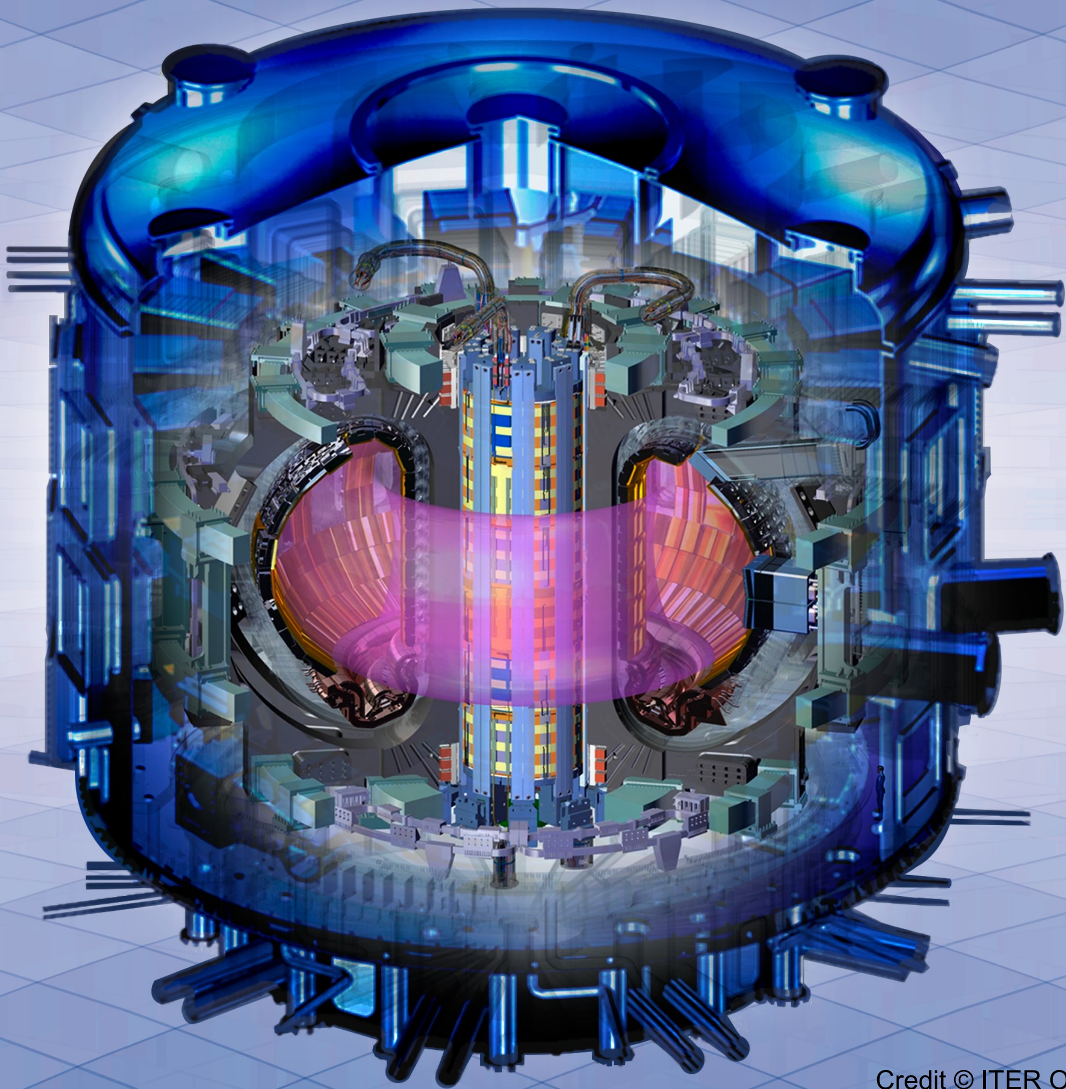
TIC
TANTALUM-NIOBIUM
INTERNATIONAL STUDY CENTER
Bulletin N° 174: July 2018

ITER: niobium-driven fusion

(see page 4)



Credit © ITER Organization

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President's Letter

Dear Fellow Members,

As the Executive Committee, staff, and subteams work on the final phase of preparation for the 59th General Assembly, our central African technical conference, the market has been refreshingly uneventful. Supply and demand show small increases and the fact that supply has handily kept up with demand appears positive.

I would like to thank everyone for the many complimentary comments received about the new statistics. Our Technical Officer is now working on trade data for ferro-niobium (FeNb), to further improve the niobium section of our statistics report. The Subteam has also received several, most appreciated, thoughtful, constructive suggestions and requests. However, please note that the T.I.C. is not able to provide statistics to individual members, over and above what can be provided to all members who participate in the statistics program. Given this limitation, it is critical that the Association's quarterly statistics reports evolve, to include all of the most useful tools and information for supporting all of our members' businesses.

The T.I.C. Executive Committee meeting in Brussels, Belgium, in April 2018. (photo: T.I.C.)

I would like to encourage members that will be impacted by the Responsible Minerals Initiative (RMI) Responsible Minerals Assurance Process (RMAP) protocol to provide input. We have received significant concern from our members that the protocol, as written, will require additional work, that will not produce any more integrity to our supply chains. The tantalum industry has the highest minerals industry participation in compliance programs, therefore it is essential that those programs function efficiently. Our members should not have onerous, ineffective requirements that are added to as a matter of course. So far we have received a lot of input that those affected by RMAP, in our membership, do not want additional requirements over and above the extremely comprehensive OECD due diligence guidance.

