TANTALUM PRODUCERS INTERNATIONAL STUDY CENTER

QUARTERLY BULLETIN ISSUE No 26 JUNE 1981 SECOND QUARTER

The T.I.C. Fifteenth General Assembly

The Fifteenth General Assembly of the Tantalum Producers International Study Center was convened on May 19th 1981 in the Intermar Hotel, Bad Harzburg, West Germany.

The Assembly accepted the resignation of the British Oxygen Company, who are no longer associated with the tantalum business, and elected six new members, bringing the total membership to fifty-eight companies. After discussion of direct business matters, including the financial status, office facilities in Brussels and reporting of production statistics, a new effort to assemble processing statistics was established. It was planned that reporting should begin with the first half of 1981 and continue quarterly, covering processing in the United States, Western Europe and Japan. Total world number, only, will be published.

The Assembly acknowledged the offered resignation of Mr Paul Leynen from the Executive Committee with regret but a full expression of appreciation to Mr Leynen for all his efforts as one of the founders of the T.I.C. Mr David Maguire also submitted his resignation as a member of the Executive Committee, due to the pressure of business. Mr R.W. Franklin of ITT in Paignton, in England, was elected to the Executive Committee. The resignation of Mr Leynen will become effective as soon as practicable : his prospective successor must also be of Belgian nationality.

The Sixteenth General Assembly will be held in Brussels on Thursday, October 29th 1981; full details will be announced later. The Seventeenth General Assembly will be held on Monday and Tuesday, June 7th and 8th 1982, in Tulsa, Oklahoma, and will include a visit to the Fansteel processing plant in Muskogee, Oklahoma.

After the completion of the business meeting, other participants — including delegates of companies elected to membership by this General Assembly, guests and members of the press — joined the assembly for the presentation of papers and discussions relating to the tantalum business. The programme consisted of :

— A presentation by Mr William F. Mooy, Commodity Group Manager, Hewlett Packard Company : "The Future of Tantalum Capacitors from a User's Viewpoint" is included in this issue of the "Bulletin".

— A paper by Mr Hidehiro Okuda, Vice President, Nippon Electric Company Limited. This address, "Tantalum Capacitors in Japan — History, Present Status and Future Outlook", will be reported in the next issue of the "Bulletin".

— A panel discussion on the prospects of the People's Republic of China as a tantalum source; an account is given in this issue.

Hermann C. Starck Berlin, the host for the Assembly and conference, entertained all delegates, guests and ladies at an excellent Banquet Dinner in the historic Kaiserpfalz in Goslar. Distinguished guests included the invited speaker, Dr Ulrich Engelmann, Ministerial Director of the Bundesministerium für Wirtschaft in Bonn.

On Wednesday morning, a detailed tour of the Hermann C. Starck Berlin processing plant in Goslar was provided. A description of this visit will be published in the next issue of the "Bulletin".

T.I.C. FIFTEENTH GENERAL ASSEMBLY

The Fifteenth General Assembly of the Tantalum Producers International Study Center was convened in the Intermar Hotel in Bad Harzburg on Tuesday, May 19th 1981, chaired by Dr George J. Korinek, President of the T.I.C. 49 of the 52 member companies were represented in person or by proxy.

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

— The election of six new members and the resignation of one member, bringing the total to 58,

— A review of the production statistics for 1980,

— Approval of the accounts,

— The election of Mr R.W. Franklin, ITT, to the Executive Committee,

— Consideration of the T.I.C. office premises and facilities.

Upon completion of the formal business, the meeting was joined by delegates from newly-elected members, invited guests, visiting government representatives and trade press journalists, bringing the total attendance to 150 people.

Presentations on end-uses of tantalum products were made by :

— Mr William F. Mooy, Commodity Group Manager, Hewlett Packard,

— Mr Hidehiro Okuda, Vice President, Nippon Electric Co.

A panel discussion on the potential of the People's Republic of China as a supplier of tantalum followed.

On Monday evening participants were the guests of the T.I.C. at a Cocktail Party, and on Tuesday evening all were the guests of Hermann C. Starck Berlin at a Banquet Dinner in the Kaiserpfalz in Goslar. The Guest Speaker at the Dinner was Dr Engelmann of the Ministry of the Economy in Bonn.

