TANTALUM PRODUCERS INTERNATIONAL STUDY CENTER

QUARTERLY BULLETIN ISSUE No 24 DECEMBER 1980 FOURTH QUARTER

T.I.C. Activities

The Fourteenth General Assembly of the T.I.C. met in the Sheraton Hotel on Wednesday, October 29th 1980. Mr Brian Reynolds, President of the T.I.C., conducted the business of the Assembly which included the election to membership of eight new member companies, bringing the total membership of the association to fifty-three.

The Assembly elected two new members to the Executive Committee, filling one standing vacancy and one vacancy created by the resignation of Mr Joseph C. Abeles from the committee. The two new members are Mr Conrad L. Brown, Vice President of Fansteel Inc., and Mr John Linden, Managing Director of Greenbushes Tin NL.

Dr George J. Korinek, President of Hermann C. Starck Inc. and Chairman of the Board of NRC Inc., was elected President of the T.I.C. for the coming year and assumed this office at the close of the General Assembly.

Other business covered included discussion of the production statistics for 1979 and the first half of 1980, as well as the need to expand the statistical programme of the T.I.C. to include product shipments by processors in Europe, Japan and the United States. The representatives of processing companies which attended the meeting agreed to consider the contribution of their production data, and will report their decisions to the President in time for him to make a report to the Fifteenth General Assembly.

Following the business meeting, Mr Barron and two of his colleagues from Emory Ayers Associates presented the findings of their study of projected supply and demand for the tantalum industry from 1980 through 1985. This survey, sponsored by the T.I.C., demonstrates the market condition and what can be expected in the way of market balance for the period covered. It concludes that tantalum materials will be consistently available throughout the period, in amounts that will readily meet a stable world demand for the metal.

The published study has been made available to all T.I.C. members, and the membership has decided to make it possible for non-members to subscribe to the study as well. The contribution from non-member companies will be US $ 4,000. Those interested should inquire of the Secretary of the T.I.C., 1 rue aux Laines, 1000 Brussels, Belgium, or Emory Ayers Associates Inc., 950 Third Avenue, New York, N.Y. 10022, U.S.A.

An additional presentation covering the new tantalite resource at Greenbushes Tin NL in Western Australia was made by Mr John Linden, Managing Director. His talk is reported in this edition of the Bulletin.

The Fifteenth General Assembly of the T.I.C. will be held from May 18th to May 20th 1981 in Goslar and Bad Harzburg, West Germany. This meeting will include a visit to the processing plant of Hermann C. Starck Berlin, the company which will be the T.I.C.'s host on this occasion.

T.I.C. FOURTEENTH GENERAL ASSEMBLY

The Fourteenth General Assembly of the Tantalum Producers International Study Center was convened in the Sheraton Hotel in Brussels, Belgium, on Wednesday, October 29th 1980, chaired by Mr Brian Reynolds, President of the T.I.C. 38 of the 45 member companies were represented.

The General Assembly conducted the business of the T.I.C., including :

- **The election of eight new members, bringing the total membership to 53;**
- **A review of the production statistics for 1979 and the first two quarters of 1980;**
- **Election of officers.**

Dr George J. Korinek, President of Hermann C. Starck Inc., New York, was elected President for the next term. All seven available places on the Executive Committee were filled : newly elected members are Mr Conrad L. Brown, Vice President of Fansteel Inc., and Mr John Linden, Managing Director of Greenbushes Tin NL.

Mr Thomas C. Barron of Emory Ayers Associates addressed the meeting on the findings of the world-wide study of the tantalum industry. Mr John Linden gave a presentation describing the tantalite ore bodies and their future potential at Greenbushes.

On Tuesday afternoon, a group of delegates visited the Royal Museum for Central Africa in Tervuren, looking particularly at the mineralogical collection.

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Museum Visit

On the afternoon of Tuesday October 28th, a party of delegates visited the Royal Museum for Central Africa in Tervuren.

