Seminar on Tantalum Source Material Supply

Following the Eleventh General Assembly seventy participants attended a seminar covering various aspects of the current supply situation of tantalum source materials. Formal speeches were offered, followed by general discussion open to all participants.

- Speaker: Mr I.R. McLeod, M. Aus. I.M.M.
  Chief Mineral Economist,
  Bureau of Mineral Resources, Canberra

Subject: Australian Tantalite Deposits
by N.D. Knight and I.R. McLeod

- Speaker: Mr J. Linden, B.Sc. (Hons), A.I.M.M.
  Managing Director,
  Greenbushes Tin NL.

Subject: Future Tantalite Production
from Western Australia.

- Speaker: Mr B. Reynolds
  Manager, Tin and Special Metals,
  Billiton International Metals, The Hague

Subject: Tantalum in Southeast Asia.

- Speaker: Mr T.C. Barron
  Emory Ayers Associates, New York

Subject: An Update on Statistical Data.

- Speaker: Mr A.C.A. Howe, B.Sc., P. Eng. A.R.S.M.F.I.M.,
  A.C.A. Howe International Limited

Subject: Tantalum in Africa and South America.

Mr McLeod felt that, with the emergence of strong and consistent demand, there is potential for significant future discoveries of tantalum in Australia and that annual production output will be enhanced as a result. Mr Linden supported this view by assessing the future tantalite production in Western Australia. Mr Reynolds’ presentation described the various types of tantalum source materials produced in Southeast Asia, demonstrating that this area is the source of more than 50 per cent of the world supply of tantalum raw material. Mr Barron added updated information to the study of the tantalum demand-supply situation prepared in 1976 by Emory Ayers Associates for the T.I.C. Mr Howe dealt with tantalum exploration with particular emphasis on activity in Africa and South America.

During the discussions which followed, the processing and consuming industry members expressed their concern about the availability of raw material on a competitive basis to meet rising demand and combat threats of substitution. The mining community, however, expressed confidence in being able to respond favourably to this challenge through new and expanded exploration and development efforts which will ensure an adequate long-term supply. All agreed that the statistical work and the continued dialogue between all sectors of the tantalum industry provided by the T.I.C. is of major importance to assure improved conditions in the future.

The papers presented at the Seminar will be printed in condensed form in the T.I.C. « Bulletin ». The first of these is included in this issue.

T.I.C. ELEVENTH GENERAL ASSEMBLY

The Eleventh General Assembly of the Tantalum Producers International Study Center was convened in the Sheraton Hotel in Perth, Western Australia, on Monday, May 14, 1979. Mr. Joseph C. Abeles, President of T.I.C., presided. Thirty-three of the thirty-seven member companies were represented at the Assembly.

Four new members were elected to membership of the T.I.C.
- Charter Consolidated Metals and Ores.
- Metallgesellschaft AG.
- Metallurg.
- Straits Trading Co.

The normal business of the T.I.C. was conducted, including a review of the activities of the past year. Dr. George Korinek of Hermann C. Starck Inc., New York and of NRC Inc., was elected to the vacant fifth seat on the Executive Committee.

The official meeting was followed by a seminar on tantalum source material supply. An official banquet was held for members and guests in the evening. The assembly was addressed by The Honorable G.C. MacKinnon, Minister of Tourism for the West Australian Government.

On the following day, Tuesday, May 15, the participants visited the mining and processing facilities at Greenbushes Tin N.L., located at Greenbushes, W.A., about 250 km. south of Perth. They were impressed with the extent and mechanization of the operations and gained an appreciation of some of the special efforts and problems encountered by the mining industry.

