Will electric vehicle demand impact future tantalum supply? (see page 14)

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**President’s Letter**

Dear Fellow Members and Friends,

With the start of a new year, I want to take this opportunity to thank all of you for your ongoing involvement with the T.I.C. and continuing efforts to help improve it. While I believe we made strides forward last year, I trust we can do even better this year.

We are gratified by the feedback from you about the apparent success of the General Assembly in Toulouse. While we appreciate the hard work all the speakers put into their presentations, I think several topics stood out, as our tantalum and niobium industries are constantly changing. The future importance of lithium/spodumene production as a by-product source of tantalum feed units is one such development. Similarly, as we’ve seen from various presentations over the last several years, there are various proposed greenfield niobium projects around the world that could change that competitive landscape.

In addition, if the new technology of geological passporting can be proven to work reliably and economically on a commercial basis, it could have interesting implications for the timely determination of coltan sourcing, including for blended material. I remind all our members again that, per OECD guidelines and as reconfirmed in our new ASM Code of Conduct approved in Toulouse, the onus is on the purchaser to undertake proper due diligence and traceability efforts, such as site visits, regardless of where tantalum feed material is purchased around the world.

As presented at the General Assembly, the T.I.C. reaffirms our ongoing support for the iTSCI Programme in central Africa, as we seek to continuously improve it. I believe its successes to date have not been fully recognized, but it always can get better. Towards that end, as we believe in the benefits of a competitive marketplace, we encourage alternatives where appropriate. As pending regulations and legislation change, such as possibly with the new EU initiatives, a global perspective is required. On a related note, we are gratified by our ongoing relationship with the Conflict-Free Sourcing Initiative (CFSI), which recently became an associate member.

In conjunction with appropriate efforts ascertaining the legitimacy of one’s tantalum supply chain, given our Transport of Radioactive Materials Policy, the onus is also on our members to adhere to all applicable regulations. From feedback received so far, the recent issuance of the information packet on transport of such NORM materials has been most welcome. We need to do a better job educating our members and others in this space. The interview in this Bulletin with Trevor Dixon of the World Nuclear Transport Institute should also be informative. We are only as strong as the weakest link in the supply chain here, and we must ensure ignorance is no excuse.

Also, as demonstrated at last fall’s General Assembly, we need to do a better job attracting and dealing with downstream customers, whether in the tantalum or niobium industries. Hopefully many of you found the presentation and perspective of Mark Alexander of Plantronics, for example, to be stimulating and informative. As mentioned many times previously, I believe this is an ongoing imperative of the T.I.C. in terms of education, promotion, and marketing.

Plans are well underway for the 58th General Assembly in Vancouver, Canada 15-18 October 2017, led by our meetings sub-team chaired by David Gussack. As you’ll see details elsewhere in this Bulletin, the Executive Committee has decided this should be a Technical Symposium, particularly as we held the last such one in Cape Town in 2012. While we will be issuing a call for papers later this quarter, your active involvement in presenting or securing talks is sought please. Several evergreen themes will undoubtedly be apparent, such as our need to better involve our downstream customers, ongoing efforts to improve our tantalum supply chain, and hopefully more emphasis on niobium.

Finally, may I also take this opportunity please to welcome the two new members of our Executive Committee elected in Toulouse: Kokoro Katayama and Raveentiran Krishnan.

Sincere best wishes to all for a happy, healthy, and prosperous 2017!

Sincerely yours,

David Henderson, President
Dear T.I.C. Members,

It was a great pleasure to meet so many of you in person at the 57th General Assembly in Toulouse. I’m especially grateful to those of you who took the time to share your thoughts about this Association and what you see as the challenges faced by the tantalum and niobium industries in the coming year.

Our event in Toulouse was a great success and topped by a visit to the plant where Airbus assembles the giant A380 aircraft. All the presentations are available to download in the members’ area of the T.I.C. website, including the 2016 statistics review. Our thanks again to our sponsors Alex Stewart International, Exotech, Inc., A&R Merchants Inc. and Metalysis Ltd for their generous support.

Financial year change

The change to the financial year occurred with the adoption of the new Charter in Toulouse. The T.I.C. financial year has previously run July-June, but from this month it will run January-December. This has required us to hold a short, six-month financial year from July-December 2016, which is why the membership invoices that were issued last November were for just EUR 1200.

Later this month members will receive a new membership invoice covering January-December 2017; but the good news is that the Executive Committee has frozen membership invoices at the 2015-16 rate of EUR 2400. Once we receive your payment a certificate of membership (see left) will be mailed to you.

Vancouver 2017

Looking ahead, the Executive Committee has decided that the 58th General Assembly will also be the T.I.C.’s 7th Technical Symposium and as such the dates are extended by one day to be October 15th to 18th 2017. If you are interested in sponsoring all or part of this event please contact director@tanb.org for details of packages and options.

Promoting the T.I.C.

The last quarter has been particularly busy in terms of T.I.C. personnel representing and promoting this Association on visits to member companies, conferences and the like.

Emma Wickens, our Secretary General, joined a working group looking at the latest iteration of the European Union’s assessment of critical raw materials (the current list includes niobium but excludes tantalum).

Our Technical Officer, David Knudson, visited ATI Specialty Alloys & Components and then attended the CFSI conference in Santa Clara, CA, USA.

For my part I visited GAM’s Boyertown plant, examined the facilities for the upcoming General Assembly in Vancouver, Canada, attended a NORM workshop at the IAEA and in a bizarre twist of fate I also shared a bar with Donald Trump at the Ryan’s Notes conference in Miami, Florida, USA.

The T.I.C. is becoming a more proactive organisation, so please let us know if you hear of an event that you think we should attend. After all, there is no substitute for getting out of the office and meeting face to face.

Best wishes,

Roland Chavasse, Director
The 57th General Assembly and associated technical meeting was held on October 16th to 19th, 2016, in Toulouse, France. The event was attended by over two hundred delegates and generously sponsored by Alex Stewart International, Exotech, Inc., A&R Merchants Inc. and Metalysis Ltd. During the General Assembly on October 17th, members passed motions that included:

- Adopting an updated governing charter (during an Extraordinary General Meeting (EGM) held within the General Assembly) that included moving the financial year to be in line with the calendar year.
- Acceptance of budgets for two financial years (July to December 2016 and January to December 2017).
- Replacing the 2009 Artisanal and Small-scale Mining (ASM) Policy with an ASM Code of Conduct.
- Adopting the previously proposed antitrust policy (see Bulletin No.165).

