TANTALUM PRODUCERS INTERNATIONAL STUDY CENTER

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Australian Tantalite Deposits

(The following paper (abridged) was written by Mr. N. D. Knight and Mr. I. R. McLeod, Bureau of Mineral Resources, Geology and Geophysics, Australia, and presented by Mr. McLeod during the Raw Material Seminar at the Eleventh General Assembly of the T.I.C.)

INTRODUCTION

Deposits of tantalite were known in Australia in 1900, but the first production was not until 1905. Prior to 1938 Australia was the major producer of tantalum ore, supplying 90 percent of the world's requirements. Today it rates fifth, producing about 8 percent of the world's total.

Up until 1940 producers in the Pilbara region of northwest Western Australia accounted for 96 percent of Australia's production. The most important source in the region was Wodgina, which, during this period, was the world's major producer of consistently high-grade tantalite. Production from Wodgina ceased in 1938, after which output from the Pilbara came from small deposits at Strelley, Tabba Tabba, Shaw River and Pilgangoora. By the end of the 1960s the Pilbara had faded into insignificance as a tantalite-producing region. In the 1950s, the Greenbushes area of southwest Western Australia emerged as Australia's major producing region, accounting for 95 percent of production in 1978.

AUSTRALIAN DEPOSITS

Most of the Australian tantalite production has come from pegmatites, or alluvial and eluvial deposits derived from them. Some were worked for their tantalite content alone, whereas in others tantalite has been a co-product of tin mining.

Western Australia

The Pilbara region is an area of about 35,000 km^2 inland from Port Hedland. The source of all the tantalite mined has been pegmatite dykes. At present three companies are producing tantalite in the Pilbara : Goldrim Mining Australia Limited at Wodgina, Endeavour Resources Limited at Moolyella and Pilgan Mining Pty Limited at Pilgangoora.

Wodgina. At Wodgina numerous pegmatites intrude the metamorphic rocks and, rarely, the granite. They are large, often exceeding 1.5 km in length, and have irregular shapes, probably intruded into tension fractures. However, some, including the tantalite lode, follow well-defined faults.

The main tantalum mineral present is mangano-tantalite but mangano-columbite, tanteuxenite and microlite have also been recorded. Concentrates generally have a Ta : Nb ratio of about 4 : 1. Other economic minerals which may occur are cassiterite, beryl, lepidolite, spodumene, and radioactive minerals such as thorogummite, pilbarite and hydrothorite.

Total production from Wodgina from 1905 until 1978 was about 200 tonnes of tantalite-columbite concentrations. Of this, over 60 percent came from the tantalite lode or alluvials derived from it. This lode is a 670-metre long pegmatite vein with a width of 3 to 9 m. The ore treated on the lease averaged about 1.4 kg of concentrate per tonne, but this included some eluvial ground and only the richer parts of the lode.

Goldrim Mining (Australia) is currently mining more than 300 tonnes per day of alluvium from a stream valley. In late 1977 the company reported reserves totalling 192,683 tonnes of probable and possible ore, containing 544 ppm Ta_2O_5 and 653 ppm SnO_2; the figures refer to « clean » ore *in situ* and no allowance is made for dilution during mining. The overburden to ore ratio is about 1.7 to 1. Work by the company on the tantalite lode suggests a geological resource there of some 600 tonnes of contained Ta_2O_5. Additional work is required to refine this estimate.

A water shortage necessitates carting the ore for about 8 km to the treatment plant established near a water source. However, water supply investigations are being carried out and the company may build a small dam at the mine site, and move the concentrator there.

Moolyella. On the Moolyella field swarms of pegmatites intrude and typically range in length from a few metres to more than 100 m. and their width ranges from less than 1 m. to about 3.5 m. Production of 2.3 tonnes of tin has been recorded from the pegmatites, but none of tantalite. Widespread thin colluvial and eluvial deposits contain cassiterite and tantalite-columbite, and a series of richer shallow alluvial deposits contain the same minerals. The alluvial deposits, which may be extensive, are generally thin and range in thickness up to 2 m. of mineral bearing alluvium overlain by 10 m. of overburden.

Tin concentrates produced in the past have contained an average of 3½ to 4 percent Ta_2O_5. Laboratory studies suggest that about 2 percent of this content is molecularly combined with the cassiterite. The remaining 1½ to 2½ percent Ta_2O_5 can be recovered separately as a columbite-tantalite concentrate assaying 40 to 45 percent Nb_2O_5 and 28 to 30 percent Ta_2O_5.

Endeavour Resources Limited is at present carrying out detailed testing of the deposits and has installed a plant to produce separate cassiterite and columbite-tantalite concentrates. The plant has a capacity of 500,000 tonnes/year of ore and expected production is about 15 tonnes of tantalite-columbite concentrate a year.

T.I.C. TWELFTH GENERAL ASSEMBLY

The Twelfth General Assembly of the T.I.C. will be convened at 9.00 a.m. on Monday, October 29th 1979, at the Cercle Royal Gaulois, 5 rue de la Loi, 1000 Brussels.