The shortlist for the Anders Gustaf Ekeberg Tantalum Prize 2018 is on the back of the brochure. It will be exciting to see the winner at the General Assembly in October and learn of the cutting edge research being undertaken using tantalum. Kigali is a wonderful, safe city. The Marriott hotel is excellent and immigration will fast track the visa process. On arrival in Kigali everyone can obtain a visa for a USD 30 fee. Delegates attending the 59th General Assembly will also be able to attend an additional (non-T.I.C.) event hosted by the Rwanda Mining Association at the hotel; which should be a novel opportunity for both of our members to network. I look forward to seeing everyone in October.

Sincerely yours,

John Crawley

President

59th General Assembly: early-bird tickets save 15%!

Sunday October 14th to Wednesday October 17th 2018

Members and non-members can book tickets by August 20th at special early-bird rates, saving 15% on the full ticket price. Full ticket price for members is EUR1125 and non-members EUR1275.

The 59th General Assembly is generously sponsored by Cronimet Central Africa AG (gold), Jiujiang Zhongao Tantalum & Niobium Co Ltd (silver) and Krome Commodities (welcome reception). Further information and booking forms are available from emma.wickens@tanb.org or at www.TaNb.org.

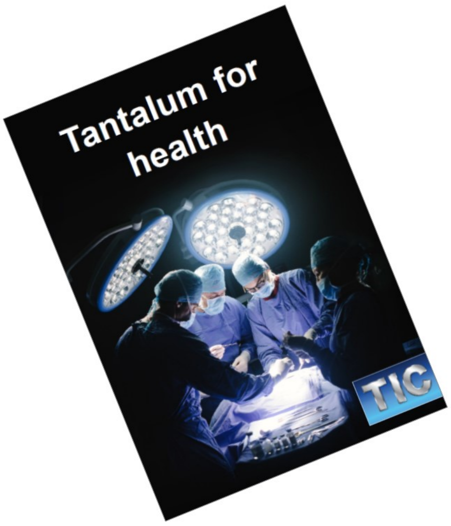
Ningxia, China

Dear T.I.C. Members,

I hope that this newsletter finds you in good health. While I was in Hong Kong recently the weather was perfect and the good news is that we are spoilt for choice in the host venue in this city for our 60th General Assembly in October 2019. After exploring Hong Kong I had the pleasure of visiting Ningxia Orient Tantalum Industry Co. Ltd (Ningxia OTIC) in Ningxia, China. There is no better way to understand our industry than a plant visit and I am grateful for the hospitality shown to me by Mr Jiang Bin and Mr Chen Wu during my visit.

As regular Bulletin readers will know, my colleagues and I are constantly on the road meeting stakeholders and promoting the interests of the global tantalum and niobium industry. For example our Secretary General, Emma Wickens, recently gave a keynote paper at the *Recycling of Strategic Metals* conference in Lille, France.

However, we often meet people from all walks of life for whom tantalum and niobium are something of a mystery. Therefore, as part of the Association's ongoing educational efforts, we are developing a series of short, introductory guides to our two exceptional elements. The first three have now been published (see www.TaNb.org) and others will follow in due course. Paper copies are available on request and I look forward to hearing your feedback on how to improve and expand this initiative.



It has been a very busy quarter for the Association. Not only have bookings opened for the 59th General Assembly (see page 10), but also the Anders Gustaf Ekeberg Tantalum Prize 2018 short-list has been created (see page 24), and the traditional statistics service has been thoroughly reinvigorated by the addition of international trade data. Members will also be pleased to hear that at the half-year meeting of the Executive Committee, held in Brussels, Belgium, on April 20th, it was noted that the projects approved at the 2017 annual general meeting remain on budget and on schedule.

With best wishes,

Roland Chavasse, Director

I meet with Mr Jiang and Mr Chen at Ningxia Orient Tantalum Industry Co. Ltd, Ningxia, China (photo T.I.C.)

Emma Wickens at *Recycling of Strategic Metals and Rare Earths 2018*, in Lille, France (photo T.I.C.)

David Knudson meets GAM at the *RAPID* additive manufacturing event in Fort Worth, Texas, USA (photo T.I.C.)

ITER: niobium superconductors show the way

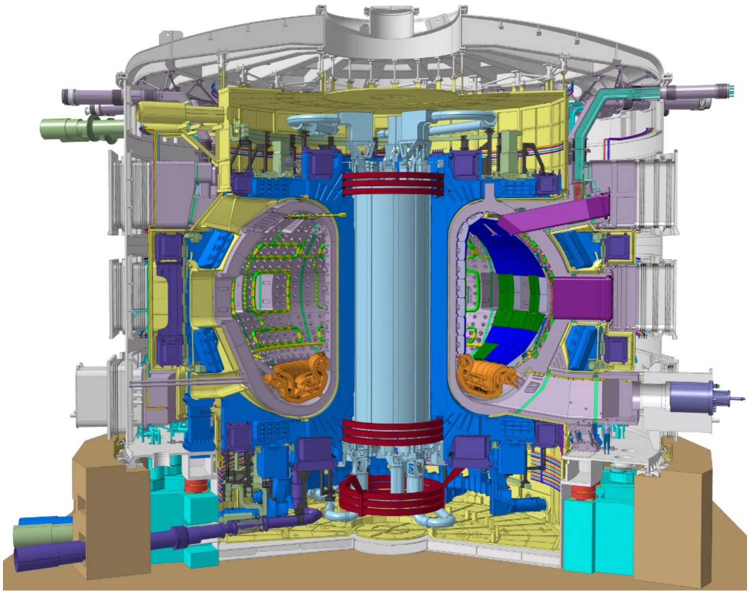
The ITER site in March 2018. The circular base of the tokamak is to the left of centre (photo: ITER Organization / EJF Riche)

Introduction

Near the quiet village of Saint Paul-lez-Durance in southern France one of the most ambitious energy projects in the world is under construction. If successful, the ITER project has the potential to radically change how we think of energy production.

