPONENTS AND DISTRIBUTION OF U.S.SUPPLY :			
Domestic mine production	—	—	—
Secondary	51	121	95
Shipment of Gov't. excesses	—	—	—
Imports	1914	2280	1580
Industry stocks, Jan. 1	2948	2753	3261
Total U.S. supply	4913	5154	4936
Distribution of supply			
Industry stocks, Dec. 31	2753	3261	3452
Exports	721	706	222
Government accessions	—	—	—
Industry demand	1439	1187	1262
TOTAL U.S. PRIMARY DEMAND (Industrial demand less secondary)	1388	1066	1167

Tantalum Markets and Marketing

This article has been extracted from a paper presented by John J. Linden,Managing Director of Greenbushes Tin Ltd. and Past-President of the T.I.C., at the Ferro-Alloy Conference in Pittsburgh, Pennsylvania during November 1983.

Tantalum is a strategic material with unique physical, chemical and electrical properties which dictate its end use application in the electronics, metal working, chemical equipment and specialty high temperature alloy industries.

DEMAND FOR TANTALUM

Excluding the Eastern Bloc Country and Government stockpiling acquisitions, the demand for tantalum, expressed in pounds of Ta_2O_5 contained in ore, has fluctuated significantly over the past 15 years. It peaked in 1974 (2.75 m lb.) and in 1979 (3.47 m lb.) and has shown an overall growth from 1.8 m lb. in 1970 to 2.4 m lb. in 1983.

Demand forecasts to the year 2000 show compound growth rates of 3 to 3.5 % with continuing large year to year fluctuations. If demand conforms to past cyclical behaviour, 1985 and 1986 will again be peak years followed by significant decline in 1987. Overall, however, demand is expected to grow from the 2.4 m lb. of 1983 to 3.0 m lb. in 1990 and to 4. I m lb. in the year 2000 with fluctuations in any one year up or down 30 % from the prior year.

Forecasting consumption levels and prices has proven to be extremely hazardous. Generally, it has been assumed that trendlines will continue at roughly the historical rate. But, without fail, such projections have proved to be disastrously wrong. With any forecasts, the basic assumptions must be analysed. To date, the published forecasts have assumed continuing periods of tight supply and unstable prices for raw materials. I disagree with these assumptions and suggest that future demand forecasting should be based on the assumption that adequate supply at stable prices will be available well into the next century.

SUPPLY OF TANTALUM

Tantalum raw materials consist of high grade tin slags (> 10 % Ta_2O_5), low grade tin slags (< 10 % Ta_2O_5),tantalite concentrates (30 % Ta_2O_5), columbites and struverites (15 % Ta_2O_5). The first two categories are by-products of tin smelting and up to 50 % of the remaining categories are a co-product from tin mining operations.

Thus, the tantalum supply is directly dependent on the state of the tin mining and smelting industry. Tantalum occurs with tin produced in Thailand, Africa, Brazil, Australia and, to a lesser extent, Malaysia. There is no tantalum associated with tin produced in Indonesia and Bolivia.

High-Grade Slags (> 10 %)

Thaisarco, the tin smelter in Thailand, has been the single largest producer of tantalum raw materials. Other high-grade slags are produced in Africa, Brazil and Australia but only in small quantities. Production from Thaisarco peaked at over one million pounds, in slags averaging 12 % Ta_2O_5, in the peak tin years of 1979 and 1980. Thailand's tin production had been steadily increasing from 1970 through 1981 with a corresponding increase in tantalum production from 700,000 lb. to 1 million lb. Since the imposition of quotas on the production of tin by the International Tin Council, production has been cut back by 40 % resulting in tantalum production levels of only 600,000 to 700,000 lb.

Since the immediate outlook for tin is not good, demand is soft and the I.T.C. quotas are expected to remain in force for at least the next two years. When the quota restrictions are eased, tantalum in high-grade slags will return to an annual level of about one million pounds. But higher production is not possible as such would exceed Thailand's maximum tin smelting capacity.