Also noteworthy was that the annual membership subscription has been frozen until December 2017. All documents pertaining to the General Assembly, together with the presentations and photos from the event, are currently available on the members’ area of the Association’s website.

During the meeting Dale Gwinnutt (Elite Material Solutions) and William Millman (AVX Corp.) stepped down from the Executive Committee. In the subsequent elections all other committee members were re-elected and Kokoro Katayama (Metal Do Co. Ltd) and Raveentiran Krishnan (Malaysia Smelting Corporation) were elected. As always, the T.I.C. asks that Executive Committee members serve as individuals, not in their corporate roles. David Henderson was re-elected President for another 1 year term.

Looking ahead, the 58th General Assembly will be held in Vancouver, Canada on October 15th to 18th and will also be the Association’s 7th Technical Symposium. Any member company interested in giving a presentation and/or sponsoring at this event should contact Emma Wickens on info@tanb.org.

A selection of photos from the Fifty-seventh General Assembly

The Welcome Reception was held at the Radisson Blu Hotel and was sponsored by Alex Stewart International.
The Gala Dinner at the Aeroscopia Museum was sponsored by Exotech, Inc. and A&R Merchants Inc.

The tour of Airbus’s plant and lunch at Château St Louis were sponsored by Metalysis Ltd (sorry, no photos were allowed inside the Airbus plant).

Sponsorship opportunities at the Fifty-eighth General Assembly

Sponsorship puts your company in front of the global leaders in tantalum and niobium in a targeted and cost-effective way.

Opportunities available include the Gala Dinner, cocktail receptions, networking breakfasts and lunches.

Sponsorship packages are available on a first-come, first-served basis so book early to avoid disappointment.

Contact director@tanb.org for details.
iTSci in focus: How to report an incident by whistleblowing

This article formed part of a presentation given by Roland Chavasse, T.I.C. Director, at the Association’s 57th General Assembly held in Toulouse, France, in October 2016. The full presentation is available to members via the T.I.C. website. The iTSci Programme aims to work within the OECD’s framework and to comply with the UN guidelines to create a system that assists companies with traceability, due diligence and audit requirements that arise from purchasing 3T minerals, particularly from the DRC and Rwanda. The T.I.C. and ITRI sit on the iTSci Governance Committee.

The iTSci Programme works with hundreds of mines in central Africa to successfully exclude conflict minerals from the tantalum, tin and tungsten (3T) mineral supply chain and avoid a blanket ban on minerals from the region. iTSci is an evolving organisation and makes no claim to be all-knowing or all-seeing. Despite having limited resources iTSci constantly works to improve and a key tool for improvement is the process of reporting incidents of wrongdoing, that allows problems to be identified, worked through and learned from.

What is an incident?

- An incident is any event that contravenes the Dodd-Frank Act (1502) or the OECD or UN guidelines.
- Abuses of the system and the guidelines by companies, miners, traders or armed groups, e.g. human rights abuses, bribery, illegal trading, or smuggling.
- Abuse of the system by government agents, e.g. selling tags, service charges, or tagging illicit material.
- Breaking the terms of iTSci membership.
- Repeated abuses or a failure to act on recommendations.

All incidents are numbered and categorised. All supporting documents, photos, tag details and the like are stored with the report. Summaries of all incidents are circulated to the iTSci membership for action.

Whistleblowing

In line with OECD’s due diligence guidance iTSci has a whistleblowing system that allows interested parties to voice their concerns regarding the circumstances of mineral extraction, trade, handling and export in a conflict-affected and high-risk area. The full policy is available from both ITRI’s and the T.I.C.’s websites.

Whistleblowers can confidentially contact any person connected with the management or operations of iTSci:

- The local and regional iTSci field staff and managers
- Pact: reporting-iitsci@pactworld.org
- The Secretariat (ITRI): itsci@itri.co.uk
- The Governance Committee: ITRI (itsci@itri.co.uk) and the T.I.C. (director@tanb.org)
- The independent evaluator, Synergy Global Ltd: http://synergy-global.net

The disclosure can be made verbally, in writing, or via electronic communication in any language. Disclosure can specify if a particular person should not be involved in the investigation. iTSci will trust that whistleblowers act in good faith; but allegations require verification and fraudulent or unsubstantiated reports will be treated as a serious offense.

If you know of risks that are currently overlooked, please come forward to iTSci, or to the T.I.C., but be prepared to answer follow-up questions and provide evidence, especially if national police authorities become involved which may be inevitable if an incident contravenes national laws.

Sunlight is often the best disinfectant and stamping out wrongdoing will improve the system for all those who are acting in a legitimate way. T.I.C.
Transporting NORM: An Introduction

This is a summary of a report recently published by the T.I.C. The transport of NORM is one of the core issues in the tantalum and niobium industries and is the focus of much T.I.C. time and effort on members’ behalf. The full report is available online or from tech@tanb.org.

What is NORM and why is it important to our industry?

Some niobium (Nb) and tantalum (Ta) raw materials contain traces of thorium (Th) and uranium (U) and are therefore naturally occurring radioactive materials (NORM).

From an assay of the material giving the concentration of Th and U it is possible to calculate the radioactivity concentration of the material measured in Becquerels per gram (Bq/g). Material below 10 Bq/g is exempt from radioactive transport (Class 7) regulations and can be shipped as general cargo, but material above this level must be transported fully Class 7 compliant.

Shipments of NORM, especially those that qualify as Class 7, face an increased compliance burden from both international and national regulations compared to non-NORM shipments. Although not insurmountable, the regulatory burden and the risks involved may deter a carrier or port from accepting NORM shipments, resulting in a denial of shipment (DOS). Raising the awareness of this issue with both industry and the public, while keeping potential risks in context, is an important part of any NORM transport strategy.