ITER ("The Way" in Latin) is a collaboration between 35 countries that has been working since 1985 to build the world's largest tokamak, a magnetic fusion device that is designed to prove the feasibility of nuclear fusion as a large-scale and carbon-free source of energy.

The knowledge generated by ITER will be crucial to advancing fusion science and preparing the way for the fusion power plants of the future, and at its heart are a set of colossal niobium-based superconducting magnet systems.



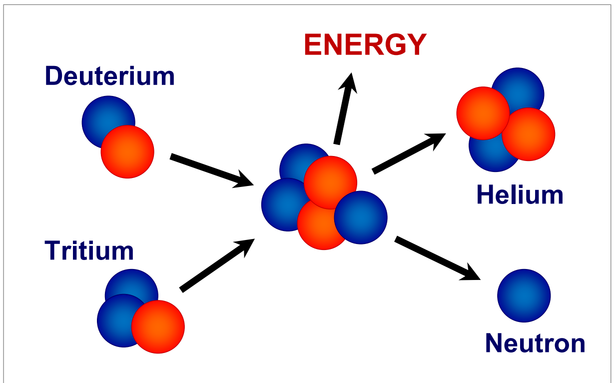
A cutaway showing the design of the ITER tokamak
(photo: Credit © ITER Organization)

Niobium-tin superconducting cable used in the D-shaped toroidal field magnets (TF).
(photo: Credit © ITER Organization)

ITER requires successful integration and assembly of over one million components (ten million parts), from around the world and delivered to the ITER site, a tremendous logistics and engineering challenge. Preparations on the ground started in 2007 and have made strong progress. The reactor is expected to be ready for preliminary testing (‘First Plasma’) in December 2025, followed by deuterium-tritium operations a decade later, in 2035.

The ITER members - China, the European Union, India, Japan, Korea, Russia and the United States - work together as the ITER Organization. All members have contributed to the design and fabrication of ITER, although Europe is responsible for the largest portion of construction costs (45.6%). Most of the Member contributions consist of hardware delivered to the ITER Organization, whether components, systems or buildings. Australia and Kazakhstan have recently signed technical cooperation agreements too.

Nuclear fusion



The fusion process

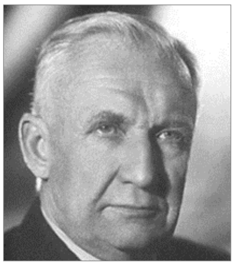
Nuclear fusion involves two atomic nuclei joining to make a larger nucleus, releasing a vast quantity of energy in the process. Fusion is the energy source of the Sun and stars.

Three conditions must be fulfilled to achieve fusion in a laboratory: i) a very high temperature (around 150 million °C, ten times the temperature at the core of our Sun); ii) sufficient plasma particle density (to increase the likelihood that collisions do occur); and iii) sufficient confinement time (to hold the plasma, which has a propensity to expand, within a defined volume).

Twentieth-century fusion science identified the most efficient fusion reaction in the laboratory setting to be the reaction between two hydrogen isotopes, deuterium (D) and tritium (T). The DT fusion reaction produces the highest energy gain at the "lowest" temperatures.

What is a tokamak?

First developed by Soviet research in the late 1960s, the tokamak has been adopted around the world as the most promising configuration of magnetic fusion device. The core of a tokamak is its doughnut-shaped vacuum chamber. Inside, under the influence of extreme heat and pressure, gaseous hydrogen fuel becomes a plasma, and the atoms can be brought to fuse and yield energy.

"Tokamak" comes from a Russian acronym for "toroidal chamber with magnetic coils", invented in the 1950s by Soviet physicists Igor Tamm and Andrei Sakharov.

Inside the tokamak the extreme conditions force electrons away from nuclei, changing the hydrogen gas into a plasma of charged particles - positive nuclei and negative electrons - that can be shaped and confined by the massive magnetic coils placed around the vessel. The magnetic fields confine the plasma away from the vessel walls and control the flow of heat energy from the plasma to the cooling system. ITER will be the world's largest tokamak - twice the size of the largest machine currently in operation, with ten times the plasma chamber volume. If it is successful, then ITER will be the first fusion device to maintain a self-heated burning plasma that will produce more fusion power than it takes to heat the plasma. Furthermore, ITER will be the first fusion device to test the integrated technologies, materials, and physics regimes necessary for the commercial production of fusion-based electricity. Traditional power plants generate electricity by converting mechanical power, such as the rotation of a turbine, into electrical power. The power released from the fusion reaction in a tokamak can be absorbed as heat in the reactor walls. In theory this heat has the potential to be harvested and converted to abundant electricity.

The role of niobium in ITER

The ITER magnet system will be the largest and most integrated superconducting magnet system ever built, and it would not have been possible without niobium. At the core of the ITER machine are a set of tightly integrated superconducting magnet systems.