The agenda for the meeting will be :

1. **Presidential address.**
2. **Minutes of Eleventh General Assembly.**
3. **New membership.**
4. **Report of Executive Committee.**
5. **Report on quarterly Bulletin.**
6. **Modification of statutes.**
7. **Statistics : production, January-June 1979; collection of data on consumption.**
8. **Statutory elections.**
9. **Thirteenth General Assembly.**
10. **Other matters.**

The meeting will be followed by two presentations concerning trends in the market for tantalum products.

— **Mr R.W. Franklin, Head of Development Engineering, ITT Components Group Europe, Capacitor Division, UK : 'The Effects of Recent Tantalum Price Rises and Shortage on Capacitor Manufacture'.**

— **Mr David Maguire, Vice President, Union Carbide Corp., Special Components Dept., USA : 'The Short and Long Term Outlook for Tantalum Capacitor Demand'.**

Interested prospective members wishing to attend the Twelfth 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 adrress Tictan Brussels.

Greenbushes. Tantalite-columbite concentrates are produced at Greenbushes, 70 km south southeast of Bunbury, as a co-product of tin mining. Most of the ore is in the main pegmatite dyke, 2.5 km long and 800 m wide. Subsidiary smaller parallel pegmatite bodies have been mined. The zones of cassiterite and tantalite mineralisation occur mainly on the western and eastern margins of the pegmatite.

The proportion of tantalite, and accompanying columbite, to the cassiterite varies considerably. The tantalite grades are usually much lower in the alluvial deposits than in the pegmatite ore.

Ore reserve estimations are based on the ore within the weathered pegmatite. Ore presently being mined averages 0.4 kg/m³ cassiterite (70 percent Sn) and 0.08 kg/m³ tantalite (40 percent Ta_2O_5). The average grades have been decreasing. Ore currently being treated consists of 75 percent primary decomposed pegmatite and 25 percent secondary alluvial ore. Secondary deposits are of three general types: claybound enriched eluvials above the pegmatite; alluvial deep leads in old drainage gutters not necessarily conforming to the present surface contours; and shallow sands, gravels and laterites on the flanks of the pegmatite intrusion.

Production for 1978 was 548 tonnes of tin concentrates and 116 tonnes of tantalite concentrates; 1,200,000 loose cubic metres of ore was treated. Throughput is expected to be the same in 1979. At present a pilot plant is being operated to convert tantalite concentrates to tantalum oxide powder. In addition a pilot tailing re-treatment plant is being built to recover very fine tin and tantalite.

Other Localities. Small amounts of tantalite-columbite ore have been recovered at irregular intervals from Warda Warra in the Yalgoo Field. The deposit is a small primary deposit within a pegmatite. The grade is patchy, but there are small areas of high-grade ore. Other localities from which small quantities have been obtained include Bellinger, near Menzies; Poona, 56 km north of Cue; Coodardy, 32 km northwest of Cue; Londonderry, 21 km south of Coolgardie; Yinnietharra, 257 km east of Carnarvon; and Dalgaranga on the Yalgoo Field.

Northern Territory

Tantalite has been found at several places in the Northern Territory, but most production has been from near Darwin. Total recorded output is about 13 tonnes of tantalite concentrates.

A belt of country which stretches from the West Arm of Port Darwin southwards for about 65 km contains numerous tin and tantalite-bearing greisens and pegmatites. The pegmatites are generally small and many are zoned. The ore minerals present are cassiterite and manganiferous tantalo-columbite. Production has come from the kaolinised parts of the pegmatites. Some of the eluvial deposits on the flanks of hills have been worked on a small scale, but no true alluvial deposits of economic grade have been proved in the area. Small low-grade tantalite deposits occur in pegmatites near Barrow Creek, about 280 km north of Alice Springs. The 310 kg of concentrates won to the end of 1944 (about half lode and half eluvial material) assayed 72 percent Ta_2O_5. A further 250 kg was produced in 1954.

Recent exploration in the area has indicated several new pegmatite deposits, with accompanying eluvial material. Two of these deposits are being worked. Production in 1978 was about 200 kg of concentrates. Production is likely to increase in 1979. Two deposits discovered in 1944 on Delny Station, 160 km northeast of Alice Springs, yielded 43 kg of concentrate assaying 77 percent Ta_2O_5 and 125 kg assaying 68 percent Ta_2O_5, respectively. Tantalite is associated with cassiterite and galena in pegmatite dykes on Anningie Station, 225 km north northwest of Alice Springs, and occurs in pegmatites and alluvium 9 km northwest of Utopia Station, 240 km northeast of Alice Springs.

Other Localities

Tantalite is known to occur at a number of places elsewhere in Australia, but production has been recorded from only the Forsayth district in north Queensland. Near Grants Creek, 27 km west of Forsayth, tantalite occurs erratically. About half a tonne of tantalite, assaying up to 65 percent Ta_2O_5, is said to have been produced but the lodes were considered too low-grade to be worked. Samples from Dividend Gully, near Percyville, 48 km south southwest of Forsayth, assayed 82.8 percent combined Ta_2O_5 and Cb_2O_5. Tantalite is associated with quartz in a pegmatite near Mica Creek, 13 km south of Mount Isa. A shaft was sunk on the prospect to 5.8 metres, but the tantalite-bearing pegmatite cut out at this deph, indicating that there would be little likelihood of any production.