On Wednesday morning a large group of delegates visited the metallurgical processing plant of Hermann C. Starck Berlin, in Goslar.

The Sixteenth General Assembly will be held in Brussels on October 29th 1981.

Address of the T.I.C. President

Since this meeting is somewhat similar to the one held in Rothenburg in 1978, I should like to compare the problems and attitudes that existed two to three years ago with the situation today. Only eighteen months ago we were faced with the problems of a tantalum shortage and a concern whether the tantalum supply was sufficient to support a healthy market. This shortage resulted in rapidly escalating prices.

These high prices resulted in technical and economic developments which had been forecast to some extent :

- Improvements were made in the capacitance capability of tantalum powder, reducing the quantity of powder being used;
- A trend developed to use smaller diameter capacitor lead-wire, also reducing use;
- Tantalum capacitors have lost some of their market to other, less expensive types, such as aluminium electrolytics and ceramics;
- In the U.S., the cemented carbide producers have increased the application of the mixed tantalum-niobium carbide, a long-established practice in Europe, reducing the consumption of tantalum;
- Fine tuning of cemented carbide compositions has resulted in partial elimination of tantalum carbide;
- The use of recycled carbide has increased.

All of these developments had been predicted in one way or another.

On the supply side, however, some predicted developments did not take place because of the higher prices. The Bernic Lake mine did not phase out and is now expected to continue to produce for several years to come. On the other hand, the high prices have increased over-all production. Small miners in Brazil have come back into the business of tantalum mining. Greenbushes Tin has announced a major increase and substantial expansion of its operations in Western Australia. Great activity in Thailand and Malaysia rediscovered substantial quantities of "old" slags which had been previously dumped. Exploration activity increased throughout the world, resulting in the discovery and potential development of large deposits in Canada and Egypt.

Naturally, all these activities on the supply side are welcome and are developments which we had hoped for. Unfortunately, however, the supply and demand do not operate on a smooth curve. We have, at present, more tantalum available than ever before. But we are experiencing a sharp decrease, hopefully a temporary one, in the use of tantalum. This has caused a temporary over-supply and a recent decrease in the price of tantalum raw materials.

I should like to make a few remarks about tantalum prices in general. The tantalum industry has often been accused by end-users of unduly and irresponsibly escalating tantalum prices. Therefore, a comparison of price change with other relatively rare metals shows that tantalum is not unique :

Metal	*Average 1955 price*	*Latest 1981 price*	*Ratio*
Ta_2O_5	$ 10.00/lb.	$ 80-90	8.5
Silver	$ 0.90/oz.	$ 12	13
Platinum	$ 80/oz.	$ 455	5.7
Cobalt	$ 2.60/lb.	$ 20	8
Molybdenum (tech. gr. oxide)	$ 1.24/lb.	$ 9.35	7.5
Gold	$ 40.00/oz. (1971, London)	$ 480	12

The purpose of the comparison is to prove that if a certain metal is in short supply, for whatever reason, and the supply does not keep up with demand, an increase in price will result.

Some people still think tantalite should cost from $ 10 to $ 20 and that tantalum products should be on a corresponding level. This is unrealistic as the supply at such prices would be negligible. What we need most is stability of price, a reflection that the industry has matured. The industry will not be served by short-term low prices for raw material. This will result only in a decrease of supply and in delays and possible cancellation of major tantalum projects. The results would be a very sharp increase in tantalum prices a year or two from now. This is definitely not in the best interests of either processors or end-users.

Tantalum processors and end-product producers should work on developing new uses and applications for tantalum. Raw material producers should bring additional sources into production as the need arises. And end-users should not over-react and panic, trying to design tantalum out of their systems.

Tantalum is and remains a unique metal. It is available and will continue to be available in substantial quantities to support those applications in which its unique properties are required. All of us have invested considerable amounts of money, skill, time and effort in tantalum. We should, therefore, try to minimise some of the speculative aspects which have affected our industry from time to time and go about our business in a more calm and steady way. If we can do this, I am very certain that we look forward to a prosperous future. We have a common goal, a sufficient supply of tantalum at a price level at which all of us — the miners, the processors and the users — can generate a reasonable profit so as to be able to reinvest some of these profits for further development of this unique metal.