The Twelfth General Assembly will be held in Brussels at 9 a.m. on Monday, October 29, 1979. The exact location will be advised later.
Tin Slag and Concentrate Production by T.I.C. Members

The members of T.I.C. continue to report their production of tin slags and concentrates on a quarterly basis. The data accumulated for 1975 through 1978 are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Tin Slags</th>
<th>Concentrates</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>879,252</td>
<td>691,185</td>
<td>1,570,437</td>
</tr>
<tr>
<td>1976</td>
<td>905,733</td>
<td>701,622</td>
<td>1,607,355</td>
</tr>
<tr>
<td>1977</td>
<td>1,003,246</td>
<td>755,886</td>
<td>1,759,132</td>
</tr>
<tr>
<td>1978</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st. quar.</td>
<td>306,710</td>
<td>170,855</td>
<td>487,565</td>
</tr>
<tr>
<td>2nd. quar.</td>
<td>241,983</td>
<td>139,907</td>
<td>381,890</td>
</tr>
<tr>
<td>3rd. quar.</td>
<td>180,373</td>
<td>153,726</td>
<td>334,099</td>
</tr>
<tr>
<td>4th. quar.</td>
<td>236,005</td>
<td>183,343</td>
<td>419,348</td>
</tr>
<tr>
<td>Total</td>
<td>985,071</td>
<td>658,631</td>
<td>1,620,902</td>
</tr>
</tbody>
</table>

The data for 1978 have been obtained from thirteen mining company members of the T.I.C. with one company not reporting. The mining company membership of T.I.C. is now fourteen companies.

A Promising Use for Columbium: Superconductors

For many years the use of columbium metal has remained essentially static, varying from somewhat more than 100,000 lb. to almost 250,000 lb. per annum. There have been various applications but generally they fall by the wayside before a substantial market develops. Throughout the last decade, however, there has been one consistent use, even though actually consuming little columbium, that holds great hope in the future: superconducting alloys.

Superconductivity is a particular physical phenomenon shared by several metals and alloys. All metals and alloys have a specific electric resistivity, that is, a resistance to the flow of electric current when they are used as conductors. In every case, the electric resistivity changes with temperature, becoming greater at higher temperatures and lower at lower temperatures. Generally, at very low temperatures nearing absolute zero (—273° C), the resistance levels out. But with some metals and alloys there is a sudden drop to zero resistance at a few degrees above absolute zero. Then at temperatures lower than this critical point, the resistance remains at zero and electric current can flow indefinitely without any energy loss. This condition is known as "superconductivity".

The phenomenon was originally discovered in 1911 by H. Kamerlingh Onnes of the University of Leiden, about three years after he had succeeded in cooling mercury to absolute zero (designated as 4.2° Kelvin or, more simply, 4.2° K). The study of superconducting phenomena remained in the laboratory for many years as associated phenomena prevented complete understanding and consistent results. Particularly important results which would permit some use of superconductivity in a practical way. However, about 24 elemental metals were identified which displayed superconductivity. For most of them, the critical temperature was very low (colder than 1° K). Of the common available metals, columbium had the highest critical temperature at 8.0° K.

After the development of a fundamental theory of superconductivity in 1957, an understanding of the phenomena involved has led to the development of new applications with considerable prospect of more. To explain the advantage of superconductors, a comparison can be made. A superconductor wire, of the same size as a copper wire which would carry 10 amperes, will carry a current of 25,000 amperes when kept at the temperature of liquid helium (4.2° K). In addition, the 25,000 ampere current can flow indefinitely without any significant resistive loss. One other major advantage is that this superconductor can be used in a coil as the energizer of a magnet, producing magnetic fields of 5 to 10 times the density of conventional iron-core magnets. An early example for use in tuning a radio telescope antenna required a complete assembly of only 75 pounds including an eight-hour helium supply. A permanent magnet built as a "back-up" weighed 1,500 pounds.

Elaborate systems are required to maintain extremely low temperatures close to absolute zero, and the closer to 0° K, the more elaborate and costly. So a search was begun for alloys which would have higher critical temperatures. The first practical development came in 1960 when wire was made successfully of niobium-tin (Nb3Sn), a brittle compound for which the critical temperature was 18° K. After considerable work with columbium-zirconium, a very ductile alloy, most applications today are using columbium-titanium which has a critical temperature of 20° K.