In New South Wales, tantalite has been found in several of the felspar quarries near Egebek, 45 km southwest of Broken Hill, and microlite has been found near the Trident amblygonite mine near Euriowie, 65 km north of Broken Hill. In addition a little tantalite has been detected in the beach sands from the far North Coast.

The only report of tantalite in Victoria has been its occurrence in association with cassiterite at the Walwa, Mitta Mitta and Mount Wills tin mines, but concentrations are too low to be economic. Tantalite-columbite has been noted in a few of the pegmatites of the Bimbowrie-Boolcoomata area north of Olary; some detrital material has also been found. Tantalum and columbium are also constituents of titanium minerals **(particularly ilmenorutile)** found in this area. Samples of one such occurrence at Mount Victoria assayed 44.8 percent combined tantalum-columbium oxides. Several of the complex uranium minerals found in the Crocker's Well area, about 75 km northwest of Radium Hill, contain appreciable amounts of tantalum and columbium. Similar minerals occur, though rarely, in pegmatites throughout the region.

PRODUCTION AND EXPORTS

Australia has produced a total of 2,123 tonnes of tantalite-columbite concentrates from 1905 to the end of 1978. Details of production are given in Table 1. The statistics provide a useful picture of the changes in importance of the various producing localities. Until recently all locally produced tantalite concentrates were exported for processing (Table 2). Domestic requirements of processed material are met by imports. Exports are principally to Japan, which in recent years displaced the USA as the largest importer of Australian tantalite-columbite concentrates.

RESOURCES

No detailed assessment of Australian tantalite resources has been undertaken, apart from a survey in 1944 which estimated Australia's known reserves in alluvial and eluvial deposits at about 100 tonnes of tantalite. A problem in any detailed assessment is the nature of the pegmatite deposits. The pegmatites are scattered and irregular in pattern, and are erratically mineralised, so accurate estimation of reserves is difficult and expensive. In addition, little information is available from past operations on the alluvial deposits, because the producers tended to work on a small scale and reserves were not proved in advance. BMR estimates, using information available to it, that recoverable demonstrated economic resources of tantalite-columbite in Australia are at least 200 tonnes. Because of the recent increase in exploration this figure is likely to be increased over the next few years.

TABLE 1 : PRODUCTION OF TANTALITE-COLUMBITE CONCENTRATES. AUSTRALIA (tonnes) (a)

YEAR	Wodgina	Other Pilbara	Greenbushes	Other W.A.	N.T.	Total
1905-10	87.43	—	—	—	—	87.43
1911-20	12.70	—	—	—	—	12.70
1921-30	60.39	1.60	.30	—	4.14	66.43
1931-40	59.15	36.12	.46	2.54	3.97	102.24
1941-50 (c)	6.26	8.61	18.57	—	3.74	37.18
1951-60	10.37	90.90	57.01	8.28	.81	167.37
1961-70 (b)	3.79 (d)	55.51 (d)	251.16	19.84	—	330.30
1971	—	.41	70.46	4.17	—	75.04
1972	—	12.54	257.24	—	—	269.78
1973	—	—	272.59	—	—	272.59
1974	—	—	138.01	—	—	138.01
1975	—	—	145.63	4.47	—	150.10
1976	—	—	117.35	1.03	—	118.38
1977	—	—	151.41	5.33	—	156.74
1978	.11	—	126.86	11.56	.20	138.73
TOTAL	240.20	205.69	1 607.05	57.22	12.86	2 123.02

(a) Figures up to and including 1964 relate to production and have been calculated on a basis of a 65 percent Ta_2O_5 content.

(b) Figures from 1965 onwards relate to sales and refer to concentrates containing around 40 percent Ta_2O_5.

(c) Figures of 1941-50 include 0.06 tonne of tantalite with a grade about 47 percent, produced from the Forsayth district of Queensland in 1944.

(d) Figures for 1968 exclude 393.22 tonnes of low-grade reject produced by Cooglegong Tin Pty Ltd; 1969 figures exclude tin/tantalite reject concentrates for which no production figure is available, but for which the metallic content was 702.95 Ta_2O_5 units. Producers were Cooglegong Tin Pty Ltd and J.A. Johnson & Sons Pty Ltd.

TABLE 2: TANTALITE-COLUMBITE CONCENTRATES EXPORTS. AUSTRALIA

YEAR	TONNES	$ '000
1937-38 to 1944-45	75	161
1946-1950	16	12
1951-1960	252	788
1961-1970	448	1 591
1971	159	802
1972	253	687
1973	199	638
1974	128	853
1975	132	1 135
1976	124	1 515
1977	158	2 165
1978	125	2 243
TOTAL	2 069	12 590

Exports of tantalite-columbite concentrates were not recorded separately before 1937-38.

T.I.C. Membership List, June 1979

B.E.H. Minerals Sdn. Berhad,
4¾ Miles Lahat Road,
Post Office Lahat,
Locked Bag Service No. 2,
Perak, Malaysia.