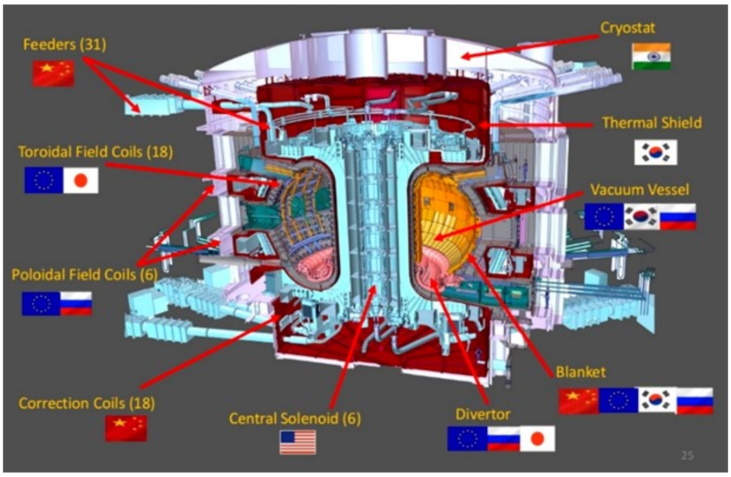
Cross-section of niobium-tin cable, showing cooling duct (photo: Credit © ITER Organization)

ITER uses high-performance, internally cooled "cable-in-conduit conductors", in which bundled superconducting strands - mixed with copper - are cabled together and contained in a structural steel jacket. The total weight of the ITER magnet system, including support structures, is about 10,000 tonnes, of which 500 tonnes are niobium-tin (Nb_3Sn) strands and 250 tonnes niobium-titanium (NbTi) strands.

“Superconducting materials are critical not only to the future of fusion energy, but to many other important scientific and industrial applications,” said John Smith, who manages the ITER program for General Atomics. “To really fulfil that promise, we need to continue advancing materials development of superconducting compounds, such as the niobium-tin conductor that enables us to fabricate the Central Solenoid.”

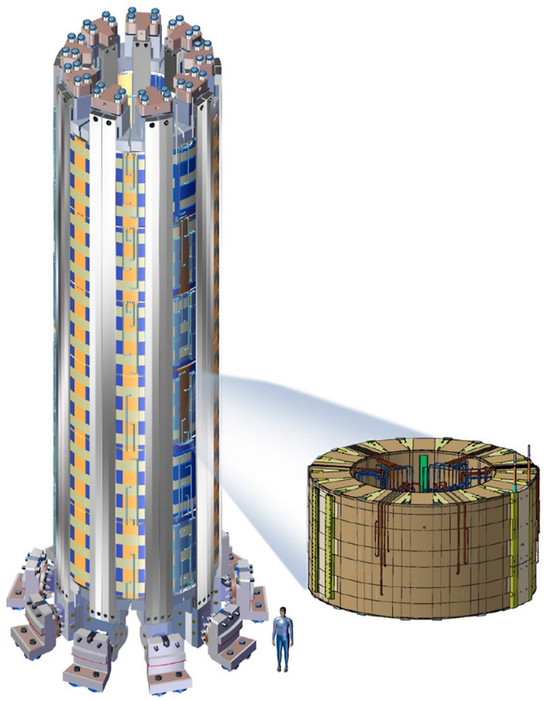
When these magnets are cooled with supercritical helium to 4 Kelvin (-269 °C) they become superconductors, able to carry higher current and produce stronger magnetic field than conventional counterparts. The combined stored magnetic energy of around 51 Gigajoules (GJ), will produce the magnetic fields that will initiate, confine, shape and control the ITER plasma.

Inside ITER, different types of magnetic fields will work in subtle combination to shape the plasma into the form of a ring, or torus, and isolate the very hot plasma away from the relatively cold vessel walls in order to retain the energy for as long as possible.



Cut-away of ITER tokamak showing magnet systems and key member contributions.
(photo: Credit © ITER Organization)

<u>The four superconducting magnet systems:</u>



Central Solenoid is 13m tall and weighs 1,000 tonnes
(photo: Credit © US ITER)

- Central Solenoid (CS)

The Central Solenoid (CS) is fabricated from niobium-tin (Nb_3Sn) and forms the "backbone" of ITER's magnet system, allowing a powerful current to be induced in the ITER plasma and maintained during long plasma pulses. The CS stack comprises six modules, each fabricated from approximately 6,000 meters of niobium-tin conductor. In total the CS is thirteen metres tall, four metres wide and weighs 1,000 tonnes, making it one of the largest components of the tokamak.

In May 2018 General Atomics, manufacturer of the CS, took delivery of the 51st and final spool of superconducting cable from its Japanese partners, Furukawa Electric, Mitsubishi Cabling, Japan Superconductor Technology, and Kiswire Advanced Technology. The CS will be the largest pulsed superconducting magnet in the world and produce a field of up to 13 tesla (T).

The CS is strong enough to contain a force equivalent to twice the thrust of the NASA Space Shuttle taking-off (60 meganewtons, or over 6,000 tonnes of force).

In total ITER uses 500 tonnes of Nb_3Sn (more than 100,000 km), produced by nine suppliers.
(photo: Credit © Luvata)

A module segment being wound using 900 m of conductor.
(photo: Credit © 2018 General Atomics)

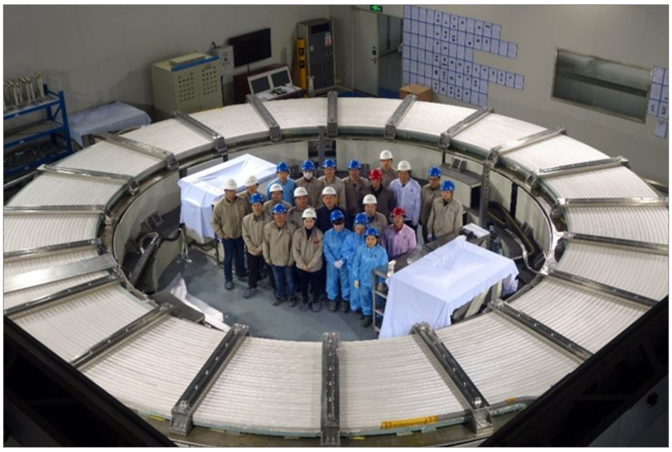
- D-shaped toroidal field magnets (TF)

Toroidal field (TF) magnets assist in stabilizing the plasma, by creating a "magnetic bottle" for confinement. Eighteen of these niobium-tin TF coils will surround the torus-shaped vacuum vessel and produce a magnetic field strength of up to 11.8 T that will confine the plasma particles. Each coil is 17 metres high, up to 9 metres wide, and weighs 310 tonnes. A nineteenth coil will be produced as a spare. These coils rank among the largest components of the ITER machine. The niobium-tin cable was fabricated by suppliers in China, Europe, Japan, Korea, Russia and the USA, including the T.I.C. member company JSC TVEL.