The large and elegant museum buildings are situated in several hectares of beautiful parkland, half-way between Brussels and Louvain. The museum was begun in 1897 by King Leopold II of the Belgians to support his belief that the Belgian people should learn more of the culture and life of their Central African colonies.

Mr Lucien Cahen, Honorary Director, guided the group expertly and enthusiastically through the wide-ranging collections of tribal exhibits and the scenically displayed birds and animals. The delegates were particularly interested in the mineralogical section, where part of the museum's large collection of specimens from Zaire, Nigeria, Zimbabwe and other African countries was shown. Several samples of tantaliferous minerals were included, and some of the exhibits were of spectacular beauty.

T.I.C. Tantalum Production and Shipments

The T.I.C. data for the production and shipments of tantalum-bearing tin-slags and concentrates for 1979 and the first six months of 1980 are as follows :
(in lbs Ta_2O_5 contained)

	Slags	*Concentrates*	*Total*
1979			
Production	1,204,945	893,157	2,098,102
Shipments	1,182,163	938,723	2,120,686
1980			
January-June			
Production	869,359	367,103	1,236,462
Shipments	797,853	338,118	1,135,971

The 1979 data have been provided by eighteen of the twenty producer members and the 1980 data by sixteen of the twenty. The total production for 1979 represents an increase of 29 per cent over that for 1978, but production in 1978 was reported by only thirteen out of fourteen producers who were members of the T.I.C. at that time.

Based on the total production of tantalum source material reported in the 1980 T.I.C. study, it appears that the T.I.C. producing members account for some 80 per cent of the free-world production.

The Tantalum Bearing Ore Deposits of Greenbushes Tin NL

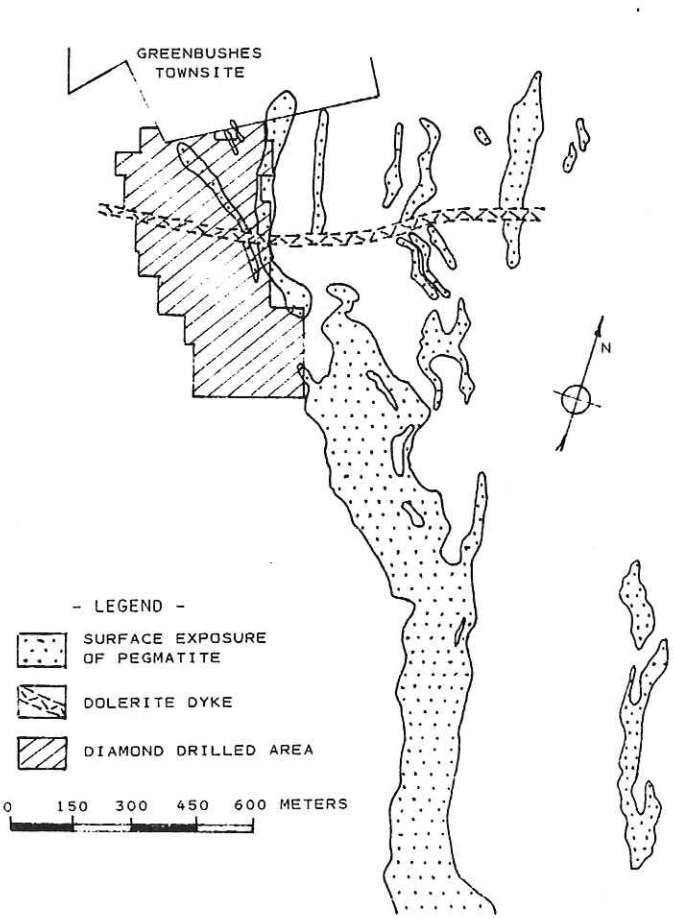
(The following article is a resumé of a presentation made by Mr J. Linden, Managing Director of Greenbushes Tin NL, to the Fourteenth General Assembly of the T.I.C.)

As a result of exploration, completed two weeks ago, of the subsurface hard-rock reserves at its site in southwestern Australia, Greenbushes Tin NL has announced the discovery of a new ore body containing 9.7 million tonnes of ore assaying 0.15 per cent Sn and 0.06 per cent Ta_2O_5 within a larger zone containing about 50 million pounds of contained Ta_2O_5. It is expected that continued exploration will eventually triple these reserve estimates.