The Future of Tantalum Capacitors from a User's Viewpoint

The following presentation was made by Mr William F. Mooy, Commodity Group Manager, Corporate Materials Management, Hewlett-Packard Company, Palo Alto, California, U.S.A., to the Fifteenth General Assembly of the T.I.C. at Bad Harzburg, West Germany, on May 19th 1981.

It is a pleasure and privilege to address you : it is not often that the opportunity comes along to make a presentation to a world-wide body such as the T.I.C.

The central message of my presentation is covered by two points :

- With the alternate technology that is presently available and within sight, there is a future for tantalum capacitors;
- The question currently is not "Is there a future ?", the question is "How much of a future is there ?".

The forces at work in the market place and the technical world will influence the "how much".

How much of a future do tantalum capacitors have ? This depends on the available technology, that is, the potential substitutes for tantalum capacitors. But it also depends on the device cost. How does it rank in price with other devices which can fill a need identically or in a similar fashion ?

The capacitance and voltage range (CV product) of tantalum capacitors is completely covered by other devices. Tantalum capacitors have no unique range. Whereas solid tantalum devices range in capacitance from 0.0047 to 1,200 microfarads, aluminium devices range from 0.47 microfarads upward and monolithic multi-layer ceramics cover the range from 4.7 microfarads downward, the latter two completely covering the tantalum range. However, tantalum capacitors are different in that they have a very high reliability in a wide range of environments, an extremely important factor. In addition, they have superior stability over a wide operating temperature range throughout the life of the device. They go on operating without any significant change.

There are several applications in which tantalum capacitors are needed and in which present technology offers no alternatives :

- In precision electronics, where stability over a wide operating temperature range is required;
- In signal conditioning or coupling circuits in which there is a signal frequency of 10 kiloherz or more, the temperature extremes are less than 0 °C. or greater than 60 °C., and operating life is more than 10,000 hours;
- In applications at 10 volts or below in which a stable insulation resistance characteristic is required;
- In RC networks in which continuous time-constant reproductibility is required;
- In bypass or decoupling digital circuits in which voltages are under 10 volts d.c. and capacitance exceeds 5 microfarads;
- In military systems, space programmes and non-entertainment automotive applications which require high reliability in a wide range of environments;
- In hybrid micro-electronics where only tantalum chips offer high capacitance (50 to 100 microfarads) in voltages ranging from 6 to 50 volts d.c., the miniaturisation area.

In other areas, substitutes may be examined.

Regardless of the characteristics, however, there is a price versus performance tradeoff. Even though solid tantalum capacitors have many unique properties, other types of capacitors are being continually improved to provide performance characteristics as close as possible to those of tantalum capacitors. Unique characteristics of tantalum capacitors include :

- Capacitance tolerance down to ± 5 % in values of one microfarad and above (aluminiums are approximately ± 20 %);
- Lowest equivalent series resistance (ESR) in the one to one hundred microfarad range. Between 25 °C. and —40 °C., tantalum is 2 1/2 to 5 times more stable than aluminium electrolytic. After 10,000 hours of service at 50 °C., tantalum has a change of 1.2 times compared to a range of 3 to 10 times for aluminium;
- Lowest impedance versus frequency from 80 kiloherz to 5 million herz;
- Low guaranteed values of d.c. leakage over a wide operating temperature range;
- After 10,000 hours of service at 50 °C., the change in capacitance is only ± 2 %.

Miniature aluminium devices are being developed to replace solid tantalum devices in the upper 70 % of the solid tantalum capacitance range. A great deal of work is progressively narrowing the performance difference. Such aluminium devices do not yet equal the solid tantalum characteristics previously discussed, especially from a stability viewpoint. There is still a long way to go, but progress is being made.

Monolithic ceramic devices may be more readily substituted in the lower third of the solid tantalum capacitance range. There is still a real problem of quality reproducibility and the development is now going through an evolutionary phase. These devices require a really sophisticated inspection by the consumer and the money saved on purchase cost is being spent on the inspection.

The incentive to spend more money on closing the "characteristics-gap" between other choices and tantalums is directly proportional to the size of the "price-gap". Consumers would be glad to pay higher prices for substitute devices if they could match the characteristics of tantalum devices.