A steel case weighing over 200 tonnes that will fit over a toroidal field superconducting winding pack and provide structural support.
(photo: Credit © ITER Organization)

- Poloidal field coils (PF)

Poloidal field coils (PF) assist in stabilizing the plasma. In ITER, the PF coil system consists of six niobium-titanium (NbTi) ring-shaped poloidal field magnets placed outside TF coils to shape the plasma and contribute to its stability by "pinching" it away from the walls with a field strength of 6 T. The largest coil has a diameter of 24 metres; the heaviest is 400 metric tons.



At ASIPP in Hefei, China, qualification activities for ITER's smallest poloidal field magnet (PF6) are underway. China is manufacturing PF6 modules.
(photo: Credit © ITER Organization)

- Correction coils (CC)

A group of 18 superconducting niobium-titanium (NbTi) correction coils (CC) will be distributed around the ITER tokamak at three levels, top, middle and bottom. Much thinner and lighter than ITER's massive toroidal field and poloidal field magnets, their role is to reduce magnetic error fields caused by imperfections in the position and geometry of the main coils.

Weighing a maximum of 4.5 tonnes and measuring up to 8.3 metres, the correction coils are the very smallest of the superconducting magnets. The Institute of Plasma Physics at the Chinese Academy of Sciences (ASIPP) is responsible for the fabrication of all 18 CC assemblies.

Looking ahead

Niobium is an exceptional element and nowhere is this more evident that in niobium-based superconductors. Since the first niobium-based superconductor was developed by Bell Telephone Laboratories in 1961 a host of exceptional technologies have already been developed, including life-saving MRI machines (see Bulletin #170), Maglev trains and the Large Hadron Collider at CERN. Today, at ITER, thanks to niobium we are approaching another major milestone in human development: sustainable energy production from fusion. The T.I.C. will continue to follow this exciting project closely and update readers of the Bulletin as it develops. TIC

Notes: Special thanks to John Smith and Greg Cunningham at General Atomics Energy Group, and all the team at the ITER Organization. Any omissions or errors in this article are those of the author alone.

Further reading: There are many sources of ITER information online. Recommended websites include ITER (www.iter.org), General Atomics (www.ga.com), and an article by Mitchell et al *The ITER Magnets: Design and Construction Status*, which is available at www.snf.ieeecsc.org.

Kigali, Rwanda: host city of the Fifty-ninth General Assembly

Kigali is Rwanda's rapidly growing capital city and the most important business centre in the country. It is located roughly in the centre of the country, which makes the perfect base for exploring this small but exquisite land.

The city is spread across a region of rolling hills, criss-crossed by a series of valleys and ridges joined by steep slopes, which is not surprising for a country often called the "land of a thousand hills".

The Marriott hotel, our host venue for the General Assembly, is located in the central business district and is adjacent to the Presidential Palace, University Hospital and the embassies of Belgium, China and Russia. The city really is remarkably safe and it is common to see young international backpackers walking in the city alone.

Gorilla trekking in Volcanoes National Park in eastern Rwanda is popular so must be booked well in advance.
(photo: Shutterstock)

Gorillas and other wildlife

The crown jewels of Rwandan tourism are the mountain gorillas that live in Volcanoes National Park in the west of the country. It is estimated that Rwanda is home to one third of the world's remaining mountain gorillas, and the country also has sizeable populations of chimpanzees, golden monkeys and hundreds of bird species.

In the east of Rwanda is Akagera National Park (www.akagera.org). It was founded in 1934 and is Rwanda's largest national park. It is home to lions, leopards, servals, hyenas, jackals and giraffes, large herds of buffaloes, impalas, zebras and several antelope species. Elephants often congregate around the lakes that are inhabited by more than 800 hippos as well as Nile crocodiles.

Culture and history

Natural History Museum at Kandt House houses a fascinating guide to Rwanda's flora, fauna, geology and biological history, along with a stuffed skeleton of a massive crocodile that terrorized a village in Lake Muhaze; a pair of shoes was found in its stomach.

The building is the former home of Dr Richard Kandt, a German explorer who visited the region in the late 1890s searching for the source of the Nile. Other museums include the residence of the former president of Rwanda, President J. Habyarimana, near the airport on the eastern outskirts of Kigali and memorials to the tragic events of 1994.

A short drive south from Kigali is The Cultural Heritage Corridor, home to a number of Rwanda's most important cultural and historical sites, including the Royal Palace located in Nyanza district. Near the palace is the Rwesero Art Museum, an art gallery where contemporary Rwandan artwork is displayed.

King's Palace Museum - Rukari, south of Kigali, was the residence of King Mutara III Rudahigwa and a grand example of a traditional royal palace. This museum provides visitors with an insight to the traditional seat of the Rwandan monarchy as it was in the 19th century. Recently the traditionally-built complex has welcomed traditional long-horned "Inyambo" cows, which form an integral part of Rwandan culture.