Bhuket Union Thai Minerals Co., Ltd.,
115/1 Bhuket Road,
P.O. Box 43,
Bhuket, Thailand.

B.O.C. Ltd., Metals Division,
Hammersmith House,
London W6 9DX, England.

Brandeis, Goldschmidt and Co. Ltd.,
4 Fore Street,
London EC2P 2NU, England.

Charter Consolidated Metals & Ores Ltd.,
40 Holborn Viaduct,
London EC1P 1AJ, England.

Datuk Keramat Smelting Sdn. Berhad,
Post Box 280,
Pulau Pinang, Malaysia.

Derby and Co. Ltd.,
Moor House,
London Wall,
London EC2Y 5JE, England.

Cia de Estanho Minas Brasil,
Avenida Rio Branco, 103-19º and.,
Rio de Janeiro - RJ, Brazil.

Fansteel Inc.,
Number One Tantalum Place,
North Chicago,
Illinois 60064, U.S.A.

Gesellschaft für Elektrometallurgie mbH,
Postfach 3520,
4000 Düsseldorf 1, West Germany.

Greenbushes Tin NL,
Metals House,
91 Kensington Street,
East Perth 6000, W. Australia.

W. C. Heraeus GmbH,
Postfach 169,
D-6450 Hanau, West Germany.

Hochmetals Africa (Pty) Ltd.,
P. O. Box 6458,
Johannesburg, South Africa.

Comp. Industrial Fluminense,
Caixa Postal 4929,
Rio de Janeiro, Brazil.

ITT Components Group Europe,
Capacitor Division,
Brixham Road,
Paignton,
Devon TQ4 7BE, England.

Kawecki Berylco Industries Inc.,
220 East 42nd Street,
New York, N.Y. 10017, U.S.A.

Makeri Smelting Co. Ltd.,
P. O. Box 653,
Bokuru Road,
Jos,
Benue Plateau State, Nigeria.

Soc. Mineira de Marropino Lda.,
P. O. Box 86,
Quelimane, Mozambique.

Metallgesellschaft AG,
Reuterweg 14,
D-6000 Frankfurt am Main 1, West Germany

Metallurg Inc.,
25 East 39th Street,
New York, N.Y. 10016, U.S.A.

Mitsui Mining & Smelting Co. Ltd.,
2-Chome,
Nihonbashi-Muromachi,
Chuo-Ku,
Tokyo, Japan.

NRC Inc.,
45 Industrial Place,
Newton,
Massachusetts 02164, U.S.A.

RefineMet International Co.,
One Main Street,
Mapleville,
Rhode Island 02839, U.S.A.

Sabemin S.A.,
Square de Meeus 18,
1040 Bruxelles, Belgium.

S.A. Minerals Ltd. Partnership,
P. O. Box 31,
Phuket, Thailand.

Showa-KBI Co., Ltd.,
Shiba Toho Bldg., 2F.,
1-7-24, Shiba-Koen Minato-ku,
Tokyo, Japan.

Siemens AG,
Werk Kondensatoren,
Postfach 1840,
D-7920 Heidenheim, West Germany.

Sominki,
c/o Cogemin S.A.,
23 Avenue de l'Astronomie,
1030 Bruxelles, Belgium.

Somirwa,
Geomines S.A.,
150 Chaussée de la Hulpe, Bte 13,
1170 Bruxelles, Belgium.

Hermann C. Starck Berlin,
P. O. Box 2540,
3380 Goslar/Harz, West Germany.

The Straits Trading Co. Ltd.,
27 Jalan Pantai,
Butterworth, Malaysia.

Tantalum Mining Corp. of Canada Ltd.,
c/o National Resources Trading Inc.,
576 Fifth Avenue,
New York, N.Y. 10036, U.S.A.

Thailand Smelting & Refining Co. Ltd.,
P. O. Box 2,
Phuket, Thailand.

Thermoelectron Corporation,
Metals Division,
9 Crane Court,
P.O. Box 546,
Woburn,
Massachusetts 01801, U.S.A.

Treibacher Chemische Werke AG,
Postfach 31,
A-9300 Treibach, Austria.

Union Carbide Corp.,
Special Components Dept.,
Box 5928,
Greenville,
South Carolina 29606, U.S.A.

Zairetain,
Geomines S.A.,
150 Chaussée de la Hulpe, Bte 13,
1170 Bruxelles, Belgium.