The Greenbushes site was first worked for tin in 1888 by prospectors panning concentrates from alluvials in creek beds. The alluvial ore bodies continued to be the main source of production right through to the 1960's, although numerous shafts and adits were dug to find the « mother-lode ». All of these attempts failed to locate sufficiently high grades in the subsurface to warrant exploration.

In 1964 Greenbushes Tin NL was formed to mine the rich alluvial tin deposits by means of a bucket dredging operation. This operation was only partially successful due to the unsuitable nature of the ground for dredging. Exploration was initiated which identified extensive eluvials, mainly thick gravel beds and pegmatites. These bodies, being unsuitable for dredging, led to the construction of a fixed treatment plant in 1972 and, from that time, all ore has been dry-mined and transported to the treatment plant.

The pegmatite has been the main source of production since 1974 and present workable reserves give the company an operating life of five to seven years, depending on the prices of tin and tantalum. Mining has exposed the full extent of the pegmatite, which is large by world standards. The strike length is 3,000 metres and varies in width from 50 to 800 metres. The weathered profile extends to a depth of 50 metres below present land surface. Mineralisation occurs throughout the pegmatite. Recovered grades are 0.25 kg/cm (0.012 per cent Sn) cassiterite and 0.07 kg/cm (0.002 per cent Ta_2O_5) tantalite.



Early explorations of the hard rock at depth date back as far as 1928, but results had not been encouraging as drill holes ran out of the dipping pegmatite and bottomed out in barren greenstone. However, when the T.I.C. studies in 1976 indicated the impending shortage of tantalum and predicted a price rise, the company embarked on a diamond drilling programme to test the pegmatite at depth.

The first drilling was located immediately below the highest grade in the weathered zone where the grades were nearly twice the pegmatite average and two parallel pegmatite targets existed. The results of three holes drilled in 1977 showed intersections ranging from 2 to 5 metres true width assaying an average 0.4 per cent Sn and 0.07 per cent Ta_2O_5. Nine more holes were drilled in 1978 both north and south from the original ones, including a number of step-back holes. The results confirmed the 1977 data in both intersection width and grade, but showed that the structure was not simplistic and that changes in dip at shallower angles could be anticipated. Because of thin intersections, less than 1.5 million tonnes were outlined.

Ten more holes were drilled in 1979 and the average depth was doubled as deeper intersections were encountered. The pegmatite was found to flatten to the west with an unexpected thickening of the pegmatite zone. However, the mineralisation increased only marginally, values averaging 0.2 per cent Sn and 0.05 per cent

Ta_2O_5. The average true width of mineralisation was now 8 metres, with one intersection reaching 46 metres. All of the mineralised zones were within 200 metres of the surface. With each new hole drilled, tonnage containing significant values rose rapidly, reaching 3.5 million tonnes by the end of the year.

The programme continued into 1980, with another 24 drilled holes extending the strike length to 650 metres toward the south. With each hole, the tonnage increased and the zones of mineralisation extended. Average intersection widths increased to exceed 12 metres and tantalite values increased while tin was generally lower. The located mineralisation no longer bore relation to the surface high-grade pit as subsurface intersections were obtained down-dip from extremely low-grade surface outcrops.

A summary of the drilling programme shows the expanding nature of the portion of the pegmatite located each year :

Year	*No of holes*	*Metres of drilling*	*Mineralisation*	
			Average width	*Indicated tonnage*
1977	3	441	2 - 5	–
1978	9	1,052	2 - 5	1.5 million
1979	10	1,218	8	3.5 million
1980	24	5,690	12	21.8 million

The exploration completed indicates that this orebody is a very significant tantalum resource by current world standards. The proven mineralisation within the drilled area only shows the following :

Cut-off grade	*Millions of tonnes*	*% Ta_2O_5*	*% Nb_2O_5*	*% Sn*	*Contained Ta_2O_5 lbs*
0.3 % Sn Equiv.*	21.8	.044	.031	.11	21.1 million
0.6 % Sn Equiv.	9.7	.060	.042	.15	12.8 million
0.8 % Sn Equiv.	3.0	.070	.058	.22	4.6 million

* Sn Equiv. = % Sn + (12 × % Ta_2O_5).