Cultural souvenirs for sale
(photo: Rwanda Tourism)

(photo: Rwanda Tourism)

Food and drink

Rwandan cooking includes a lot of sweet potatoes, beans, corn, peas, millet, plantain, cassava, and fruit. Chicken and goat meat are popular and more common than beef, although the latter is increasingly available too. Rwandan food tends not to be especially spicy, unless you decide to add some akabanga chilli oil, which is pure liquid fire.

Rwanda grows world-class coffee, although many Rwandans prefer to drink a strong tea served with honey, milk and ginger that is wonderfully refreshing. After work there are several good local beers to choose from, with Virunga Mist and Mützig standing out. Mützig is brewed to a German recipe and is perfect after a day on the road visiting mines and processing plants.

Climate

Kigali, like all of Rwanda, has a temperate tropical highland climate, with lower temperatures than are typical for equatorial countries because of its high altitude. In mid-October the city typically experiences a comfortable temperature range of 16 to 27°C (60 to 80°F), with rain occasionally.

Getting to Rwanda

Kigali airport is well served by international flights and has direct flights from many major hubs, including London, Amsterdam, Brussels, Dubai, Istanbul and Johannesburg. Visas can be bought on arrival at Kigali airport by visitors from around the world.

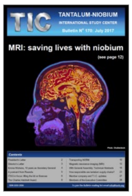
Once in the city, car taxis (known as 'special hire' or 'taxi voiture') are everywhere and getting around the city is cheap and efficient. There are also many motorcycle taxis and ‘matatu’ minibus services available used by Kigali residents (but perhaps not recommendable for visitors).

Further information on visiting Rwanda and links to book safaris are available at www.rwandatourism.com.

If you get the opportunity to visit Rwanda then do; you’ll not be disappointed!

A traditional fishing craft on Lake Kivu. Pleasure boats and canoes can be hired by visitors who make the short journey from Kigali.

(photo: Rwanda Tourism)



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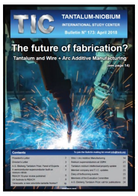


Our mission with the Bulletin is to provide the global tantalum and niobium community with news, information and updates on our work. We hope you enjoy reading it and you will want to continue receiving it in the future.

Email **info@tanb.org** to join our mailing list and keep up to date with the T.I.C.

Fifty-ninth General Assembly: Technical Programme Abstracts

Photos: T.I.C., Marriott and Jaydene Chapman, The Stocks

The T.I.C.'s 59th General Assembly will be held in Kigali, Rwanda, from October 14th to 17th 2018. The event is generously sponsored by Cronimet Central Africa (gold sponsor), Jiujiang Zhongao Tantalum & Niobium Co. Ltd (silver sponsor) and Krome Commodities (welcome reception sponsor). The event is now open for booking and full information, including the booking form, is available at www.tanb.org. The final booking deadline is October 5th 2018. A special "early bird" booking rate is available for bookings received before August 20th 2018.

The following papers are expected. The announced presenter is the first author listed, unless otherwise specified. Please note that this list is subject to change. The papers are shown in alphabetical order of first author.

Risk-based due diligence and the RMAP

by Hillary Amster and Leah Butler, Responsible Minerals Initiative (RMI)

In 2010, the tantalum industry led the tin, tantalum, tungsten and gold (3TG) responsible sourcing space by initiating and completing the first Conflict-Free Smelter Program audit. Eight years later, the tantalum industry has again blazed the trail for industry with early adoption of the Responsible Minerals Initiative's (RMI) revised standards, resulting in the first participating and conformant tantalum smelter under the new requirements. After a discussion of programmatic updates from the RMI, the presentation will take an in-depth look at the revised Responsible Minerals Assurance Process (RMAP) Tin and Tantalum Standard, providing early feedback on its implementation, general observations about key challenges and opportunities, as well as preview the guidance, tools, and resources available to smelters for risk-based, OECD–aligned due diligence. In addition to the revised Standards, RMI released additional tools in 2017, including the Risk Readiness Assessment (RRA). The presentation will preview some of the RRA's functionality and share insights into adoption of the RRA within the tantalum industry.

Stable source of tantalum from Western Australia

by Ken Brinsden and Anand Sheth, Pilbara Minerals Ltd

Tantalum production from Western Australia (WA), as a by-product of lithium, will soon become one of the largest, low cost, stable and sustainable suppliers globally. In the 1990s, WA's share of the tantalum concentrates produced, predominantly from two mines, Greenbushes and Wodgina, was ~75%, but dropped to ~65% by 2006 with advent of new tantalum operations and artisanal mining. These two mines were dedicated tantalum operations with lithium as a by-product. However, as the global adoption of electric vehicles continues to accelerate, hitting a new record high in 2017, lithium demand is set to soar. According to Roskill, lithium supply needs to grow by 250% to 2025 and by more than 500% to 2030 in order to support the massive growth in the lithium-ion battery industry. Lithium hard-rock deposits will become a significant supplier to this sector and several new lithium projects are already under commissioning stages in WA, Canada and Africa. Some of these new projects including the existing largest lithium operations have a significant capacity to produce tantalum as a by-product, at relatively very competitive costs. By 2025, Roskill forecasts that WA will be able to secure more than 40% of the new tantalum supply globally. The presentation will include, as a case study, an update to Pilbara's Pilgangoora lithium tantalum project that is soon to commission Stage 1 and progress towards Stage 2 expansion. It will become a significant and important producer of lithium and tantalum concentrates by 2020.