U. S. Shipments of Tantalum and Columbium Products

The data for the 1978 shipments of tantalum and columbium products by U.S. processors are again available. These, with comparative data for 1974 through 1977, are as follows (1,000 lb. units) :

PRODUCT	1974	1975	1976	1977	1978
Tantalum					
Oxides & Salts	226.1	127.4	55.4	62.8	38.2
Alloy Additive	24.8	8.5	13.2	12.2	4.4
Carbide	163.4	106.5	93.3	113.5	116.9
Powder & Anodes	929.4	436.6	759.0	759.2	840.0
Ingot	1.7	1.0	7.7	8.0	7.2
Mill Products	288.8	172.2	238.5	292.4	321.9
Scrap	45.6	13.0	130.7	168.3	184.1
Other	1.3	—	—	2.0	2.1
Total	1,681.1	865.2	1,297.8	1,418.4	1,514.8
% Change	11.9	(48.5)	50.0	9.3	6.8
Columbium					
Compounds	1,520.5	930.8	791.3	872.4	1,611.0
Metal	133.4	112.7	101.6	189.3	223.7
Miscellaneous	34.0	21.2	41.0	16.6	12.5
Total	1,687.9	1,064.7	933.9	1,078.3	1,847.2
% Change					

The data demonstrate that tantalum shipments have at least remained firm in 1978 even with rapidly increasing prices. There is no sign of a reduction in demand as the fourth quarter shipments were larger than any other quarter of the year. The fourth quarter total was also 20.2 % larger than the total in the fourth quarter of 1977. Thus it appears, at least for the short term, that the threatened substitution for tantalum and the reduction in use expected is not materializing.

The total use of the three major products, i.e. carbide, capacitor powder and mill-products, showed continued increase. The increase in carbide was very slight, not enough to indicate any trend in usage. In view of the general level of industrial activity

in the United States during 1978, the levelling of carbide shipments could actually indicate a decrease in the proportion of tantalum carbide used in cutting tools. It is believed that the expected substitution of the columbium-hafnium carbide had not affected the use of tantalum carbide in 1978, but the use of some columbium-tantalum carbide, so common in Europe, has been reported to have made some headway in the United States. Recycling of carbide cutting tools also seems to be increasing, inspired by the very high tantalum carbide price. The trend during the year is slightly downward, fourth quarter shipments being only 79 % of the first quarter shipments.

Powder and anode shipments remained strong, about 11 % greater than in 1977. Although the total number of capacitors produced is not known, continuation of the sustained downward trend of the average size of anode would indicate significantly more tantalum capacitors made in 1978 than in 1977. In this product also the fourth quarter shipments were the largest of the four quarters of the year.

Mill product shipments were up 10 % over 1977 and reached the same level as the peak year of 1973. Scrap sales by the tantalum processors also increased but remained at the level of 12 % of total shipments established in 1977.

Based on the reported shipments of products, an estimate can be made of source material requirements, 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 slags consumed each year by U.S. processors (1,000 lb. units) :

Year	lb. Ta_2O_5	lb. Cb_2O_5	$Ta_2O_5 : Cb_2O_5$
1974	2,250	2,700	0.83
1975	1,160	1,700	0.68
1976	1,740	1,490	1.17
1977	1,910	1,720	1.10
1978	2,040	2,947	0.70

Recent estimates of the 1978 production of tantalum source materials are in the range of 2.2 to 2.4 million lb. Ta_2O_5. With combined European and Japanese use of at least 0.75 million lb., it appears that inventories were again reduced during 1978 by at least 0.5 million lb. Of interest is the reverse again in the $Ta_2O_5 : Cb_2O_5$ ratio to the higher columbium production, relative to tantalum, as experienced during 1975. This is probably due to a number of factors. In 1975, a sustained market for columbium oxide concurrent with a weak market for tantalum caused the ratio to favour columbium. In 1978 there seem to be other factors involved. The demand for columbium oxide was continuing upward and the price reached very high levels. But, also, increased use of columbites containing some tantalum probably enhanced the tantalum supply.

Japanese Tantalum Production : 1978 Data and 1979 Forecast

Reports from the Japanese Association of New Metals provide statistics for the consumption of tantalum during 1978 :

Product (unit : kg.)	1977 Actual	1978 Actual	% Change
Consumption			
Powder (capacitor & metallurgical)	76,300	73,500	(4)
Chemical Compounds (carbides & oxides)	38,000	44,000	16
Mill Products (electronics & chemical)	25,200	28,380	13
Grand total	139,500	145,880	5

Total import data is not provided this year as it has been in the past. Imports are available only for tantalum powder. In 1978 such imports were 30,121 kg., 41.0 % of consumption, compared to 1977 imports of 25,709 kg., 33.6 % of consumption. Thus the domestically produced powder dropped in 1978 to 43,373 kg., 14.3 % less than 1977 production.

An important aspect of powder consumption is that the forecast reduction in capacitor size is progressing. A peak was reached in 1976 at a consumption of 0.160 grams per unit on the basis of 509,500,000 units produced. Production of capacitors increased in 1977 to 671,400,000 units and the tantalum powder consumption reduced to 0.102 grams per unit. In 1978 capacitor production reached 819,600,000 units. The unit powder consumption again dropped to only 0.083 grams. The total capacitor powder consumption in both 1977 and 1978 was the same at about 68,500 kg. but 22 % more capacitors were made from it in 1978. Although there probably has been a capacitor market shift toward smalelr capacitance units, a large part of the gain in the number of units has resulted from increased usage of higher capacitance tantalum powders. Since such powders are principally available from West German and American suppliers, the use of these materials accounts for the increased imports in relation to total demand.