This report aims to support T.I.C. members striving to comply with international, national and local regulations governing the safe and secure transport of radioactive materials, as required by the T.I.C.’s Transport Policy, since inappropriately shipped materials can have a negative impact on our industry.

Introduction

Naturally occurring radioactive materials (NORM) are ubiquitous in the natural environment and are commonly found in sands, clays, ores and minerals, by-products, recycled residues, and other materials used by humans. For many niobium and tantalum raw materials thorium and uranium atoms are locked within the mineral matrix and therefore these raw materials are NORM. Thorium and uranium atoms are almost impossible to separate from tantalum and niobium raw materials solely by physical mineral concentration and instead specialised chemical processing is required, typically digestion in hot hydrofluoric acid (HF) and sulphuric acid (H₂SO₄), following which the Th and U can be removed safely. It is common that such processing facilities are far from the mine sites and that transport is required, most often by sea.

Transporting radioactive materials is challenging but feasible. International transport regulations and agreements based on regulations and guidance from the International Atomic Energy Agency (IAEA) have determined that the maximum radiation level for tantalum and niobium raw materials is 10 Bq/g. Materials below this limit can be treated as general cargo but above this level they must be transported as Class 7 Dangerous Goods and in compliance with the relevant regulations to ensure their safe transport.
Companies have a legal duty of care to their workers and the public and need to comply with these requirements. In addition to the IAEA’s regulations and guidance country-specific requirements frequently add a layer of complexity to transporting NORM. Individual countries have the sovereign right to amend or add to the regulations applicable in their country, and frequently do, which can add considerably to the complexity of this subject.

**Calculating Becquerels per gram (Bq/g) from an assay**

In all documentation issued by the T.I.C., unless noted otherwise, figures quoted in Bq/g (the “radioactivity concentration”) refer to the relevant (parent) nuclide only, in accordance with the values for Th(nat) and U(nat) listed in the IAEA regulations SSR-6 of 2012, which have remained unchanged since first introduced in 1996 and are still the authority at time of writing.

The Bq/g values can be measured directly by gamma spectroscopy, or by a simple conversion from elemental analysis for thorium and uranium. Since assays can measure either elemental Th/U or the oxide form the method of calculation is given here for both.

The conversion factors applied are as follows:

- **For Th/U oxide:**
  - 1% ThO₂ = 35.6 Bq/g
  - 1% U₃O₈ = 104 Bq/g

- **For elemental Th/U:**
  - 1% Th = 40.6 Bq/g
  - 1% U = 123 Bq/g

**Worked examples**

1) If a material contained 0.04% ThO₂ and 0.06% U₃O₈, the radioactivity concentration would be:

\[
(0.04\% \times 35.6) + (0.06\% \times 104) = 1.42 + 6.24 = 7.66 \text{ Bq/g}
\]

In this case the material would be below the 10 Bq/g exemption level for transport and therefore could be transported as general cargo. Note however that low activity materials that qualify as general cargo may still trigger alarms e.g. gate monitors at industrial facilities or handheld monitors used by authorities in ports and at border crossings, therefore documentation to demonstrate the low activity should always accompany such materials during transport.

2) If a 200 kg drum contained 0.08% ThO₂ and 0.09% U₃O₈, the radioactivity concentration would be:

\[
(0.08\% \times 35.6) + (0.09\% \times 104) = 2.85 + 9.36 = 12.2 \text{ Bq/g}
\]

In this case the material would be above the 10 Bq/g exemption level.

Materials above the 10 Bq/g exemption level and therefore subject to transport regulations, will also need to have the total radioactivity calculated for the package. The total radioactivity for the 200 kg dry content of the package:

\[
200'000 \times 12.2 = 2'440'000 \text{ Bq} = 2.44 \text{ MBq}
\]

Note that total radioactivity figures are always likely to be large, therefore for convenience these are expressed as MBq, GBq etc.
3) If a 20 tonne container held 0.80% Th and 0.18% U (note the difference from ThO₂ and U₃O₈), the radioactivity concentration would be:

\[(0.80\% \times 40.6) + (0.18\% \times 123) = 32.5 + 22.1 = 54.6 \text{ Bq/g}\]

In this case the material would be above the 10 Bq/g exemption level.

As in example 2, materials above the 10 Bq/g exemption level also need to have the total radioactivity calculated for the package. The total radioactivity for the 20 tonne dry content of the package:

\[20'000'000 \times 54.6 = 1'092'000'000 \text{ Bq} = 1.09 \text{ GBq}\]

Further information and guidance

The new NORM guide from the T.I.C. contains more information on this subject and goes into the background of NORM regulations in greater detail. The guide also includes links to sources of information from third parties, a guide to the key steps companies could take to ensure they fulfill their regulatory obligations and a note on denial of shipment (DOS).

Due to the complexity of this subject and variations in national regulations the T.I.C.’s guide cannot claim to be exhaustive and notice should be taken of the disclaimer it contains.

The T.I.C. regularly attends stakeholder meetings at the International Atomic Energy Agency (IAEA) in Austria and sits on both the IAEA Transport Safety Standards Committee (TRANSSC) and Transport Facilitation Working Group (TFWG).

For further information please visit [www.TaNb.org](http://www.TaNb.org) or contact the T.I.C. Technical Officer, David Knudson, on tech@tanb.org.

Trevor Dixon, Specialist Adviser to the World Nuclear Transport Institute (WNTI) explains why this subject is so complex.

The international transport of NORM is subject not only to the internationally agreed standards set by the IAEA, IMO and ICAO but also to the individual countries’ interpretation of the regulations especially the IAEA Safe Transport Regulations.

These interpretations must not only be understood by the competent authority and shipper but also by the intermediate organisations such as the harbour or airport authorities. Which for some, due to the very limited movements of NORM, it is not worth their time or effort to try to understand and easier to say “We do not accept radioactive NORM material”.

Even when the port or airport allows for loading of these materials, it is subject to the airline or shipping companies’ willingness to accept these cargoes, due to misunderstanding of the hazards associated with these material many do not accept. This may be due to concerns for their crews’ wellbeing, or other concerns such as the impact on other cargoes they are carrying. The pilot or the ship’s master has the last say on whether the cargo gets loaded or not, which may be down to his knowledge regarding the cargo or just his personal preference.