Production of tantalite in Tanganyika Province of the Democratic Republic of the Congo

by John Crawley, Minerals Resources International AG

Tanganyika Province was created in 2015, from Katanga Province. Katanga has large deposits of both copper and cobalt, while Tanganyika Province contains a rich supply of both tin and tantalum. The two largest industrial producers of tantalum in Tanganyika Province have recently gone through expansions and modernizations. The Kisengo mine is located close to the village of Kisengo, 100 kilometers from Kalemie, the capital of Tanganyika. Kisengo has numerous primary and secondary zones containing easily accessible decomposed pegmatite. The mineralized material can be extracted simply using an excavator and contains high concentrations of tantalite which can be efficiently upgraded in a new 120 MT per hour state of the art facility. The Kanuka mine straddles two territories with 10% in the territory of Manono and 90% in the Malemba Nkulu area. Kanuka produces a concentrate containing 60% tin and up to 10% tantalum. Kanuka offers the advantage that both elements in the ore are of value, reducing relative beneficiation cost of each valuable element.

Challenges and solutions for the transport of tantalum-niobium ores with trace radionuclides

by Louis Gallois, Orano TN / TN International

Tantalum and niobium deposits often occur in association with radioactive uranium (U) and thorium (Th) isotopes. After processing the ore, these isotopes may then show up as trace constituents in the final products (columbite, columbo-tantalite, struverite, pyrochlore, lueshite, betafite, samarskite, tin slags), which usually need to be transported to the customer by road, rail or sea, and most often crossing borders. Roughly, any material with a threshold value above 0.1 Becquerel per gram (Bq/g) is classified by the United Nations (UN) as a Class 7 "radioactive material" subject to certain regulations on handling and shipment. The threshold value for such regulations is even lower in some jurisdictions, and there is a tendency for the regulations to become tighter still. Therefore, producers, traders, importers, shippers and customers of tantalum-niobium ores need to be well advised as to how to comply with the legal complexities during transport and in ports. Orano TN (formerly Areva TN), headquartered in Paris, is a global leader in nuclear logistics, with a world-wide network for assuring the safe and compliant transport of Class 7 materials. In this presentation, we will discuss the challenges facing the tantalum-niobium industry and propose workable solutions.

T.I.C. yearly statistics presentation with augmented trade statistics

by David Knudson, Tantalum-Niobium International Study Center (T.I.C.)

Each quarter the T.I.C. administers the collection of anonymous statistics data from its members by an independent intermediary, Miller Roskell Ltd, an accountant. This data is then verified and certified by Miller Roskell and provided to the T.I.C. The data is then collated and presented in report form to our members, also on a quarterly schedule. In 2018 the statistics service evolved from using purely members' data to also include international import and export data. Categories having missing data are investigated by the T.I.C. Technical Officer and international trade data is added to complete the reporting category. This presentation will provide a comprehensive report on collected member data for calendar years 2007 through 2017 and discuss the challenges inherent to the old system of relying only on members' data. This presentation will also examine the use of publicly available international trade data, the methodology for its integration with members' data, and new procedures for collection and reporting of augmented members' trade statistics.

The new challenge and opportunity in the Chinese tantalum market

by Maggie Lee, Asian Metal Ltd

China is one of the major tantalum producers in the world. As the Chinese local government places many policies about environmental protection and safe production for smelters, the actual output and consumption of tantalum materials changes. Many tantalum smelters and end-users in China face new challenges and opportunities due to the new policies and insiders are seeking for a new balance between supply and demand under the new market conditions. In 2017, the global tantalum market began to face blooming demand with higher prices, so production in China continued to increase accordingly. However, entering 2018, many tantalum smelters faced a more strict policy from Chinese government with reduced output while costs of minerals from Africa and South America increased. An important question is how to control the production cost and make fair prices for downstream products.

Technology research on preparation of a new type texture on the tantalum blank

by Li Zhao-Bo, Ningxia Orient Tantalum Industry Co. Ltd (OTIC)

This article describes the influence of textured component types of tantalum sputtering target blanks used for semiconductor production on the sputtering rate. It introduces the preparation of a new type texture on the tantalum blank. Our research group used as starting material high purity tantalum ingot of diameter 330 mm, through SPD forged, WR rolled with variable speed heating technology to produce 12-inch tantalum blanks. Using Electron Backscatter Diffraction (EBSD) to characterize texture shows the new texture component of samples was improved from 25-35% variation to less than 5%. The new tantalum sputtering target with the new type texture ensures uniformity of sputtering rate through increased target life while improving sputtering efficiency. The new blank can be used for the production of 12-inch tantalum sputtering targets.

Qualitative benefits of the implementation of the ICGLR Regional Certification Mechanism (RCM) in Member States

by Ambassador Ambeyi Ligabo, International Conference on the Great Lakes Region (ICGLR)

Following their political decision to implement the Regional Certification Mechanism (RCM) in the framework of their Regional Initiative on the Fight Against the Illegal Exploitation of Natural Resources, the ICGLR conducted a cost-benefit analysis of implementation of the RCM in Member States. The study further analyzed unquantifiable benefits of the RCM. First and foremost, the study sees the major benefit in implementing the RCM around regional security as it is a regional tool designed to fight against the raising of revenues from the illegal exploitation of natural resources to finance armed conflicts. It also suggests that sustainable access to market can only be achieved by demonstration of ‘conflict-free’ status leading to strong economic incentive for government, companies and civil society to invest the time and resources in properly implementing the RCM. Concretely, the RCM can play an important role in protecting the reputation of mineral producers, traders and exporters amongst investors, financiers, insurers, employees, regulators, suppliers and consumers. Also the study found that miners’ livelihoods benefited through market access, tax revenues increased where there was improved data collection and management; and increased third-party audits (TPAs) increased the likelihood of tax avoidance and under-declared profits being detected.