The J.A.N.M. has forecast that capacitor production will reach 907,300,000 units in 1979 but there will be a continued trend in the reduction of unit size. It is expected that tantalum powder consumption will be down to 0.079 grams per unit resulting in a total demand of 72,000 kg. Thus the increase in capacitor volume will offset the reduction in unit size to the extent that tantalum powder sales are expected to increase by 5 %.

Consumption of carbide and oxide increased again in 1978 by 16 % over 1977 almost attaining, at 44,000 kg., the peak usage of 45,000 kg. in 1974. The continued demand for cutting tools, even though the market pattern for such is changing, has resulted in higher consumption of tantalum powder. The Ultra-Hard Tool Association reports that consumption of tantalum carbide by their industry increased from 24,067 kg. to 26,514 kg. from 1977 to 1978. This increase of 10 % is greater than the 2 % increase in the production of cutting tools indicating a probable shift in the product mix in cutting tool sales. The J.A.N.M. forecast for carbide and oxide sales for 1979 shows a reduction of the total to 41,000 kg. but without explanation of the reasons. It is probable that there is a trend, as is occurring elsewhere in the market, that greater use of niobium-tantalum carbide and niobium-hafnium carbide will cut into the use of pure tantalum carbide in cutting tool manufacture.

The total forecast for all products for 1979 consumption is 147,100 kg., a slight increase of 1 % over 1978 consumption. Considering that the J.A.N.M. is always conservative in its forecasts, it is probable that actual 1979 consumption will be higher. As an example, last year J.A.N.M. forecast that 1978 consumption would be 124,000 kg. : actual consumption was 17.6 % higher.

Tantalum Supply Potential

(The following paper (abridged) was presented by Mr. A. C. A. Howe of A.C.A. Howe International, Ltd. during the Raw Material Seminar at the Eleventh General Assembly of the T.I.C.).

Last year's meeting of the First International Symposium on Tantalum in West Germany indicated an increasing concern by consumers that there would be insufficient supplies of tantalum during the mid-80's. This concern has been reflected in a swift rise in the price of the raw product during the past two years. It is evident that continuing acceleration of price will ultimately cause a substitution of tantalum by other cheaper minerals. This must cause distress to both miners and producers or processors alike. In order to counteract this trend it is in the interest of the miners particularly to show the processors that tantalite can and will be produced in sufficient quantity to balance the market. I think everyone will agree that tantalite prices in the period 1969-1974 were unrealistically low for the miner and resulted in the present shortage of supply, because some mines were forced to close down, and there was no incentive to explore for new ones. Although the price incentive has now been restored, it is unfortunately a well known fact in mining exploration that new production occurs about 10 years after the search begins. In my opinion, however, this process of producing new supplies of tantalite can be speeded up considerably by applying the following techniques :

1. **Exploration** — Reassessing areas of known tantalite occurrence which may now be economic with prevailing prises and concentrating exploration in those areas initially.
2. **Milling Techniques** — Improvement of recovery at presently producing mines and retreatment of tailings. I believe this to be outside the scope of this paper and I will therefore concentrate on :

Exploration in Known Tantalite Producing Areas

Major production in the world comes from alluvial/eluvial or surficial weathered pegmatite deposits. In both cases the sources of the minerals, namely the hard rock pegmatite, has rarely been explored. The great majority of pegmatites are too small for mining except on a very small scale in shallow opencast workings. In general, the pegmatite mining operations, particularly in southern Africa, Australia and South America, have ranged in size from one-man enterprises to small companies with a limited capital investment, and the mines are very small in relation to mines in other sectors of the mineral industry. Very often also the pegmatites have been exploited in the past for one particular mineral, such as beryl, petalite, feldspar and mica, and the potential of the tantalite-columbite was ignored due to prevailing low prices.

In my opinion, therefore, a first step in the establishment of new tantalite production should be an evaluation of known pegmatites, particularly those in areas where tantalite has been reported or where there has been production from alluvial and surficial deposits. The purpose would be to discover a large pegmatite (minimum 2,000,000 tons of rock) that has been overlooked by previous operators or is obscured by overlying rock or soil.

It is easy to overlook an important pegmatite due to the fact that the section appearing on surface may be barren and mineralized areas may be hidden. It is important to understand the geology of pegmatites and that the most favourable pegmatites from the tantalite source point of view are the complex zoned type. The mineral distribution is closely allied to the size, shape and internal structure of the containing pegmatite body, and manifests itself as a series of successive shells, roughly concentric about a number of innermost cores, developed internally along the strike of the pegmatite. The most common innermost core is generally quartz which due to its resistance to weathering is often exposed on surface. The mineralized outer shells may well be covered. In order to establish whether tantalite may be present in economic quantities in a pegmatite, it is first essential to determine whether the pegmatite is of the complex zoned type. Various geochemical tests have been established to provide this determination, such as sampling exposed micas and/or feldspars for traces of rubidium, lithium or cesium. Having established that the pegmatite is of the right type, a detailed geological interpretation of the pegmatite must be carried out. This will determine the length of dip, type of zoning and enable prediction of the location, potential size and type of mineralization that may be encountered and whether follow-up drilling is warranted.