The transport of NORM is fraught with hurdles and challenges but, working closely with partners and developing relationships with ports and shipping and airline companies, it is achievable.

WNTI represents the collective interests of the radioactive materials transport sector, and those who rely on safe, effective and reliable transport. More information about WNTI is available at [www.wnti.co.uk](http://www.wnti.co.uk)
Tantalum applications in numismatics and jewelry

Paper written by Alexey Tсораyev, Director of Tantalum Operations, NAC Kazatomprom / Ulba Metallurgical Plant JSC and presented by Kseniya Solomina on October 17th 2016, as part of the Fifty-seventh General Assembly held in Toulouse, France.

ULBA Metallurgical Plant JSC, 102, Abay Avenue, Ust-Kamenogorsk, 070005, Republic of Kazakhstan

email mail@ulba.kz, www: http://www.ulba.kz

Abstract

Recently tantalum has been used in jewelry and numismatics along with its traditional fields of application. This is facilitated by its unique properties such as corrosion resistance, high plasticity, ability to be polished with a mixture of very strong acids and property to be covered with very thin and resistant oxide films of beautiful iridescent colours such as intensely green, purple or iridescent blue when anodized at very high voltage. In many cases platinum is successfully replaced by tantalum in jewelry and numismatic applications.

Furthermore tantalum is used in the production of coins, medals, watchcases, bracelets and various adornments, not least because of the similar densities of tantalum and gold. Tantalum is a relatively rare and expensive material that makes it valuable for jewelry and numismatics where the majority of products are manufactured by means of forging due to the fact that tantalum cannot be soldered or welded. Kazakhstan Mint is located on the same production site as Ulba Metallurgical Plant JSC, the Kazakhstan tantalum producer, and mastered the production of bicolor commemorative coins in 2006. Sophisticated minting and decoration techniques enable the coins to be treated as a means of payment at their nominal value as well as being collectible items.

Introduction

This paper examines the subject of tantalum and niobium in a non-traditional application as part of an initiative to examine all different markets for these metals and to promote our elements to the public.

Figure 1: The unique properties of tantalum
It is perhaps unsurprising to note that tantalum applications are characterised by the unique properties of this element, which include corrosion resistance, high plasticity, ability to be polished by a mixture of strong acids and the property to be covered in a strong, thin film of oxide when anodized at a high voltage. The thin film can be of different iridescent colours including purple, pink, blue, racing green and others.

**Figure 2: Tantalum application in jewelry**

In jewelry tantalum became popular in 1977. Adornments made of tantalum in jewelry had the benefit that the specific weight of tantalum is close to the specific weight of gold (their atomic masses are 180.948 and 196.967 respectively). In jewelry tantalum and niobium can be matched with glass crystal, silver and gold as well as enamel, precious and semi-precious stones, pearls, amber and coral.

It is also interesting to note that in recent years tantalum has become popular among the leading producers of luxury items, including Montblanc cufflinks, rings and in watches made by Panerai, Wyler and F. P. Journe.

**Figures 3 and 4: Watches and cufflinks made using tantalum**

Coins are another niche application for tantalum and niobium. In the last decade niobium has been used with silver in Austrian 25 euro commemorative coins and more recently Kazakhstan has manufactured tantalum coins. Kazakhstan Mint is located at the same industrial site as Ulba Metallurgical Plant in Kazakhstan. The mint manufactures special memorial and commemorative coins using tantalum prepared using a proprietary process. Special stamps are used and some tantalum coins are produced with silver rings.

The Kazakhstan Mint has mastered production of three main types of tantalum coin: a central tantalum disc surrounded by a silver ring, an anodized central disc, and a tantalum ring. All the tantalum used by the Kazakhstan Mint is supplied by Ulba Metallurgical Plant in the form of mill products.
In 2011 Kazakhstan Mint produced a limited edition celebratory coin for Cosmonautics Day called The First Spaceman that used a tantalum inner disc and silver outer ring. The 500 Tenge coin shows symbols of the unity of mankind with the world on the obverse side and on the other side is Mr Yuri Gagarin who on April 12th 1961 was the first man in space.

This ground-breaking coin won first prize in the 2012 Vicenza Numismatic exhibition and began a series of coins celebrating space exploration.
One further application for tantalum is for Russian medals. In the early 2000s Oleg Galatin, a Russian artist and jeweller, created a series of medals using high purity metals. These medals were then awarded to leading artists, scientists and politicians. The medals used a range of metals including tantalum and niobium, as well as zirconium, nickel and other metals. These medals have been exhibited at the Hermitage Museum in St Petersburg and the Kremlin Armoury in Moscow, Russia, as well as in Florence, Italy, and other leading museums.

Figures 10 and 11: Russian medals manufactured from high purity tantalum

In conclusion, it can be said that despite a generally low awareness of tantalum and niobium by the public those familiar with the unique properties of these elements will not be surprised to learn that, although small, this niche market exhibits strong growth.

It is hoped that through the efforts of the T.I.C. and member companies the wider public will also come to recognise these unique and special elements in due course.

Statistics: do you need help with the new website?

The majority of T.I.C. members submitted their Q3 statistics successfully using the highly secure Statistics Collection Website at http://ticsstat.millerroskell.co.uk:8080/.

However, if you are experiencing any problems at all with the new system please contact David Knudson, T.I.C. Technical Officer, on tech@tanb.org.

As previously, please do not send your trade statistics to the T.I.C. directly as we must have no access to members’ data. Members’ trade data is only seen by Miller Roskell Ltd, the 100% independent chartered certified accountant that has collected members’ statistics since 2015. Miller Roskell is a member of the Association of Chartered Certified Accountants, and is ruled by their client confidentiality rules.

Their website is www.millerroskell.co.uk.
Tantalum supply from the lithium industry

Paper written by Michael Tamlin, Chief Operating Officer, Neometals Ltd, and presented by Michael Tamlin on October 17th 2016, as part of the Fifty-seventh General Assembly held in Toulouse, France.