The later holes encountered the thickest portions of the pegmatite to a vertical depth of 300 metres. The pegmatite and mineralisation continue strongly and show no signs of diminishing. The trend north to south indicates a wedge-shaped emplacement from the south. The surface workings indicate a further southerly strike length of 2,000 metres not yet tested by diamond drilling. The total resource delineated to date has an overburden to ore ratio of 4.5 to 1, and is decreasing with every hole drilled to the south. A substantial portion of the ore delineated has an overburden ratio of less than 3 to 1 and continued intersections to the south will reduce the ratio even further.

Late in 1979 a decision was made to investigate the subsurface by means of an opening. Taking advantage of a competent dolerite dyke which traverses the explored area from east to west, a decline from the west has been cut early in 1980 to provide a 5.5 metre by 5 metre opening. This is progressing well and will encounter the mineralised zone by the end of the year.

In comparison with other known deposits, this resource is three-quarters of the grade of the producing Tanco deposit in tantalum, but also contains tin. It is double the grade of the undeveloped Abu Dhabbi deposit in Egypt. Comparison with the deposit in Zaire is not known and comparison with the prospect in the Northwest Territory of Canada is not valid because of the small amount of information about that area.

As to exploitation, it is clear that, at current price levels for tin and tantalite, this deposit, if already developed, would be operating profitably. But in order to determine if this prospect is worthy of being brought into operation further examination is required of the level of operation and timing in relation to the market needs and the expected prices of the commodities.

The most likely level of production is assumed to be at one million tonnes of ore mined and crushed per year. With an in-ground grade of 0.15 per cent Sn and 0.06 per cent Ta_2O_5, allowing 15 per cent dilution and 65 per cent recovery, annual production would be 730,000 lbs Ta_2O_5 and 830 tonnes of tin. These production levels could also be obtained by mining a smaller tonnage of higher grade material or a larger volume of lower grade material. Maximising the resource would be best achieved by mining larger tonnages of lower grade materials : to this end, studies are being made to determine whether underground mining or open-cut mining is more suitable.

As to timing, Greenbushes Tin NL is ideally suited to bringing the production on stream at a comparatively low capital cost and in a remarkably short space of time, should the market warrant the development. The capital cost will be only about $ 60 million, due to the fact that the site is already a fully operating mine and facility with technology, energy source, service facilities and skilled personnel already in place. The controlling factor is the time required to design and construct the treatment plant. Metallurgical test work is sufficiently advanced that a process with a satisfactory flow sheet will be complete by early 1981, and the detailed plant design finished by mid-1981. With construction requiring 12 to 18 months, preliminary production could begin in January 1983 at an annual rate of 250,000 lbs Ta_2O_5, building up to capacity over a period of three years.

Once in production, this ore body and treatment facility will have the capacity to deliver to the market somewhere between 500,000 and 1,000,000 lbs Ta_2O_5 per year for a period of twenty years, in the form of high-grade concentrates, high-grade tin slags, refined tantalum oxide or K-salt. However, the timing for the commencement and the level of production will depend on the requirements of the market. A possible production schedule could be :

(in 1,000 lbs Ta_2O_5)

Operation	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*
Present mining	185	200	205	200	200	230
New Hard-rock	—	—	150	350	600	650
Total	185	200	355	550	800	880

Tantalum from Thailand

Although the current price level of tantalum source material has stimulated increased production throughout the world, record shipments out of Thailand have assured a more than adequate supply to meet the demand for tantalum during 1980 and the next few years. Tin production in Thailand has reached record levels and the « mining » of old tin slags has resulted in Thai sources yielding almost 50 % of the free-world supply in the period of 1978 through 1980.