Low-Grade slags (< 10 %)

Low grade slags are produced in Malaysia and South Africa, usually at about 200,000 lb. annually, but production is now depressed due to the restrictions on tin production. These slags assay between 1.5 % and 6.0 % Ta_2O_5 and cannot be used as direct raw material feed by processors. Instead, they are upgraded to a synthetic concentrate containing more than 20 % Ta_2O_5 by H.C.Starck and GFE. Synthetic concentrates have been a major contributor to the tantalum supply over the past seven years. The upgrading technology led to the much publicized reclaiming of « old slags » from the streets and backyards of Penang during the apparent tantalum shortage of 1979 which, while being costly, contributed some 2.3 m lb. to the tantalum supply during the period from 1976 to 1982.

Concentrates (30 %)

Concentrates are mainly produced in Canada, Africa, Australia and Brazil. Except for the Canadian production at the Tanco mine, they are produced as co-products and by-products of tin.

Tanco can produce 300,000 lb. p.a. but is currently closed awaiting recovery of the tantalum market. Greenbushes can produce 250,000 lb. but is currently operating at 50 % capacity. Production in Africa and Brazil is also restricted to some 100,000 lb. p.a. due to market conditions and internal problems.

Total concentrate supply has ranged from 700,000 lb. to 1,000,000 lb. between 1970 and 1980 but current production is only 450,000 lb. Future production will be governed by the tin market as continuing quotas will restrict by-product tantalite production from I.T.C. member countries.

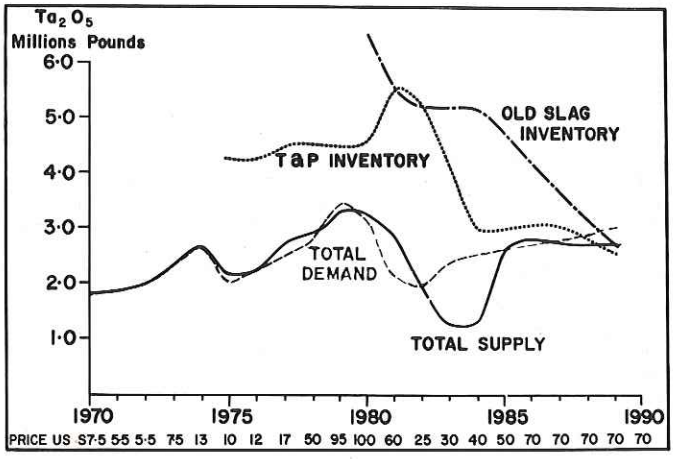
Price, however, is the single main determinant in the production of concentrates. Past increases have generated additional and new production from many relatively small, high-grade alluvial deposits.

Production Summary

Total supply from all "current" production sources of concentrates has increased from one million pounds in 1970 to 2.8 million pounds in 1979. This increased production was stimulated by increased prices for raw materials. The future sources of supply and the production costs are summarized as follows :

Source	*Production 1983*	*Capacity 1986*	*Capacity 1990*	*Production 1990-2000*	*Cost of Production*
Slags >10 %	780	990	970	Steady	$ 5 - 15
Slags <10 %	230	330	420	Steady	22 - 40
Tin Mines co-product	220	420	300	Decreasing	29 - 32
Secondary deposits	170	610	140	Decreasing	10 - 45
Primary deposits	-	370	800	Increasing	26 - 36
Total	1400	2720	2630		

INVENTORIES



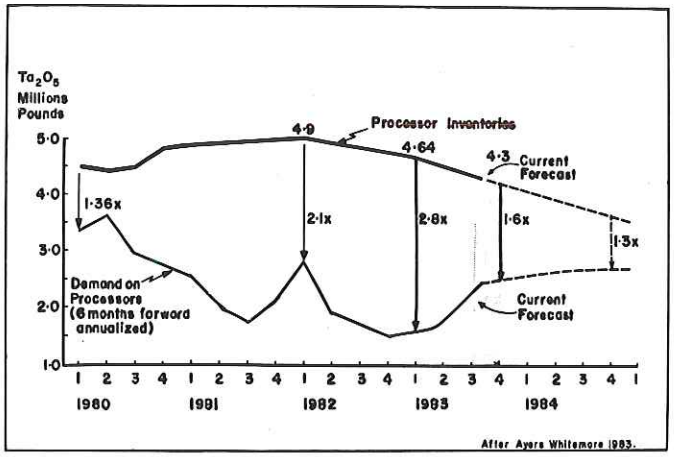
Since 1970, total demand has exceeded total supply by some 3.23 m lb. The shortfall, however, was more than made up for by releases from GSA stockpile (1.4 m lb.) and upgrading of "old slags" (4.0 m lb.). Estimates of world inventories are as follows (at the end of 1982) :

Processor's working inventory ..... 4.64 m lb.