Neometals Ltd, Level 1, 672 Murray St, West Perth 6005, Western Australia, Australia

Abstract

Tantalite and other tantalum minerals co-occur with lithium minerals in many pegmatites. Lithium mineral production is rising due to the double digit growth in lithium demand from electric vehicles. By-product tantalite production is likely to increase as a result. Some instances of primary tantalite production like Greenbushes and Tanco Mine are well known to T.I.C. members from past operations although they are now closed as significant producers. The lithium mineral spodumene occurred with tantalite at both mines. At Greenbushes, spodumene was produced as a technical grade concentrate from an adjacent section of the pegmatite while a large quantity of spodumene was rejected from the tantalite concentrator tailing because there was no economic use for large volumes at the time. At Tanco Mine, spodumene concentrate was mined and processed separately to the tantalite. Since then, the production of spodumene has doubled in response to the demand while tantalite production has declined at the major mines so tantalite by-product is becoming more common. Will the aggregate be a significant share of global production? This paper examines the potential sources of tantalite as by-product from new and future lithium mineral operations globally.

Disclaimer

Summary information: This document has been prepared by Neometals Ltd (“Neometals” or “the Company”) to provide summary information about the Company and its associated entities and their activities current as at the date of this document. The information contained in this document is of general background and does not purport to be complete. It should be read in conjunction with Neometals’ other periodic and continuous disclosure announcements lodged with the Australian Securities Exchange, which are available at www.asx.com.au.

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Investment risk: An investment in securities in Neometals is subject to investment and other known and unknown risks, some of which are beyond the control of Neometals. The Company does not guarantee any particular rate of return or the performance of Neometals. Investors should have regard to the risk factors outlined in this document.

Competent Persons Statement: The information in this document that relates to, “Barrambie Mineral Resource Estimates”, “Barrambie Pre Feasibility Study Results”, “Mt Marion Mineral Resource Estimates” and “ElI Lithium Downstream Feasibility Results” is extracted from ASX Releases set out below. The Company confirms that it is not aware of any new information or data that materially affects the information included in the ASX Releases set out below, and in the case of estimates of mineral resources, that all material assumptions and technical parameters underpinning the estimates in those ASX Releases continue to apply and have not materially changed.

The Company confirms that all the material assumptions underpinning the production target and the forecast financial information derived from the production targets in the Barrambie Pre-feasibility Study and ElI Lithium Downstream Feasibility Study continue to apply and have not materially changed.
Introduction

It could be said that lithium and tantalum are born together despite being almost opposites in physical characteristics. They occur in hard rock deposits, most commonly in pegmatites, which are igneous rocks that form as intrusions into granite rocks. Pegmatites are quite plentiful in a geological sense but those that have economic concentrations of lithium or tantalum, or both, are quite rare. Those that can be commercially mined by mechanised methods are even less common. Once extracted from the pegmatite host rock, lithium and tantalum concentrates usually go their own separate ways. Tantalum processors and lithium processors operate very different chemical processes. However, they do share some common ground in that the principle uses of each in modern times are the electronics industry. Tantalum has long been dominated by the capacitor sector for consumer electronics while lithium has come to be dominated by the rechargeable battery sector for consumer electronics.

A brief introduction to the company Neometals so you understand my perspective and the reasoning behind my analysis. Neometals’ principal objective in business is to make a good return on investment to its shareholders, deliver the return to those shareholders and keep on doing it sustainably and by mitigating business risks. Neometals is small in staff, focuses on a sound resource base in business sectors that respond to the development of processing technologies that reduce cost and increase productivity. We engage strong partners in appropriate disciplines where we are not equipped nor intend to be equipped ourselves.

The principle business ventures for Neometals are the development of a significant lithium hard rock (or spodumene) deposit to produce lithium compounds and a significant scale titanium deposit to produce titanium dioxide, both at the low end of the cost scale through developing new processing technologies.

Why discuss lithium in a tantalum and niobium conference?

At this point, you are probably wondering whether I am a bit off topic. However, there is a sensible explanation for the apparent digression. My paper is exploring the potential for increased contribution of tantalum raw materials from the lithium industry due to the remarkable growth in demand for lithium.

Tantalite By-Product

I have chosen to define a potential tantalite producer in this context as a “new lithium mineral producer with a tantalite by-product”. I am seeking to identify new sources of tantalite into the supply chain, when they are likely and in what volume. Tantalum concentrates are typically produced from spirals or magnetic separators to clean up the spodumene stream.

The typical tantalite by-product concentrate grade is predicted to be at the levels found in the old tin slags and will usually need upgrading to make it into a marketable specification (similar to the old Wodgina or Bald Hill operations that were upgraded to 20-30% Ta2O5 at Nagrom’s facility in Perth).

Lithium deposits that I have considered in my analysis but not included in the list of potential tantalite producers are:

- Cinovec (Czech Republic) which is a Li-Sn-W project but no economic tantalum mineralisation
- Wolfsberg (Austria) appears to be spodumene only but is early in development
- Whabouchi (Canada) appears to be only spodumene and focused on lithium hydroxide
- Separation Rapids (Canada) has been “under development” for 20 years
- Moblan, Crescent Lake, Seymour Lake, Rose, James Bay are all a very long way from production, whether or not they have any tantalum

The Lithium Market

A look at the lithium market illustrates why this discussion is relevant. Lithium demand has surged in the last 2 years and put enormous pressure on its supply chain to respond. As in tantalum some years ago, there are concerns among raw material producers to understand whether the surge will be real and sustained – factors that are of vital interest when developing long lead-time and long life investments.

The production response to this increased demand has some potential to create a new source of tantalum concentrates as a by-product to the lithium production. What is not well known, is the quantum and the probability of any new tantalum units entering the supply chain from the lithium industry.
The demand for lithium has grown at double-digit annual rates for the last decade and is forecast to continue. All traditional application sectors are growing at normal economic growth rates. The rechargeable battery sector is forecast to continue growing at roughly 20% pa due firstly to the growth in consumer electronics and later to plug-in electric vehicles and grid storage applications. The batteries are getting more plentiful and much larger now that batteries are reaching commercial use in vehicles and energy storage.