In order to correct many problems associated with the building of high-intensity magnets based on superconductor, it was found that the wires had to be made up of many, many extremely fine columbium-titanium filaments embedded in a matrix of normal metal such as copper or aluminum. To achieve this, a process has been developed along the following lines:

- Columbium-titanium alloy is produced by conventional means and rolled and drawn into rods about 6 mm. in diameter. These rods are cut into pieces about one meter long.
- The Cu-Ti rods are inserted into hexagonal shaped copper tubes of the same length.
- These hexagonal tubes are stacked, honeycomb fashion, and put into a round copper can which is then capped on each end and welded shut to provide a billet from 25 to 30 cm. in diameter. The billet will then contain from 1,500 to 2,500 Cu-Ti rods equally separated by copper.
Tantalum in Southeast Asia

(A paper presented at the Eleventh General Assembly of T.I.C. on May 14, 1979 in Perth, Western Australia)

Introduction

Southeast Asia comprises a rather small proportion of the earth's surface, but it is the world's largest producer of tantalum source materials. In the entire area, cassiterite is the most important economic mineral. The principal minerals associated with it in the alluvial deposits may be monazite, wolframite, xenotime, columbite, tantalaite and gold. The major tantalaite associations are found in Thailand which gradually shift toward Colombia and Indonesia in Malaysia at the ends of the belt, north in Burma and south in Indonesia, virtually no tantalaite or columbite exists.

Independent deposits of tantalaite and columbite are not known to exist anywhere and they are extracted only as by-products of tin processing either during concentration or in tantalum/columbium-rich slags. The major problem is that the tanalaite and columbite need to be recognized, to identify the dependency of this production on the world demand for tin. The tantalum value in the ores is not great enough, even at today's prices, to mine and process the ores unless tantalum is recovered. To recover tantalum, the tin or the production of tantalum source materials will fail.

Thailand and Malaysia represent the major free world source of tantalum materials. The importance has been gradually increasing from 41.5% of total production in 1974 to 53.8% in 1977. When 1978 data are totally available, they will probably show a continued increase to perhaps as much as 55%. In pounds of Ta₂O₅ contained, the actual production in the area has increased by 43% in the period of four years, an average annual increase of 8.4%. Of the total production in the area, 65% to 70% is generated in Thailand, 33% to 38% in Malaysia. The production of source materials is in a great variety of forms. The great bulk is in tin slag from both countries, tantalaite principally from Thailand, columbite principally from Malaysia, and a new product in recent years, struvite, an ilmenite containing commercial quantities of tantalum and columbium, from both countries.

The General Processing in the Area

Although the end products vary from area to area within Southeast Asia, the processing is generally the same. Tin ore, after mining, is concentrated by the normal methods. These methods, however, will not separate out the small fraction of free columbite and tantalaite, which is not intercumulative with the tin. It will be necessary to separate the tantalum and tantalite can be processed by high-tension separation to yield most of the tantalaite and columbite. The great bulk of the tin ores does contain some columbium and tantalum which, when smelted, results in in slags which contain columbium and tantalum. Thus the total content can be obtained for commercial use in one form or another.

Reprocessing of mine dumps extracts further columbite and tantalaite but also results in another product which had always been left behind, one type of ilmenite, struvite, which contains up to 30% combined Ta₂O₅ and Cr₂O₃. Recovery has become widespread and it now accounts for 5% to 7% of the tantalum values shipped from Southeast Asia.
Production in Malaysia

During a geological survey mase of Malaysia in 1966, only two areas were found in which deposits contained high tantalum and columbium content, but these deposits were too small to be economically exploited. In general, most of the cassiterite deposits contain tantalum and columbium oxide, but those with a better tantalum content are on the western side of the north-south central mountain range, but there is no uniformity of content. The distribution is erratic and often occurs in patches within the same mine.

The volume of columbite production has generally followed the price level, from about 50 m.t. per year in the mid-1960's to 89 m.t. in 1967, but only 24 m.t. were produced in 1971. After a large buildup to the 80 ton level from 1972 through 1974, production has again dropped to the 50 to 60 ton level, not as a result of price, but due to the depletion of deposits containing separable columbite. The grade of columbite varies and contains from 10% to 15% Ta2O5. Today, the columbite from Malaysia is supplying about 20,000 to 25,000 lb. of Ta2O5 into the world market annually.