Old low-grade slags
- — Processor's inventories ..... 3.8 m lb.
- — Merchant's inventories ..... 1.4 m lb.
- — In-situ at point of origin ..... 4.0 m lb.

Processor's working inventories have traditionally been high, at least equal to 1.7 times demand, due to the long in-transit lead times and comfort level requirements.

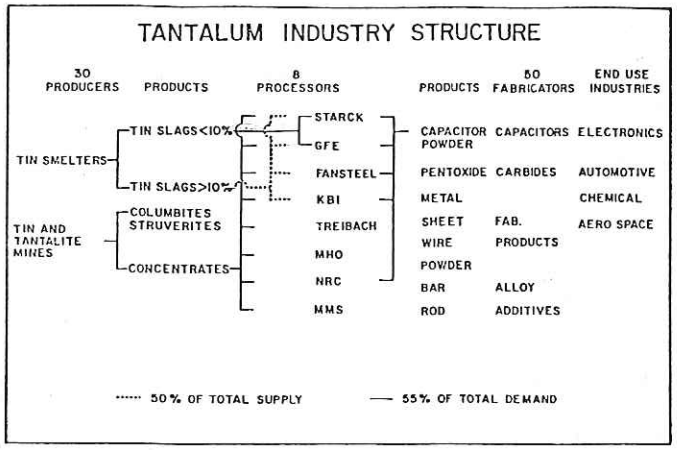
Low-grade slag inventories require upgrading in Germany to synthetic concentrates before becoming raw material for other processors. The use of low-grade slags to balance the shortfall between demand and supply is expected to continue. But these inventories are finite and their depletion is inevitable and it is only the



time to depletion which is in question. Identified, in-situ low-grade slags in Southeast Asia will again be reclaimed when the price justifies the considerable expense involved.

INDUSTRY STRUCTURE

The pivot point of the tantalum industry is the processors and they are the conduit through which all raw material must pass. There are eight processors in the Western World, three in the U.S.A., four in Europe and one in Japan.



These processing companies acquire raw materials from the thirty-odd producing companies and from ten merchants and then convert the materials either into intermediate products, such as tantalum fluo-tantalate and tantalum pentoxide, or continue to process the intermediates into a range of products required by the fifty-odd companies involved in the fabrication of tantalum endproducts.

I believe that the tantalum industry is unique because of the small proportion of processor involvement with the production side of the industry. Only two of the processors have any interest in a raw material source and the percentage of their needs supplied from this interest has been less than 10 % of the total demand.

Of the eight processors, two carry large stocks (3+ years), two carry medium stocks (2 to 3 years) and the balance operate on an annual requirement basis.

CHANGES IN THE INDUSTRY

Certain structural changes in the tantalum industry have commenced and will continue over the next decade as manifested by Thailand's proposed embargo on the export of slags, G.S.A. and Eastern Bloc purchases and Greenbushes' increase in production of concentrates.

The Thailand Tantalum Industry Corporation (T.T.I.C.) has been established to construct a tantalum processing facility in Thailand using the Thaisarco high-grade slag as the initial feed. It is proposed that the plant will produce an intermediate product, potassium fluo-tantalate, and be in production in 1986. H.C.Starck is to provide the technology and they will have an off-take agreement for a percentage of the production. The Thai government has stated that export of slags will be embargoed when this facility is established. At some 50 % of traditional supply, this change in availability of raw material will mean a major reshuffling of supply sources for the major processors or a change away from raw material processing in favor of starting with an intermediate product. With low-cost, fully depreciated processing facilities, U.S. processors will prefer to continue processing and will look for new sources of supply.

The GSA recently tendered for 240,200 lb. of tantalum in highgrade concentrates and, while this is not significant with the current inventory positions, the ongoing policy of the G.S.A. will be extremely important to the supply-demand balance over the next few years. The Eastern Bloc countries have been net importers of tantalum over the past ten years and are expected to remain so in the foreseeable future. Estimates of imports are around 200,000 lb. per year. The combined effect will mean reduced availability of concentrates in the short term leading to a more rapid use of low-grade slag inventories.