Such stunning annual growth rates support development of the supply side by requiring expansion as well as new supply sources. The probability of sustained growth in demand is illustrated below in figure 1.

![Lithium Demand by Application - 2014 (200,000t of LCE) and Lithium Demand by Application - 2025 (500,000t of LCE - forecast)](source: signumBox estimated)

**Figure 1: Lithium Demand by Application, 2014 to 2025**

As production increases, unit costs decrease and lower the price hurdle for adopting lithium batteries. The two charts in Figure 2 depict this relationship and the forecast to 2030.

![It's All About The Batteries](source: Data compiled by Bloomberg New Energy Finance)

**Figure 2: Demand for Batteries vs Cost**
Lithium ion rechargeable batteries have very limited threat of replacement. The current lithium ion battery technology has been in commercial deployment and development for 25 years and alternative battery technologies that could pose a replacement threat are well behind in commercialisation.

**Lithium Production**

The map in Figure 3 depicts the distribution of global lithium production. Lithium compounds such as lithium carbonate and lithium hydroxide are the main industrial materials. There are two primary raw material sources:

1. hard rock mineral concentrates produced from pegmatite deposits
2. concentrated, hyper saline brines that are typically sourced from continental brine deposits in crystallised salt and sedimentary sand formations in the Andes area of South America. The 67,500tpa LCE (lithium carbonate equivalent) produced in South American countries is almost entirely derived from brine deposits that have no tantalum associated with the lithium. From here on, I will only refer to hard rock operations for lithium production since these are the only economic lithium deposits associated with tantalum.

![Mine Production in 2014 of Contained Tonnes of Lithium Carbonate Equivalent (LCE)](image)

**Figure 3: Global Distribution of lithium production resources**

To put the quantities into perspective, 68,000tpa LCE lithium production from Australia equates to about 550,000tpa concentrates produced from about 3Mtpa ore. That quantity will rise to about 1Mtpa concentrates from 6Mtpa ore by the end of 2017. You might see where this is leading later in the paper when we start to talk about typical tantalite grades in the spodumene deposits.

Already, Greenbushes (Lithium) Mine and Bikita Mine contribute minor but material quantities of tantalite to the tantalum supply chain as by-product from lithium mineral extraction operations.

The tight supply conditions in lithium have driven up prices for lithium compounds and lithium concentrate prices have followed in their wake (see Figure 4) to a historic high point.
Long term, the large-scale future lithium supply capacity increases are most likely to come from large brine deposits (the lowest cost sources) but the development of hard rock operations and associated conversion plants has a much shorter time to market. Consequently, there has been a dramatic increase in the number of projects claiming to be focused on lithium exploration and concentrate production.

Two of these prospective projects (Mt Marion and Mt Cattlin) have been developed sufficiently by late 2016 to construction and one, Mt Marion, through to production. There are the Wodgina Project and two projects focused on the Pilgangoora deposit (better known for its tantalum history) that could fit into the current development window. The key issues for these projects are development time and the relationship of development time to the current window of financing opportunity. Financing is, of course, directly linked to the availability of sound offtake counter-parties (equivalent to tantalum processor offtake contracts).

Projects that are commencing resource definition and development during 2016 are likely to miss the boat for the foreseeable future and there is also the chance for an oversupply of concentrate capacity from this wave of mines that deflates concentrate prices and further discourages the financing of other ventures.

Hard Rock Lithium/Tantalum Deposits

New lithium mine developments have the potential to produce tantalite as by-product in:

- Deposits where Ta grades don’t support primarily Ta production
- Deposits where the product can or must be cleaned of heavy minerals

Hard rock lithium mines extract mineral concentrates from pegmatites that are igneous rock intrusions into granites and basalts. For example, some mines well known to this audience include Greenbushes, Mt Marion, Yichun, Tanco, and Bikita.

Tantalite usually occurs with the lithium minerals. I have characterised them for the purposes of this paper as:

- Mines with Enriched Ta zones - producers of tantalite
- Mixed deposits – mainly chemical lithium production, tantalum by-product

Greenbushes (closed), Tanco, Yichun, Wodgina (closed), Mibra have lithium in tailings

Mt Marion, Mt Cattlin, Pilgangoora

Technical Lithium deposits

Greenbushes, Bikita, Pakeagama
Technical mines will almost certainly be tantalite producers. Tantalite is an impurity that can detract from lithium concentrate quality but generate by-product income if extracted. Technical lithium concentrates are consumed in the production of glass and ceramics and the refractory tantalite is strictly not wanted because it harms final ceramic product quality. Scavenging of tantalite from these concentrates is essential. The problem is, they are small volume throughput and few of them. In “mixed” mines, tantalite is usually present but extraction as a by-product depends on grade, mineralogy and economics. The mixed mines are typically producers of chemical conversion raw materials. Tantalite is essentially inert in the conversion process and reports to residue from a chemical plant if it has not been extracted from the concentrate. The diagrams in Figure 5 depict the elementary parts of the lithium and the tantalum supply chains. The common ground exists at the raw materials end of the chains and doesn’t reappear except in niche applications such as lithium tantalite crystal SAW filters. Interestingly though, both elements rely on the electronics industries for their success.

The Issues to be Considered in Forecasting Tantalum Production by a Lithium Miner

I have evaluated the potential for a new economic deposit of lithium to produce tantalite using a few key criteria:

- How likely is the mine to be developed based on its lithium resource?
- What is the likelihood that it will produce a by-product? This is influenced by the application sector for its lithium concentrate as well as economic, mineralogy and flow sheet issues
- How much tantalite can it theoretically produce based on in-situ grades and on its mineralogy?
- What is the development timeline and how does the timeline relate to the lithium demand and supply expansion response?

Why will a lithium producer consider producing tantalum? The questions that will be asked include:

- Does the concentrate have to be free of tantalum and other heavy minerals?
- Do tantalite prices justify the effort?
  - Tantalum can be a handy bonus to offset production costs
- Value-adding
  - If conversion of concentrates into lithium compounds is co-located with the concentrator, there is arguably a lower chance that tantalite by-product will eventuate, to avoid complication in operations
- Ownership
  - Several operations are controlled by Chinese lithium compound producers that have minimal interest in tantalum and consideration of tantalum production is subordinate to that of lithium
Greenbushes produces a by-product from spodumene concentrators that is contracted to GAM as a result of the evolution of those companies from the single parent company.