It is clear that the greatest saving/cost incentive occurs on the high capacitance units where the price ratio of tantalum capacitors ranges from 5 to 10 times that of aluminium capacitors. It is also in this range that the special characteristics of tantalums are least likely to be needed and aluminium substitution is most likely to occur. Tantalum capacitor usage in the future, therefore, will be inclined to be concentrated in the smaller two of the four anode case sizes. Although discontinuance of the larger two anode sizes will have an impact on tantalum material usage, it will probably not be serious on an over-all basis as the usage has been relatively small to begin with.

The challenge for the tantalum capacitor producers is to recapture their competitive position in the lower microfarad device range where costs are only 1.5 to 3 times as high as competitive dielectric products. There are two methods of accomplishing this objective, either by providing powder with higher CV-rating or by reducing powder prices.

At Hewlett-Packard Company we have placed a limit on the devices we buy to be made from powder with a CV-product no greater than 10,000. We are concerned that the use of higher-rated powders will result in a change of unspecified parameters. We expect there will be changes in high-frequency performance, a parameter which is very difficult to specify. Even if we could specify adequately, it would be hard to force such specifications on capacitor producers. So we have to see much more testing before we will be willing to use tantalum devices made from powders with ratings over 10,000.

It is important to remember that, as the performance of a tantalum device declines to approach the performance of a ceramic monolithic device, the tantalum device price premium will become less and less justifiable. As a result, there really does seem to be a limit on how far the gain on CV-rating can be pushed without becoming counterproductive.

Thus, a number of conclusions can be stated :

- The higher capacitance tantalum capacitors will be replaced more and more by the miniature aluminium electrolytics now being developed. To recapture this segment of the market would require powder price reductions and/or gain increases such that the device price would be slashed to 20 % of the present price. This is probably unobtainable;
- A way should be found to remove the price-pressure on the lower-capacitance device. Increase in powder capacitance rating may take this part of the way, but it probably will not take it far enough to remove the competitive pressures that will continue to grow from other dielectric types where such devices will be made to approach the characteristics of tantalum;
- Very high gains on powder rating, beyond 10,000, are a cause of concern about performance and process sensitivity. Resolving these unknowns represents risk and expense to the capacitor manufacturer and user;
- At present powder price and technology levels, there will be a decline in market penetration of tantalum capacitors. Since electronic design engineers are known to be "creatures of habit" with a great deal of inertia, once a market share is lost, even if the loss is low in coming, it would be extremely difficult to regain;
- There is nothing in sight to replace tantalum totally. With the proper financial incentive, however, it will be only a matter of time before one or a combination of the following will happen :
  a. Alternative devices, such as complex labyrinth-type ceramics, will be developed,
  b. Integrated circuit technology will be oriented to reduce the number of devices needed, or
  c. New technology will be developed to facilitate capacitor deposition on substrates.

Thus, the "Bottom Line" is that there is a need for increased powder efficiency without significant performance degradation, both specified and unspecified, and for a reduction in the base price of powder.

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 1980 are as follows, including the total production for 1978 and 1979 for comparison (in lbs. Ta_2O_5 contained) :

	Slags	*Concentrates*	*Total*
1978			
Production	965,071	655,831	1,620,902
1979			
Production	1,204,945	893,157	2,098,102
Shipments	1,182,163	938,723	2,120,686
1980			
Production	1,383,704	792,528	2,176,232
Shipments	1,589,729	726,480	2,316,209

In the first half of 1980, 20 producing members were asked to provide figures and 16 responded; in the second half, 19 of 22 companies responded.

The total production for 1980 represents an increase of 3.7 % over that for 1979.

It is estimated that the T.I.C. producing members account for some 85 % of the total free-world production of tantalum source materials.

The Current Situation at Greenbushes Tin

In response to a question from the floor of the General Assembly, Mr John Linden provided information about the developments at Greenbushes Tin since his last report to the T.I.C. in October 1980.

The current production rate has been increased from 100,000 lbs. Ta_2O_5 to 180,000 lbs. per year by further gains in tin smelting and setting in operation a primary separation plant retreating tailings. Output is about 80 % concentrates with 40 % Ta_2O_5 content and 20 % tin slag containing 20 % Ta_2O_5.

The pegmatite reserve reported last October on the basis of forty drill holes has been expanded to fifty-eight drill holes and the reserve has been increased by about 25 %.