One of the main benefits from the recent price rise for tantalum was the generation of exploration activity and the identification of new resources.

DEMAND-SUPPLY SUMMARY

The tantalum supply is assured to meet all demand forecasts for the next twenty years. Current levels of production are restricted by recent low demand — and hence prices — for tantalum and by restrictions on tin production.

TANTALUM SUPPLY AND DEMAND

000's lb Ta_2O_5 in Ore

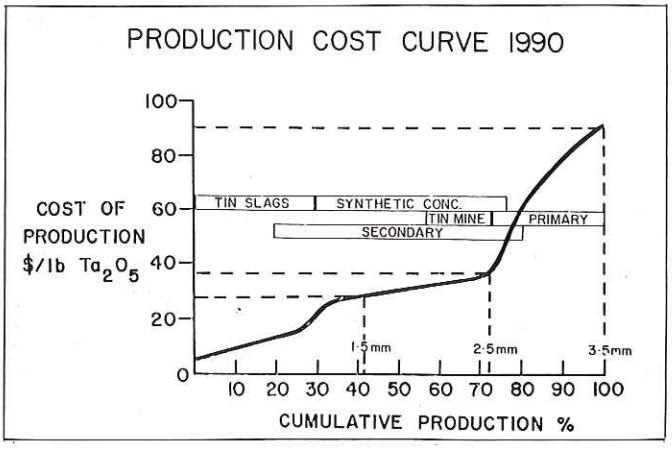
Year	Price US$/lb	SUPPLY Tin Slags	Tantalites	Columbites	Old L.G. Slags	Total Supply	Total Demand	Inventory Trade Processor	Old Slags	Eastern Bloc and GSA Purch.Est.
1975	10.00	1 140	820	190	-	2 150	2 000	4 300		
1976	12.00	1 171	780	115	200	2 266	2 300	4 266		
1977	17.00	1 281	802	338	350	2 771	2 550	4 487		
1978	50.00	1 147	787	408	550	2 892	2 825	4 554		
1979	95.00	1 432	855	513	600	3 400	3 475	4 479		
		6 171	4 044	1 564	1 700	13 479	13 150			
1980	100.00	1 263	995	422	600	3 280	3 205	4 554	6 560	150
1981	60.00	1 100	440	300	1 060	2 900	2 099	5 355	5 450	100
1982	25.00	1 000	480	150	250	1 880	1 900	5 335	5 200	200
1983	30.00	700	400	100		1 200	2 400	4 135	5 200	500
1984	40.00	700	500	100		1 300	2 500	2 935	5 200	500
		4 763	2 815	1 072	1 910	10 560	12 104			1 450
1985	50.00	1 000	1 000	200	500	2 700	2 650	2 985	4 700	
1986	70.00	1 000	1 150	150	500	2 800	2 700	3 085	4 200	
1987	70.00	1 000	1 150	130	500	2 780	2 600	3 065	3 700	
1988	70.00	1 000	1 150	60	500	2 710	2 900	2 875	3 200	
1989	70.00	1 000	1 150	60	500	2 710	3 000	2 585	2 700	
		5 000	6 600	600	2 500	13 700	14 050			

Development of new production capacity has started at Greenbushes to produce an additional 250,000 lb. in 1985 with the capability of increasing this production to 600,000 lb. when required by the market. Production from Brazil and Africa will also increase with return to normal market conditions and a new deposit in France will also be developed. The structural changes in the industry brought about by the T.T.I.C. project in Thailand will be partly offset by this increased concentrate availability.

The processors will remain in firm control of the tantalum market while sufficient inventories of low-grade slags exist to satisfy any apparent shortfall in supply for the short term. The buying patterns and prices offered by processors will determine the rate of development of additional production.

PRICES

The tantalum price has fluctuated markedly reflecting the cyclical nature of the demand cycle of the end products. The cyclical demand was artificially suppressed in price patterns prior to 1976 due to releases from G.S.A. stockpiles and because the bulk of world demand was supplied by the extremely low-cost by-product tantalum from tin smelting. But, by 1990, production cost will govern.