Figure 6 shows the mines that I consider to have potential for development as lithium mines with tantalum by-product before large-scale brine deposits expand capacity. It is clear the grades are sub-economic for Ta only production, with even the former tantalum mining area at Wodgina now sub-economic.

<table>
<thead>
<tr>
<th>Mine</th>
<th>Location</th>
<th>Grade (ppm Ta₂O₅)</th>
<th>Annual Throughput (tpa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mt Marion</td>
<td>Australia</td>
<td>75</td>
<td>2.3M</td>
</tr>
<tr>
<td>Mt Cattlin</td>
<td>Australia</td>
<td>100</td>
<td>1.6M</td>
</tr>
<tr>
<td>Pilgangoora 1</td>
<td>Australia</td>
<td>132</td>
<td>2M</td>
</tr>
<tr>
<td>Pilgangoora 2</td>
<td>Australia</td>
<td>N/A</td>
<td>1.4M</td>
</tr>
<tr>
<td>Wodgina</td>
<td>Australia</td>
<td>N/A</td>
<td>TBA</td>
</tr>
<tr>
<td>Pakeagama</td>
<td>Canada</td>
<td>N/A</td>
<td>TBA</td>
</tr>
</tbody>
</table>

Figure 6: Potential Tantalum By-product Lithium Concentrate Operations

Summing up the tantalite potential, my forecast is in Figure 7, using probabilities for both prospect of the project reaching production coupled with the prospect that a tantalite by-product will be produced from the initial flow sheet.

<table>
<thead>
<tr>
<th>Mine</th>
<th>Production probability (%)</th>
<th>Tantalum probability (%)</th>
<th>Timing</th>
<th>Production (lbs Ta₂O₅ p.a.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mt Marion</td>
<td>100</td>
<td>60</td>
<td>2016</td>
<td>50,000</td>
</tr>
<tr>
<td>Mt Cattlin</td>
<td>100</td>
<td>100</td>
<td>2017</td>
<td>100,000</td>
</tr>
<tr>
<td>Pilgangoora 1</td>
<td>50</td>
<td>100</td>
<td>2018</td>
<td>320,000</td>
</tr>
<tr>
<td>Pilgangoora 2</td>
<td>50</td>
<td>40</td>
<td>2018</td>
<td>Nil</td>
</tr>
<tr>
<td>Wodgina</td>
<td>50</td>
<td>50</td>
<td>2018</td>
<td>TBA</td>
</tr>
<tr>
<td>Pakeagama</td>
<td>50</td>
<td>50</td>
<td>2018</td>
<td>TBA</td>
</tr>
</tbody>
</table>

Figure 7: Potential Tantalite By-production

Mt Marion will start production in October 2016 and Mt Cattlin will follow by the end of 2016. The two Pilgangoora mines are problematic and will need to attract substantial finance to proceed to construction. Since they are very close to the old Wodgina tantalite operation, there are much higher levels of tantalum in the deposits that can be expected to be produced as a by-product. Interestingly, the Pilgangoora 2 of Altura has not reported its tantalite grades publicly and neither Mt Cattlin nor Pilgangoora deposits proved feasible as tantalum operations during the boom of 2000 but might still end up contributing to the supply chain.

The reopening of Wodgina is an interesting prospect because it is planned as a dedicated spodumene concentrate operation with a likely tantalite by-product. The transfer of ownership from GAM to Mineral Resources has only just been completed but the development is already in advanced planning and design stages. Mineral Resources has been associated with Wodgina as the operator of the crushing circuits since the late 1990s.

Pakeagama is an interesting deposit that is owned by Frontier Lithium, a small Canadian developer. It has a very high grade lithium zone that is also low iron contamination that makes it suitable for the production of technical spodumene concentrate grades for glass ceramics, ceramics and glazes that are sensitive to discolouration. It also has some tantalite “contamination” and has a tantalum enriched zone. In the product sense it is similar to the lithium operation at Tanco. Tantalite may become a by-product from spodumene extraction in the short term while dedicated tantalite concentrate production is more likely to be a medium term consideration and will rely on sustained tantalum raw material prices being considerably higher than they are now.
At the last count, I think there were 60 projects in Australia and about 20 in Canada claiming to have lithium deposits other than the 5-10 well known longer-term lithium projects but I only have a list of 6 potential mines reaching production.

**Case Study: Mt Marion Lithium Project**

The Mt Marion lithium mine is starting production. As a small project developer with not very deep pockets, Neometals’ approach has been to engage a strong operating partner to provide experience and de-risk the implementation and a strong offtake partner to secure development finance. Mineral Resources is the largest and most successful contract processor of minerals in Australia. It has earned into the project by funding development and entering a BOO contract for the processing plant at Mt Marion to deliver a mine to port service at no capital cost to Neometals. Ganfeng is the most diverse and successful producer of lithium compounds in China and has entered a very secure offtake contract for all of production at market rates and become an equity partner. This has given Neometals the opportunity to deliver a world scale project while restructuring its balance sheet and delivering 2 dividends to its shareholders. Lithium grades of 1.36% Li₂O are economic and attractive at Mt Marion. The tantalum grades are quite low in the near term mining areas at approximately 50ppm Ta₂O₅ but vary somewhat across the deposit. Mt Marion will produce its first lithium concentrates in October 2016 and also make its first shipments in the same month. Ramp up is expected to be fast due to the nature of the plant. Concurrently, construction of other parts of the concentrator will be completed before commissioning in January 2017. (See Figure 8)

![Figure 8: Development Schedule Mt Marion Mine](image)

Tantalite production has not been integrated in the initial phase to reduce commissioning risk and simplify meeting the initial contracted production objectives. Once operations for the primary product have stabilized, tantalite will be re-considered.