The 6 × 5 metre cross-section incline is one kilometre long with an intersection of the ore body extending 180 metres. The rate of extension will be increased with a second crew starting another incline in about one month and a third crew starting mining in about three months. The final flow sheet for the plant is finished and the design will be complete in August. Construction of the treatment plant will begin in December and will be completed in eighteen months. New production will begin in the first quarter of 1983 at an annual rate of 150,000 lbs. Ta_2O_5 and will progressively increase each year for four years reaching 600,000 lbs. in 1986, bringing total Greenbushes production to 750,000 lbs.

All the needed funds have been raised and are committed.

Greenbushes Tin have changed their marketing policy. The practice of tendering periodically to the spot market has ceased since June 1980. They now negotiate directly with consumers, material to be shipped quarterly. Prices are negotiated each quarter in the month before the beginning of the quarter in which shipments are to be made. A price will be developed, the same for all customers, which will be known as the "Greenbushes Producer Price, 40 % Grade". It will be published in the "Metal Bulletin" and will become public about one week before the end of the quarter in which negotiations take place.

The People's Republic of China as a Source of Tantalum Supply

The panel discussion during the Fifteenth General Assembly of the T.I.C. covered the prospects of supply from the People's Republic of China. The delegates from China were Mr Xhao Xizhong, Mr Ma Fukang and Mr Zeng Fang-Ping, all of the China Metallurgical Import and Export Corporation. The Western members of the panel, all of whom had recently visited China, were Mr John Linden of Greenbushes Tin, Mr Tom Barron of Emory Ayers Associates, Mr Peter Maden of Sprague Electric Company and Mr Michael Ian of Cabot Mineral Resources.

The panel discussion was opened by Mr Ma Fukang explaining briefly the role of the China Metallurgical Import and Export Corporation. It was formed in 1980 by the Ministry of Metallurgical Industries to integrate the metallurgical industry economically, covering manufacturing and trading. The scope of its responsibility covers expertise in raw materials, production, and the processing of iron and steel, rare earths, alloys, refined metals. It establishes projects for the metallurgical industry and secures the import of metallurgical technologies. The delegates' objective in coming to the T.I.C. meeting was to establish contacts which can assist in the development of the Chinese tantalum business and to develop commercial relations with members of the industry outside China.

Mr Ma Fukang stated that China is rich in tantalum resources and that the country has more than ten years' experience in tantalum development and research. There are tantalum refining factories completely integrated to finished tantalum and niobium products with complete quality control and a technically trained research staff. He pointed out that as newcomers to the world market, they need time to learn about the market situation and would like to have help from the T.I.C. They welcomed the opportunity to be at the meeting and to discuss the tantalum business with friends from so many different countries of the world.

Mr Michael Ian stated that Cabot Mineral Resources have the responsibility to supply raw materials to KBI and to search out new material sources. In this capacity they have been active in the China scene, sending two missions there. They have visited the mine and smelter described by Mr Ma Fukang and are working hard to bring understanding of Western quality and standards. They will continue the effort in the future.

Mr Peter Maden stated that a Sprague Electric task force had visited, in the fall of 1980, some of the several Chinese factories producing capacitors to discuss the supply of capacitor grade powder. They obtained and have evaluated eight samples of capacitor powder. The material is all generally capable of production use. The physical capability and capacitance per unit weight, however, need considerable work to come up to free-world standards. It appears that the fact that the Chinese tantalum industry has been captive to the capacitor industry has led to a slow-down in technical development.

Mr Tom Barron said he had visited China for two weeks in January at the invitation of the Chinese tantalum industry. The purpose of the trip was to investigate the long-term supply and demand situation in the People's Republic and to determine the possibility of supply to the outside.

He found that there is a continuing geographic decentralisation in the minerals business which makes it difficult to achieve a precise evaluation of activities. He was very impressed by the general size of the metallurgical industry, which employs 3.6 million people, but also found that the cultural revolution had affected the ability to explore, develop and produce.

The outlook is relatively modest for the next five years, but after 1985 China could become a significant source of minerals, tantalum carbide and tantalum powder. There is a slow, steady increase in production.