The areas in which there are known sources of tantalite should be the obvious places to commence exploration. In my opinion the most favourable areas are :

1. **Australia** — Australia's potential is great due to the fact that tantalite mineralization is widespread, and exploration for it has been largely ignored. The Pilbara area in particular has important potential as does the Greenbushes area (both of which are in west Australia) and areas in northern Queensland.
2. **Southern Africa** — In the Republic of South Africa and South West Africa the most important areas are the Namaqualand Belt, three areas in the Transvaal, and two in S.W.A. including the Karibib area. J.W. Von Backstrom in a report to the Atomic Energy Board dated March 1973 states that in the northwestern Cape Province and Namaqualand 12,000 pegmatites were examined. There is a potential in the 12 largest pegmatites of 4.5 million tonnes of pegmatite material present for every 30 metres of depth, and he estimated resources of tantalite-columbite averaging 0.1 % (2 lbs.) grade totalling 2,200 tonnes of tantalite-columbite. Other sources in South Africa indicate a total potential of 44,000,000 lbs. Ta_2O_5-Cb_2O_5 at 0.1 % grade. In Swaziland there are reported but undeveloped tantalite bearing pegmatites. The well known Piet Retief deposit in R.S.A. lies close to its border. Botswana is relatively unexplored although the West Transvaal pegmatites lie on its border. Deposits in Rhodesia and Mozambique are not considered for political reasons.
3. **South America** — Tantalite/columbite has been mined from pegmatites occurring in four countries in South America, namely Brazil, Guyana, French Guiana and Argentina. Production has been minimal and sporadic with the bulk of the mineral produced deriving from Brazil. All mined occurrences are of tantalite/columbite mineralization in pegmatites which range in size from 1-2 metres to 20 metres in thickness. These bodies are generally deeply weathered and mining is by simple washing of eluvial material. Two carbonatites in Brazil, namely Araxa and Tapira, exhibit extensive « proven » resources of niobium (9,000,000 and 50,000 tons respectively) — however, with very low tantalum content.

   A paper by Parker R. L. et al (1973) entitled « Niobium (Columbium) and Tantalum » states :

South American reserves of tantalum

	Ta_2O_5 (tons)	Type of Deposit
Brazil	4,000	Pegmatite
French Guiana	1,200	Pegmatite
Guyana	250	Pegmatite
TOTAL	5,450	

In addition to the above, a minor production from Argentina is recorded.

The Brazilian pegmatites lie within a zone of similar bodies which runs roughly parallel to the South American shoreline. The zone has an approximate overall length of 2,000 miles — it rises in Guiana and reappears eastwards in Ceara and in the Bororema Plateau. After a long gap the pegmatites reappear in the Bahia state.

Two important areas are in Northern Brazil in the states of Rio Grande do Norte, Paraiba and Ceara, and in the Sao Joao del Rei area of the Minas Gerais. Much of the Brazilian tantalum production is a by-product of tin mining — slags generally containing approximately 9 % tantalum oxide.

The production of tantalum from the other countries cited has been limited and sporadic. All has been from similar pegmatite origin, with mining in Guiana being situated within the same pegmatite belt that runs through Brazil. The Argentinian bodies are apparently similar to those in Brazil and Guiana but lie within a separate zone.

In conclusion I would like to stress that tantalite reserves can be increased if the large and well financed companies who process and consume the material would provide the exploration financing for the small mining companies who constitute the main suppliers of the product. These mining companies generally have the knowledge of where to look but not the spare cash with which to do it.

World Tantalum Market Outlook : an Update on Trends and their Implications

(The following paper (abridged) was presented by Mr. T. C. Barron, Emory Ayers Associates Inc., during the Raw Material Seminar at the Eleventh General Assembly of the T.I.C.)

INTRODUCTION

In 1978, tantalum mine and smelter production was approximately 350,000 lb. Ta_2O_5 short of meeting world demand for raw material. We estimate that world requirements (excluding Eastern bloc countries) by processors were about 2.8 mm - 2.9 mm lb. last year, while tantalum production was about 2.5 mm - 2.6 mm. This gap is, of course, of great concern to producers and ultimate consumers alike, because it raises the possibility that some tantalum uses may be eliminated entirely out of fears over availability. It is in no one's interest, be they miner, trader, processor, fabricator, or consumer, that this gap should continue. The better the reasons for its existence are understood throughout the industry, the more likely it is that actions will be taken to close the gap without disruption.

I would like to summarize and interpret key current trends in both demand and supply, to explain why the gap has not yet closed, and to focus attention on important long-term issues for tantalum. This concerns 1979-1980 demand trends — in capacitors, carbides and other markets.

CEMENTED CARBIDES

Carbides represented about 41 % of world tantalum demand in 1976 and today probably account for 45 % (= 600 m.t.). The carbide industry has been slower than expected in reducing its tantalum requirements per unit.

Complex tungsten carbides (W/Co/Ta) which have high tantalum content have lost some market share to TiC-based, coated, and other carbides.