PRE-1980 PRODUCTION

The Thai Department of Mineral Resources (DMR) has released the following export data, provided in gross metric tons :

	1975	*1976*	*1977*	*1978*	*1979*
Thaisarco slag	1,733	1,890	2,575	2,736	3,507
Old-slag	—	—	1,000	4,900	831
Struverite	—	—	91	265	284
Tantalite	30	103	53	47	118
Columbite	—	—	102	45	114

The DMR does not provide the tantalum content of these materials. But numerous interviews with suppliers in Thailand have made enough information available to be able to evaluate the tantalum content of the exported materials. Using these estimates, the export data can be converted to Ta_2O_5 contained as follows, in metric tons :

	1975	*1976*	*1977*	*1978*	*1979*
Thaisarco slag	208	227	309	328	421
Old-slag	—	—	55	270	46
Struverite	—	—	7	21	23
Tantalite	9	31	16	14	35
Columbite	—	—	26	11	29
Total (m.t.)	217	258	413	644	554
Total (1,000 lb.)	478	569	910	1,420	1,221

Thus, with total free-world production in 1978 and 1979 believed to be in the range of 2.6 to 3.0 million pounds Ta_2O_5, the Thai supply has provided almost 50 % of the material.

The increasing world demand for tin has led to record production of tin ores in Thailand, primarily as a result of the tremendous growth of illegal mining. The so-called « illegal-miners » operate small boats and dredges in the shore areas controlled by the Offshore Mining Organization (OMO). Whereas these operations began as small boats with divers scooping up sand, they have progressively become more sophisticated and many of the « illegal-miners » now operate fairly large suction-dredges, some of which range in cost up to $ 200,000. The effect of small-boat operations is evident from the Thai tin ore production data. The total increase in tin concentrate production from 1976 through 1979 has been 18,146 m.t. (65 %). The total increase in the production of the « illegal-miners » has been 12,083 m.t. (191 %). Thus, the production of Thaisarco slag has increased proportionately as all of the tin concentrates produced in Thailand are smelted at the Thaisarco smelter.

The old-slag seems to be derived from two sources :

— At one time, as far back as a hundred years, there were a number of small smelters in Thailand. Many were quite crude shaft-type furnaces. As there was no market for smelter slag at that time, the slag output was dumped. The great variation in tantalum content, now evident, apparently resulted from each small smelter operating from a local source of tin ore. Some of these local ore bodies contained more tantalum than others and so the slags ended up richer in tantalum than others did.

— The other source seems to have been from ship ballast. Prior to the erection of the Thaisarco smelter, most of the Thai tin concentrates were shipped to Singapore and Penang for smelting. The small coastal vessels which carried the ore required ballasting for the return trip. The smelters provided slag for such ballasting. Upon arrival in Thailand, the ballast was unloaded and dumped, often on shore. There it has remained until recent years, but is now being dug up and sold for its tantalum content.

The quantity of tantalite and columbite extracted during tin-ore concentration is expected to increase. The trend is already established. The DMR production data show only 7 m.t. produced in 1976, less than 0.01 % of the tin concentrate production. In 1979, 407 m.t. were produced, about 0.88 % of the tin concentrate production. There is significant economic benefit to the miners and processors to extract as much of the tantalite as possible before selling the tin ores. Toward this end of greater tantalite extraction, at least five new installations are currently being made to recover more tantalite and columbite.

1980 PRODUCTION

The production of tantalum source materials is expected to peak in 1980. Tin concentrate production is expected to reach about 48,000 m.t. which would result in the production of Thaisarco slags at about 3,650 m.t. containing almost 440 m.t. of Ta_2O_5 (950,000 lb.). Tantalite, columbite and struverite shipments will probably be at a slightly higher level than in 1979, about 90 m.t. of contained Ta_2O_5. In the first six months of 1980, shipments of old-slags totalled 5,600 m.t., with at least another 1,000 m.t. known to be ready to ship before the end of the year. Thus at 6,600 m.t., the contained Ta_2O_5 will be about 330 to 400 m.t., depending on the average assay value.