Mr John Linden had the opportunity to visit the tantalum mines at Limu in the province of Quanxi in November 1980. The people here claim their operation is the largest tantalum producer in China, the operation employing 10,000 people. The three mines, one open-cut and two underground, cover ten square miles. The open-cut mine, with a reserve of four million tons, runs 0.1 % Sn, 0.015 % Ta_2O_5 and 0.015 % Nb_2O_5. One underground mine has reserves of 30 million tons assaying 0.2 % tungsten oxide and 0.006 % total tantalum plus niobium oxides. The second underground mine has 30 to 100 million tons reserves assaying about 0.015 % tantalum oxide and 0.015 % molybdenum. The underground workings at present are very small.

The open-cut mine is capable of producing 300,000 tons per year but the crushing capacity in the processing facility is limited to 10 tons per hour. New crushers will bring that capacity to about 500,000 lbs. per year. The mineral dressing consists of the usual steps of milling and separating by wet tables and spirals. The low concentrate obtained is further concentrated pyrometallurgically to 50 % tin and 6-8 % tantalum oxide. This is smelted, producing 300 to 400 tons per year of 90 % tin metal and a slag rich in tantalum and tungsten. The tin is refined subsequently to 99.9 % purity and the slag is upgraded by a carefully guarded technology.

The tantalum processing, based on hydrofluoric acid leach and alcohol separation, yields an excellent grade of potassium fluotantalate. Tantalum metal powder is produced with a CV-rating in the range of 3,200 to 4,000.

Another mine site has ore with 0.015 % maximum tantalum oxide content. At this site 25,000 lbs. of tantalum are produced each year and production will be increased to 50,000 lbs. in four to five years, and to 100,000 lbs. in twelve to fifteen years.

After these presentations there was considerable discussion from the floor of the Assembly. Mr Becker-Fluegel asked about the prospects of China as a market for tantalum products or for raw materials. Although the Chinese delegates did not venture a reply, Mr Joseph Abeles, who had visited China in February, offered the opinion that it would be quite a while before China would be customers for the free-world, being able to take care of their own needs for the next five to ten years.

Dr Korinek told of his discussions at the Non-Ferrous Research Institute, where development is being conducted on tantalum and super-conducting alloys. The laboratory is well-equipped with Western analytical equipment. There is a small electron-beam furnace for research, with a larger furnace for the production of EB-grade capacitor powder in another department. Some of the technology seemed obsolete but the scientific personnel were of very high calibre although there is a certain lack of trained people, an effect of the cultural revolution.

After a question about capacitor production in China, Mr Maden stated that the People's Republic had been showing tantalum capacitors in its trade shows for at least the past ten years. He visited a factory which produced at least one million devices per year. Since there are five or six such factories, total annual production might be five to six million pieces.

Mr C. Hanna of Kennametal, following a statement that he had visited a very large tungsten ore mine and a modern, up-to-date tungsten carbide factory using low levels of combined tantalum niobium carbide, asked if there were any published production and export statistics. The Chinese representatives stated that there were not any statistics now because of the decentralisation movement, and there would not be any until that was complete. Mr Barron said that exports in 1980 were about 2,000 lbs. tantalum content. His evaluation indicated about 50 to 60,000 lbs. of total tantalum product in 1980. Mr Linden said that the three producing tantalum mines had production of about 50 tonnes oxide content in 1980 production. In response to a question as to whether there are any primary tantalite mines, Mr Linden replied that very well documented mineral charts show no primary pegmatites with grades greater than 0.03 % combined tantalum and niobium content. Thus, the deposits are more similar to the one in Egypt than to those at either Tanco or Greenbushes.

Further questions brought out more information, which may be summarised as follows :

- There is active exploration under way, with the whole country mapped and significant outcrops drilled. There is a joint venture with a German company for an exploration programme in the Central Provinces;
- There will be more decentralisation of the industry in the future;
- The autonomous regions are free to proceed as they judge best, with no limit to their authority.

NEW MEMBERSHIP

The following companies were elected to membership by the Fifteenth General Assembly :

Mineracao Canopus Ltda.,
Centro Empresarial de Sao Paulo,
Av. Maria Coelho Aguiar, 215 - Bloco B,
05804 Sao Paulo, Brazil.
(Delegate in France.)