But the substitution for tantalum in the substrates of coated carbides has not occurred, and coateds' share of the insert market has risen from 20 % to perhaps over 40 %. The net effect has been to raise, rather than lower, tantalum requirements. Coated inserts' machining performance is demonstrably superior, and insert users are willing to pay a premium for them. The cemented carbide producers have been unwilling to substitute in substrates since the tantalum price increases of the past three years have been passed on. However, they have continued to do the R & D necessary to enable them to make substitution ultimately. And, price rises in cobalt and titanium have also been substantial, and tantalum's rise is not seen as unique.

While the overall strength of the metalworking markets and the upsurge in coated carbides have kept tantalum requirements at high levels, two counter trends have begun :

1. U.S. companies have begun using Cb/Ta blends for the first time and could reach 10 % Cb : 90 % Ta by 1981.
2. Hafnium-niobium carbide, long in development, has been introduced as a substitute for TaC, and could reduce the annual tantalum requirements of carbide-makers by 10 % - 15 % by 1980-1981.

Because cemented carbide producers number in the hundreds and their customers in the thousands, sudden and catastrophic changes do not occur. However, each of the delayed trends are negative ones, and will not be quickly reversed.

Overall, tantalum demand for carbides will be up 6 % - 8 % overall in 1979, but by the end of the year the pace of demand should slacken as the U.S. recession takes hold. Since the carbide market usually lags the overall economy by 4-6 months we expect 1980 demand to be down at least 5 % - 10 % from this year. The long term view, however, is that cemented carbide requirements should still grow at an average (through 1985) 3 % - 4 % per year.

CAPACITORS

Two trends have worked to reduce tantalum demand in this market — higher capacitor powder productivity and substitution of aluminium and ceramic capacitors. Tantalum shipments have still grown as the electronics market has been strong. The strength of capacitor demand was seen in a 6 % rise in tantalum unit shipments in 1977 and 1978, despite all the negative trends. The capacitor powder manufacturers have developed higher CV powders, which provide the same performance for less tantalum. They have doubled their powders' productivity in recent years and tantalum capacitors have remained relatively competitive with aluminiums and ceramics.

However, powder productivity gains cannot keep pace with the increases in tantalum price and tantalum capacitors will inevitably lose more market share. Tantalum capacitor manufacturers cannot pass through their raw material costs as the carbide producers do because competitive capacitors have not seen comparable materials price increases. In late 1979 and 1980, I look for capacitor demand to slow or fall and tantalum needs with it. Over the longer run, requirements for capacitors from this market will probably grow only about 2 % annually.

OTHER MARKETS

In the past four years there have been no significant new uses of tantalum. Further, the T.I.C. has educated the market to the true supply/demand condition. Now, in a number of industries, decision-making on a development involving tantalum often involves a detailed review of long-term needs and tantalum availability, whereas in the past senior management might have made such decisions without knowing (quite literally) how to spell tantalum.

SUMMARY OF DEMAND

1978 world tantalum demand was about 2.9 mm lb. Ta_2O_5, and 1979 will probably be about 3.0 mm - 3.1 mm despite a very slow fourth quarter. This is partly due to the delayed effects of trends in carbides and partly to favorable growth in the world economy. We look to 1980, however, for demand to be off in the U.S. and overall.

SUPPLY

We estimate that world tantalum production was about 2.5 mm - 2.6 mm lb. in 1978, about the maximum that could be expected. Two positive reasons for this production are the political and economic conditions favorable to tantalum development in Thailand, and the construction of the Marropino Mine in Mozambique despite the change in government. However, until 1978, the only long-term prospect for tantalum supply has been totally gloomy because of steadily declining production in several areas (Zaire, Nigeria, Brazil); exhaustion of Tanco reserves expected in early 80s; and, no hope of closing the gap between production and demand, except from inventories.

For the first time, however, it appears that there may be major movement in the right direction. For example, events potentially favorable to long-term supply have taken place in China where interest expressed to Mitsui on tantalum development indicates possible large, low grade reserves; in Canada where Hudson Bay has invested in Tanco; in Brazil where GFE has invested in Sao Joao and exploration has been undertaken by others; in Malaysia and Thailand where struverite processing from tin tailings is up substantially; and in Australia where active prospecting is being carried out by Greenbushes Tin N.L. and others. This is not enough, but it is significantly better than last year. More efforts in exploration and development will be necessary in the next 2-3 years if the tantalum market is to be supplied satisfactorily in the mid-1980s.

PRICE

Because of the availability of inventories of slags, consumers can be assured of supply for some years to come. At the same time, there can be short-run discontinuity in prices, as has recently occurred. I believe the recent run-up in price to be due to the strength in the U.S. (and European) economy, above expectations at this point last year, and the inflexibility of processors' capacity to fast increases in demand. But this situation is temporary and I look for greater price stability later in 1979 and into 1980. A modest recession would be welcome, and is apparently coming, which will further reduce price pressures as pipeline inventories are reduced all along the chain from end users back to the miner.

In summary, the industry can look to some welcome slowing of demand in 1980, while it faces the continuing urgent need to find new supplies for the early 1980s. Without these supplies, demand would ultimately fall off to a level last seen in the 1960s.

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