**Adding Value Drives the Strategy of Lithium Producers**

Is lithium concentrate production going to become another major component of the tantalum supply chain in the way that tin slag was? Probably not is the short answer. Relatively speaking for a lithium concentrate producer, the commercial gains from integrated lithium production can outweigh any pocket money from tantalum by-product. Neometals is actively developing its lithium flow sheet into an integrated supply chain from mine to battery grade compound as is shown in Figure 9. The patented ELi process is in pilot commercialization phase. The final product is high purity lithium hydroxide for use in making cathode materials for lithium ion batteries.

The priority issues for business success are competitive opex and capex and the feasibility study has concluded that Neometals has a downstream lithium project in the lower sector of the industry cost curve with a project IRR of >50%.
### Conclusions and Food for Thought

In my view, there are a few important conclusions to draw from the current developments in the lithium market.

- This increase in lithium demand is very strong and will be sustained for several years.
- The growth has already supported a supply response from mining pegmatite deposits that should result in tantalite production on a small scale.
- The number of mines will be constrained by the timing and scale of supply response from brine resources that do not contain tantalum.

Anyone who was at the General Assembly in 2000, was witness to the great tantalum boom of the day. Is this the same for lithium? To some extent, the answer is yes. A rapid and significant increase in price driven by tight supply has stimulated a similar rush to test every possible pegmatite for lithium. If we were wanting more moose pasture, we’ve got it. In fact, there has arguably been more success finding lithium in some of these same pegmatites than when they were the next great tantalum hope. Pilangoora pegmatites for example have developed into a very large lithium resource while 15 years ago, they were only a marginal tantalite resource. They might or might not attract enough finance for development before the window closes and that will determine whether they become near term tantalum raw materials contributors.

There is no question that the lithium growth is real and will be sustained. Lithium prices support new capacity development. The contribution from hard rock will rely on speed to market and developing solid offtake partners. Any mine that becomes a producer and elects to recover tantalum as a by-product can be anticipated to operate at full practical capacity for some years and be a reliable producer.

Is this another tin slag type part of the supply chain? It is clear that new spodumene mines could contribute some quantities of 2-5% $\text{Ta}_2\text{O}_5$ concentrates. However, it will not be to the extent that tin slag was a major source due to the limited number of mines that are likely to reach production in the next 5 years.

What about the iron ore boom and bust? My view is that the proliferation that arose of many barely economic iron ore mines and smelters will not develop in lithium with the consequence that the new supply will be more permanent than it was in iron ore. Therefore, while the supply will be limited and relatively minor, it will be lasting. Let us not forget that I have confined my views to those new mines and not counted the existing by-product tantalite sources.

Can the tailings from old tantalum operations like Greenbushes and Wodgina be reprocessed for lithium and tantalum? The answer is a very conditional yes. Certainly, high prices stimulate reprocessing of tailings dams but they are generally very fine particles that make re-extraction quite difficult. Any reprocessing operations might not recover much tantalite at all given the effort that was made to recover tantalite in the first treatment.

Finally, the tantalite that will be produced from these Australian and Canadian spodumene deposits will be about as far from “conflict mineral” as you can get.

*For further information please contact Michael Tamlin on mtamlin@neometals.com.au.*
Members of the Executive Committee of the T.I.C. 2016-2017

The Executive Committee is drawn from the membership and committee members may be, but need not also be, the delegates of member companies. The Executive Committee named here was approved by the T.I.C. members at the Fifty-seventh General Assembly and consists of (in alphabetical order of member’s surname):

Conor Broughton  conor@amgroup.uk.com
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Of these twelve, Mr David Henderson was re-elected as President of the T.I.C. until October 2017. The next elections will take place on Monday October 16th 2017 in Vancouver, Canada. We are always looking for enthusiastic T.I.C. members to join our range of subteams. If you are interested in doing so and have a couple of hours each month spare, please don’t hesitate to contact director@tanb.org.

Member company updates

Transfers of membership

At the Fifty-seventh General Assembly the following two membership transfers were approved:

- From Ethiopian Mineral Development Share Company to Ethiopian Mineral, Petroleum and Bio-Fuel Corporation (EMPBFC). The delegate to the T.I.C. has also changed from Dr Z. Desta Zeleke to Mr Mulugeta Seid Damtew.

- From B.W. Minerals Pty Ltd to B.W. Minerals (s) Pte Ltd. The delegate to the T.I.C. remains Mr Wu Guiping, but the contact details for the new company are 30 Raffles Place, 23/F Chevron House, Singapore 048622, Singapore; e: bwminerals@bw.com.sg; w: http://www.hhezhong.com.

Note: Anglo American Níóbio Brasil Ltda has applied to transfer its membership to Niobras Mineracao Ltda, a subsidiary of China Molybdenum Co. Ltd (“CMOC”), at the 58th General Assembly. The delegate, Dr Frank Jackel, is now contactable at frank.jackel@cmocuk.com.

Changes in member contact details

Since the last edition of this newsletter the following changes have been made to delegate contact details:

- The delegate for AVX Corporation has changed from Mr William Millman to Mr Rick Gould. Mr Gould can be contacted at rick.gould@avx.com.

- The delegate for Better Sourcing Program (BSP) has changed from Mr Harrison Mitchell to Mr Benjamin Clair. Mr Clair can be contacted at benjamin@bsp-assurance.com.

- Jiujiang Tanbre Co. Ltd has changed its name to Jiujiang Nonferrous Metals Smelting Corp. Ltd. All other contact details for the company remain the same.

Resignations

The following companies have resigned from the Association since issue 167 of the Bulletin was published: Hi-Temp Specialty Metals Inc., Nanoscale Powders LLC, Solar Applied Materials Technology Corporation and Sovereign International Metals & Alloys Inc.
New members of the T.I.C.

At the Fifty-seventh General Assembly held on October 17th 2016 in Toulouse, France, nine new corporate members and three new associate members were elected.

Corporate membership of the T.I.C. is open to companies and organisations actively involved in any aspect of the niobium and tantalum industries, from explorers to miners, traders and processors, through to end users and suppliers of goods and services to the industry. Associate membership is available to organisations that are not commercially involved in our industries, such as academies, associations, government bodies and civil society.

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To apply for membership, please complete the membership application form from www.TaNb.org.