The tin slag produced at Penang is of much greater importance. Prior to the construction of the smelter in Phuket, most of the Thai tin ores were smelted in Penang. Since these ores are richer in tantalum content than the Malaysian ores, the slags produced averaged from 4% to 4.5% Ta2O5 content. Now, however, the average content has dropped below 3%.

All of the Malaysian cassiterite is sold to the two smelters at Penang: Datuk Keramat Smelting, Bhd. and Straits Trading Co., Ltd. Datuk Keramat segregates ores in relation to their tantalum content. Whenever possible, ores from the mines known to contain tantalum are smelted together in batches of 40 to 50 tons. The resultant slags fall into three grades ranging from less than 2% up to 3.5% and are loaded and sold by the above classification. At Straits Trading Tin ores are smelted without regard to tantalum content. Straits finds it uneconomic to hold ores with higher tantalum content until a furnace batch has been accumulated. Since Straits receives hundreds of deliveries from as many mines weekly and has no control over the mine delivery patterns, trying to stockpile deliveries by tantalum content would result in unmanageable furnace programming.

It is difficult to total the annual production of tin slags in Malaysia. The production at Datuk Keramat has averaged from 2.5% to 2.8% and the total production of Ta2O5 content has ranged from about 150,000 lb. in 1968 to slightly more than 300,000 lb. in 1973. Since that time the extraction of more tantalite and columbite by miners and the general reduction in supply of tin ores with significant tantalum content has reduced the production of usable tin slags to about 150,000 lb. of Ta2O5. Production at Straits Trading also varies, with an exceptional lot is high as 10%. In general, the average grade of usable slag probably runs around 2% to 2.5%. Production in total provides about 150,000 lb. of Ta2O5 per year.

The new factor in tantalum source material from Malaysia is the production of struvite. BEH Minerals of Lahat in the state of Perak was established in 1970. BEH acquires feed stock from old discard dumps at mines and processing plants which are methodically stripped of their mineral content through the employment of wet gravitational, pneumatic, and magnetic/electrostatic methods of ore separation. Commercial grade ilmenite, monazite, zircon and xenotime are produced. BEH developed the method to strip struvite from the ilmenate. This tantalum rich rich rutile typically contains 12-13% each of Ta2O5 and Cb2O5. Production of the first commercial lot occurred in 1972 and regular production began in 1975. Output was about 250 m.t. in 1976, about 65,000 to 70,000 lb. Ta2O5.

During the past two years, other Malaysian processors have begun to extract struvite and their total production about equals that of BEH Minerals. Thus, well over 100,000 lb. of contained Ta2O5 is being provided by Malaysian ore processors. It can be expected that total columbite and slag production from Malaysia will continue to decrease, but turning to old mine dumps as sources of columbite and struvite should maintain total supply at about the current level of 400,000 to 425,000 lb. of Ta2O5 per year.

Production in Thailand

With the advent of ThaiSarcro in 1967, Thailand became the world's largest producer of tantalum source materials. About 15% of the tantalite in tin ores is separable. Thai ore processors recover free tantalite and produce a grade which runs as high as 35% to 40% Ta2O5 and 25% to 30% Cb2O5. Annual production is approaching 100,000 lb. of Ta2O5 per year, probably close to the maximum obtainable at current mining levels.

The slags produced at Thaisarcro is a very fine quality, ranging from 11% to 14% Ta2O5 and 7% to 9% Cb2O5. The volume has been consistent with the production of tin. At present, slag production is approaching 700,000 lb. of contained Ta2O5 per year.

In Thailand, also, the processing of mine dumps began in 1977. During 1978 production of struvite is believed to have reached almost 200 m.t. containing as much as 50,000 lb. Ta2O5. Further expansion is expected.

The total production of tantalum source materials from Thailand is probably at present in the range of 300,000 to 850,000 lb. Ta2O5. It can be expected that this level will be maintained as long as the tin market continues its present level of demand.

Conclusions

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NEW MEMBERSHIP

At the Eleventh General Assembly the following companies were elected to membership of the T.I.C.: Charter Consolidated Metals and Ores Limited, 40 Holborn Viaduct, London EC1P 1AJ, England. 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. The Straits Trading Company Limited, P.O. Box 2, Butterworth, Malaysia.

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