The total shipments from Thailand for the year 1980 are thus forecast at 850 to 900 m.t. contained Ta_2O_5 (1,870,000 to 1,985,000 lb.). This will probably bring free-world total source supply to about 3.5 million pounds Ta_2O_5 of which about 55 % will originate in Thailand.

POST-1980 PRODUCTION

Informed sources in Thailand do not expect this level of shipments to be maintained after 1980. Tin concentrate production will drop as a result of the reduction of the illegal mining. These small-boat operators have been high-grading and the pockets of higher grade tin ores in the off-shore areas are being rapidly depleted. Many of these miners are beginning to find that their operations are marginal and, with lower tin prices, they are expected to drop-out and move along to more profitable activities elsewhere. In addition, this high-grading has made it more difficult for the large dredges to maintain their production. Even though the OMO is currently placing a new large dredge into operation, its expected production of 1,300 m.t. per year will not make up for the decrease in the output of the « illegal miners ». Most sources forecast a drop in tin-concentrate production of 12 % to 15 % from 1980 to 1985. On this basis, total output of tantalum in slags and concentrates can be expected to drop proportionately to 450 m.t. Ta_2O_5 (970,000 lb.).

Surveys have been made from 1977 to the present to determine the amount of old-slag available in Thailand. The results range from 13,000 to 18,000 tons, including the amounts that have already been recovered and shipped. In view of the fact that shipments through 1980 will have already totalled 13,000 tons, the maximum remaining is about 5,000 tons. If so, there is another 250 m.t. contained Ta_2O_5 available in these old-slags. Assuming that prices maintain at a level which makes it worthwhile to dig out these slags and process them for shipment, this resource will probably be exhausted before 1985.

Struverite production from old tin mine dumps depends on a continuity of prices at near current levels. Although ilmenite, a co-product when processing the dumps, could help support continued processing, not very much is sold. Ilmenite requires bulk shipment. There are no bulk shipment facilities in southern Thailand, the location of most of the dumps. Thus, the dumps are processed mainly to obtain struverite. At best, production will remain at current levels.

As a result, it appears reasonable to forecast that tantalum source material production in Thailand will be about 450 m.t. to 475 m.t. contained Ta_2O_5 (990,000 to 1,050,000 lb.) by 1985, a drop of about 45 % from the expected 1980 output. If an excess supply of tin develops, as occurred in 1975-1976, a cut-back in tin production could reduce the output to a much lower level. On the other hand, only a tremendous surge in tin requirements could significantly increase the tantalum source material output beyond the one million pound level.

PROJECTED INDUSTRY STRUCTURE CHANGES

Important changes in the structure of the Thai tantalum source material industry are under way. Two new tin smelters are being constructed. A joint-venture company, Thailand Tantalum Industry Corporation Ltd., has been formed and has been authorized by the Thai Government to build a slag-upgrading plant utilizing technology provided by Hermann C. Starck Berlin. The current planning also includes a chemical processing plant which will, if current plans are carried out, process all of the tantalum source materials produced in Thailand to refined tantalum-oxide and potassium fluotantalate. This project will result in almost 50 % of the free world supply being extracted from the new materials in the source country.

An article covering the new operations in Thailand will be included in a future issue of the T.I.C. « Bulletin ».

NEW MEMBERSHIP

The following companies were elected at the Fourteenth General Assembly :

A. Johnson & Co. HAB,
P.O. Box 7714,
S-103 95 Stockholm,
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Alfred H. Knight International Ltd.,
18 Church Road, Seacombe,
Wallasey, Merseyside L44 6JG,
England.

Mepco/Electra, Inc.,
5900 Australian Avenue,
West Palm Beach,
Florida 33407, U.S.A.

Nigerian Mining Corporation,
P.M.B. 2154,
Jos, Nigeria.

Norore Corporation,
230 Park Avenue,
New York, N.Y. 10017,
U.S.A.

Pilgan Mining Pty. Ltd.,
72 Brown Street, East Perth,
W. Australia.

Samincorp Inc.,
425 Park Avenue,
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Seco Tools AB,
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