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 Hidehito 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".
Address of the T.I.C. President

Since this meeting is somewhat similar to the one held in Rothenburg in 1976, 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 discussed with the presidents of a tantalum sludge 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 capability of tantalum capacitors, 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 aluminum 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 Bemic 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. Smaller 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" slag which had previously been 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 which has 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.

<table>
<thead>
<tr>
<th>Metal</th>
<th>Average 1955 price</th>
<th>Latest 1981 price</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ta2O5</td>
<td>$10.00/lb.</td>
<td>$60-90</td>
<td>6.6</td>
</tr>
<tr>
<td>Silver</td>
<td>$0.50/oz.</td>
<td>$12</td>
<td>13</td>
</tr>
<tr>
<td>Platinum</td>
<td>$50/oz.</td>
<td>$45</td>
<td>5.7</td>
</tr>
<tr>
<td>Cobalt</td>
<td>$2.60/lb.</td>
<td>$20</td>
<td>8</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>$1.24/lb.</td>
<td>$3.35</td>
<td>2.70</td>
</tr>
</tbody>
</table>

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 a more realistic 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 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 Eleventh General Assembly of the T.I.C. at Bad Harzburg, West Germany, on May 19th 1981.

It is a privilege and pleasure to address you: it is not often that the opportunity comes along to make a presentation to a world-wide gathering 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 meaningful range. Whereas solid tantalum devices range in capacitance from 0.0047 to 1,200 microfarads, aluminum devices range from 0.47 microfarads upward and monolithic multilayer 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 kilohertz or more, the temperature extremes are less than 0 °C or greater than 60 °C, and operating life is measured in more than 10,000 hours;
- In applications at 10 volts or below in which a stable insulation characteristic is required;
- In RC networks in which continuous time-constant reproducibility 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 programming, 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 packages 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 (where aluminumum capacitors are ±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 aluminum 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 aluminum;
- Lowest impedance versus frequency from 80 kilohertz to 5 megahertz;
- 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%.
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. Ta₂O₅ contained):

<table>
<thead>
<tr>
<th>Year</th>
<th>Slags</th>
<th>Concentrates</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>965,071</td>
<td>655,831</td>
<td>1,620,902</td>
</tr>
<tr>
<td>1979</td>
<td>1,204,946</td>
<td>893,57</td>
<td>2,098,102</td>
</tr>
<tr>
<td>1980</td>
<td>1,182,163</td>
<td>938,723</td>
<td>2,120,886</td>
</tr>
</tbody>
</table>

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 increased from 100,000 lbs. Ta₂O₅ to 180,000 lbs. A fourth drum has been fully commissioned and is setting in operation a primary separation plant treating tailings. Output is about 10% concentrates with 40% Ta₂O₅ content and 20% tin slags containing 20% Ta₂O₅.

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 x 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 floor plan 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. Ta₂O₅ 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 offering half the spot market price has ended.

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. Xue Xuehong, Mr. Ma Fukang and Mr. Zeng Peng-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 Lawrence of Greenbushes, Mr. Tom Barron of Emory Ayers Associates, Mr. Peter Maden of Sprague Electric Company and Mr. Michael Ivan 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 ore. 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 Futang 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 which complete fully tantalum control and analysis of technical 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 has 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 Futang 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 had obtained and 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 slowdown 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 capacitors and tantalum powder. There is a slow, steady increase in production.

Mr. John Linden had the opportunity to visit the tantalum mines at Linu in the province of Quanzhi in November 1980. The people there 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% Ta₂O₅, and 0.015% Nb₂O₅. One underground mine has reserves of 30 million tons assaying 0.2% tantalum oxide and 0.008% 10% tantalum plus niobium oxides. The second underground mine has 30 to 100 million tons reserves assaying about 0.15% 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 stages of milling and separating by wet tables and spirals. The low concentrate obtained is further concentrated pyrometallurgically to 50% tin and 8-8% tantalum oxide. This is smelted, producing 300 to 400 tons per year of 80% tin 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 fluoride/tantalum. 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 80,000 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 a significant market for tantalum products, 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 superconducting 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 foreign trade 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. Hanno of Konmometal, following a statement that he had visited a very large tungsten ore mine site 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 such 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:

Minercaco Canopus Ltda.,
Centro Empresarial de Sao Paulo,
Av. Maria Coelho Aguiar, 215 - Bloco B,
05804 Sao Paulo, Brazil.

(Delegate in France.)

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

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

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

Patt & 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.
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,
4/4, Miles Lahat Road,
Post Office Lahat,
Locked Bag Service No. 2,
Perak, Malaysia.

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

Bisichi Jantair (Nigeria) Ltd.
c/o Bisichi Jantair Nigeria (London),
Stationers Hall Court,
30/32 Ludgate Hill,

Brandis, Goldscheidt and Co. Ltd.,
4 Fore Street,

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,

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

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

Derby & Co. Ltd.,
Moore House,
London Wall,

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

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

Fannstei 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,
81 Kensington Street,
East Perth 6000, W. Australia.

W. C. Heraeus GmbH,
Postfach 189,
D-6450 Hanau, West Germany.

Hochmetals Africa (Pty) Ltd.,
c/o Sudamin S.A.,
60 rue Ravenstein, bte 2,
1000 Brussels, Belgium.

Companhia Industrial Fluminense,
Rua Sete de Setembro, 95 -
S/011,01/02/03,
Rio de Janeiro, CEP 20060, Brazil.

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

A. Johnson and Co. HAB,
P.O. Box 7714,
S-103 58 Stockholm, Sweden.

Kannemetal Inc.,
One Lloyd Avenue,
Latrobe,
Pennsylvania 15650, U.S.A.

Alfred H. Knight International Ltd.,
Church Road,
Seacombe,
Wallsley,

LTT,
B.P. 5,
78702 Conflans Ste Honorine Cedex, France.

Malerri Smelting Co. Ltd.,
P.O. Box 653,
Bokuru Road,
Johor,
Semeny State, India.

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

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

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

Mapco/Elconda Inc.,
5900 Australian Avenue,
West Palm Beach,
Fla. 33407, U.S.A.

Metalgesellschaft AG,
Rauverweg 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.,
8th Floor, Kaying Bldg.,
114 Belfield Street,
Ipoh, Malaya.

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

Sociedade Agricola e Industrial Montanica,
Av. Estados Unidos Americo no 29, 2 Esq.,
1700 Lisbon, Portugal.

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

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

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

Pilgrim 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,
182 Main Street,
Woosocket,
Rhode Island 02895, U.S.A.

Sabemini 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 42096,
S-126 12 Stockholm 42, Sweden.

Seco Tools AB,
Faxc,
77301 Fagerstaa, Sweden.

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

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

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

Somirwa,
Geominas S.A.,
150 Chaussee 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, Malaya.

Tantolum 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.

Thermoelectro Corporation,
Materials Recovery Operation,
3 Crans Court,
P.O. Box 646,
Woburn,
Massachusetts 01801, U.S.A.

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

Union Carbide Corp.,
Special Components Dept.,
Box 9228,
Greenvile,
South Carolina 29606, U.S.A.

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

Zairetain,
Geominas S.A.,
150 Chaussee de La Hulpe, bte 13,
1170 Brussels, Belgium.