If the total tantalum demand is less than 2.5 m lb., almost 50 % of the demand will be supplied from tin slags which have a negligible cost of production. Approximately 1 m lb. will be supplied in the form of high-grade slags with a cost of production at less than $10 per lb. The next 1.5 m lb. can be supplied from synthetic concentrates and tantalite concentrate production with costs of production averaging $35. Additional requirements over 2.5 m lb. will require production from new primary sources with a substantial rise in production costs.

The current price level of $33 per lb. is not sufficient to encourage a return to production by those producers who were forced to close production capacity. The longer this situation persists, the greater the reaction will be in price when resumed production is required. Processor inventory position is sufficient to defer resumed production if the processors elect to use inventory to maintain a period of prices below the true cost of production.

Just as the processors were in control of the prices during the period of apparent shortage, so the processors are in control of the price of tantalite raw material during the current period of surplus. Producers of raw materials simply react to the price offered in the only way that they can — to increase production or to decrease production. Similarly, the endproduct consumers and fabricators react to the prices set by the processors for the processed products. They reduce consumption because of shortage and price by substitution and replacement.

MARKETING

The tantalite market is a physical market similar to tungsten but on a smaller scale and completely different from tin which is internationally controlled and nickel which has terminal market facilities. The structure of the industry determines that the producer can sell to only eight processors or to ten merchants who must also, in turn, sell to the same eight processors.

During the 1978-1980 period of shortage, Greenbushes elected to offer its production by tender on a closed bid system. The supply-demand condition dictated the price in the same way that the current G.S.A. tender determines the market price.

Tantalum, being a relatively small industry, has suffered from an additional problem of not having an identifiable market of any size for the past two years.

Processed tantalum products have an added marketing component, especially in the case of capacitor-grade powder. A technology component is incorporated in the product and this component has a value which is determined by individual processors in setting their product prices. In the end these processors must compete with each other for market share and so the laws of supply and demand again prevail.

Mining is a high risk business and it is traditionally acknowledged that the cyclical and high risk nature of the metals production business must be offset by periods of extremely high returns and periods of low return or losses. Some companies attempted to insure against the bad times by fixing producer prices substantially below the free market during the cyclical highs. Generally, such insurance did not work as during downturns customers rightly purchased from the cheapest available source.

The tantalum market has a proportionately large number of merchants acting in both a genuine intermediary role and in a speculative capacity. The merchants' role can collectively influence the market unduly, mainly because the market is physical and small. The cyclical nature and historical price fluctuations have enticed more players to this commodity than is required for the proper marketing of the commodity.

The short term will not see any changes to the market behaviour of tantalum raw materials or processor products. The market will continue to be dominated by processor inventories and merchant speculative interest. In the long term, the emergence of major processing facilities in Thailand and significant production increases at Greenbushes should be seen to be stabilizing influences in the tantalum markets.

Capacitor statistics

The statistics of capacitor sales in the U.S.A. and Japan are given below. For the U.S.A. data "Manufacturers" covers U.S. capacitor manufacturers' products sold in the U.S.A. "Distributors" covers products imported by those manufacturers for resale. Other imports are not included.

The "Export" data in the Japanese manufacturers' statistics cover sales to eight main overseas countries only.

U.S. TANTALUM CAPACITOR SALES (THOUSANDS OF UNITS)

(Data from Electronic Industries Association)

1983 TOTALS

Type	*Manufacturers*	*Distributors*	*Export*	*Grand total*
Foil	825	372	55	1252
Metal cased solid	159096	52785	39219	251100
Non-metal solid	384961	94133	59453	538547
Chips	19091	145	14356	33592
Wet slug	7291	3177	1377	11845
TOTAL	571264	150612	114460	836336

GRAND TOTAL BY QUARTER 1983

	1st Q	*2nd Q*	*3rd Q*	*4th Q*
Foil	308	324	321	252
Metal cased solid	56768	64105	65530	64697
Non-metal solid	107750	123211	145962	161624
Chips	7713	8532	8632	8613
Wet slug	2841	2874	2887	3243
TOTAL	175380	199046	223332	238429

JAPANESE TANTALUM CAPACITOR SALES (THOUSANDS OF UNITS)

(data from Japanese Electronic Industry Development Association)

	Production	*Of which export*
1981	1289634	288915
1982	1295440	282784
1983	1577229	378976

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40, RUE WASHINGTON, 1050 BRUSSELS

PRINTED BY PUVREZ
59, av. Fonsny, Brussels