Componentes Electronicos, S.A.,
Calle H s/n,
Poligono Industrial Fontsanta,
San Juan Despi,
Barcelona, Spain.

Ekman & Co. AB,
P.O. Box 230,
S-401 23 Gothenburg, Sweden.

Sociedade Agricola e Industrial Montanisca, Lda.,
Av. Estados Unidos America no. 29, 2 Esq.,
1700 Lisbon, Portugal.

Pratt & Whitney Aircraft Group,
400 Main Street,
East Hartford,
Connecticut 06108, U.S.A.

Vacuum Metallurgical Co., Ltd.,
No. 14-10, 1 Chome,
Ginza, Chuo-Ku,
Tokyo, Japan.

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Fifteenth General Assembly

Arrival of the guests for Festive Dinner

President of the T.I.C. toasting the Assembly

Lord Mayor of Goslar tapping the beer keg

The dinner speaker, Dr U. Engelmann, Ministry of the Economy in Bonn, during his address

The flavour of the meeting is very international

Mediaeval Musical Interlude

T.I.C. Membership List, June 1981

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.

Bisichi Jantar (Nigeria) Ltd.
c/o Bisichi Jantar Nigeria (London),
Stationers Hall Court,
30/32 Ludgate Hill,
London EC4M 7ND, England.

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

Cabot Mineral Resources,
220 East 42nd Street,
New York, N.Y. 10017, U.S.A.

Mineracao Canopus Ltda.,
c/o Compagnie Industrielle et Minière,
25 Quai Paul Doumer,
92408 Courbevoie Cedex, France.

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

Componentes Electronicos, S.A.,
Calle H s/n,
Poligono Industrial Fontsanta,
San Juan Despi,
Barcelona, Spain.

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

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

Ekman & Co. AB,
P.O. Box 230,
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Cia de Estanho Minas Brasil,
Avenida Rio Branco, 103-19° 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,
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Hochmetals Africa (Pty) Ltd.,
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60 rue Ravenstein, bte 2,
1000 Brussels, Belgium.

Companhia Industrial Fluminense,
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A. Johnson and Co. HAB,
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One Lloyd Avenue,
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Makeri Smelting Co. Ltd.,
P.O. Box 653,
Bokuru Road,
Jos,
Benue Plateau State, Nigeria.

Malaysia Mining Corporation Bhd.,
16 Jalan Tangsi,
P.O. Box 300,
Kuala Lumpur, Malaysia.

Mamoré Mineracao e Metalurgia S/A,
Rua Haddock Lobo, 578 - 1° and.,
Caixa Postal 11931,
CEP 01414,
Sao Paulo, SP, Brazil.

Soc. Mineira de Marropino Lda.,
Minas Gerais de Mozambique, Lda.,
Box 1152,
Maputo, Mozambique.

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

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.

Minex Corporation Sdn. Bhd.,
6th Floor, Kaying Bldg.,
114 Belfield Street,
Ipoh, Malaysia.

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

Sociedade Agricola e Industrial Montanisca, Lda.,
Av. Estados Unidos America no. 29, 2 Esq.,
1700 Lisbon, Portugal.

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

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

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

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

Pratt & Whitney Aircraft Group,
400 Main Street,
East Hartford,
Connecticut 06108, U.S.A.

RefineMet International Company,
162 Main Street,
Woonsocket,
Rhode Island 02895, U.S.A.

Sabemin S.A.,
Rue Joseph II 36-38, bte 3,
1040 Brussels, Belgium.

Samincorp Inc.,
425 Park Avenue,
New York, N.Y. 10022, U.S.A.

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

Sandvik AB,
Box 42056,
S-126 12 Stockholm 42, Sweden.

Seco Tools AB,
Fack,
77301 Fagersta, Sweden.

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 Brussels, Belgium.

Somirwa,
Geomines S.A.,
150 Chaussée de La Hulpe, bte 13,
1170 Brussels, Belgium.

Sprague Electric Company,
81 Marshall Street,
North Adams,
Massachusetts 01247, U.S.A.

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,
Materials Recovery Operation,
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.

Vacuum Metallurgical Co., Ltd.,
No. 14-10, 1 Chome,
Ginza, Chuo-Ku,
Tokyo, Japan.

Zairetain,
Geomines S.A.,
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