Supply chain stability, corporate social responsibility and the ceramic capacitor (MLCC) shortage: a “perfect storm” for tantalum

by Per-Olof Loof, KEMET Electronics Corporation

Demand for tantalum is influenced by a number of factors; those that immediately come to mind are politics, ethics, technology, the market and the overall supply chain. The relative importance of each of these factors changes over time. This presentation will take a look at how the confluence of increased stability in the tantalum supply chain, corporate social responsibility (CSR) directives and the current shortage in the market of ceramic capacitors (MLCCs), can all prove beneficial in creation of a “perfect storm” that will serve to increase the demand for tantalum for the foreseeable future.

Responsible artisanal mining support mechanisms

by Dirk Musser and Candida Owens, Cronimet Processing / Cronimet Central Africa AG

The continued importance of Central Africa as a source for tantalum, tin and tungsten, means that every responsible company wishing to purchase from the region must do more than just buy whatever is available. Companies must look to ensure that the mines and co-operatives they are buying from are adhering to regional government and international laws, in regard to due diligence and maximization of return on mineral value for the miner and for the exporting countries. Cronimet has been committed to helping regional miners and co-operatives for many years. Cronimet spent time educating owners and miners on how to build washing stations to capture water and not pollute streams. The next step would be the mechanization of the processes in order to increase productivity and output, reduce the environmental impact and improve the health and safety conditions for the miners. For that, Cronimet supports the miners in planning and implementing the right structures and machinery.

The ITSCI Programme, a regional programme bringing international standards to the 3Ts supply chain

by Emily Turner and Kay Nimmo, ITSCI Programme

The ITSCI Programme was developed as a response to a regional need for mineral due diligence and traceability in the 3T industry, and enables miners in the Great Lakes region to access the international tantalum market, in doing so maintaining the livelihoods of 70,000 miners working on over 1,900 mine sites. In 2018 an independent review of the leading due diligence industry programmes found that only ITSCI was 100% aligned with OECD's guidance on the subject. Continued focus on improving the effectiveness and efficiencies of operations, including with technological improvements, as the programme has progressed, has meant the ITSCI Programme has been able to continue to provide the close follow-up on the ground and support of in-region actors, even as ever more regions and mine sites have been covered. This paper will discuss the Programme's wide-ranging scope, OECD due diligence guidance focus, and the support for continual monitoring that has ensured continued access to the international tantalum market for participating countries in the Great Lakes region.

Tantalum capacitors: world markets, technologies and opportunities for vendors of ore, powder and wire from 2018 to 2023

by Dennis Zogbi, Paumanok Publications, Inc.

This presentation will focus on the worldwide market for tantalum capacitors by configuration, case size and cathode system. It will also look at the consumption of tantalum capacitors by end-use markets, world regions and channel of distribution. Competition and market shares will be considered, as will lead time trends. Of particular interest to the tantalum capacitor industry is the impact of the shortage of multi-layer ceramic capacitors (MLCC) on the FY2019 tantalum supply chain. Other topics that this presentation will consider include capacity expansion, supply chain and raw materials, and forecasts to 2023.

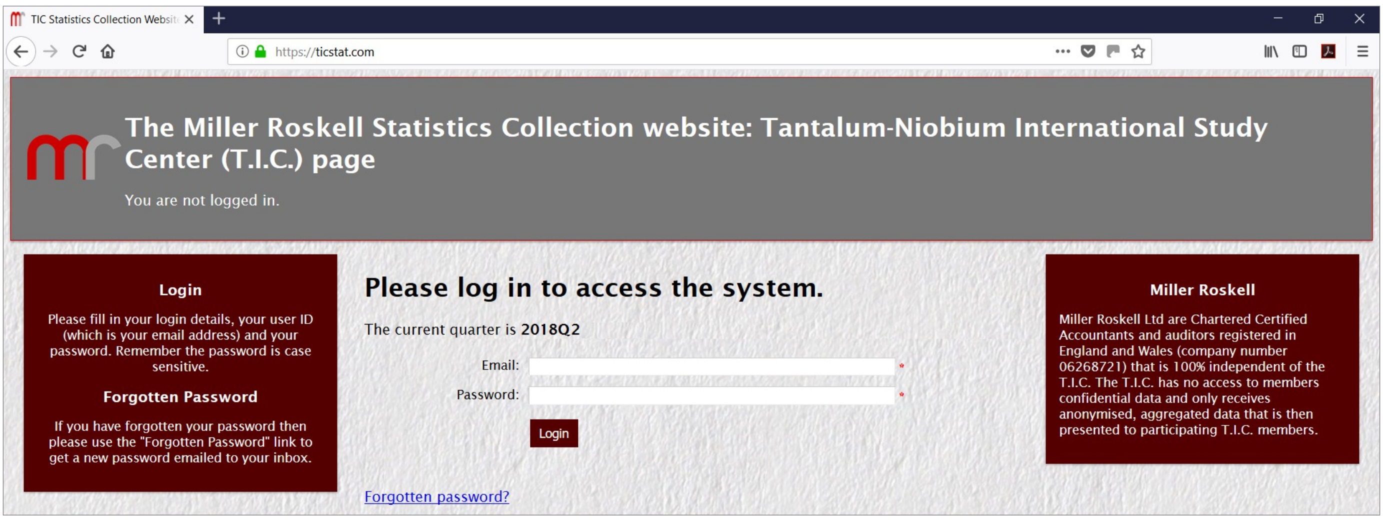
Note: The programme of technical abstracts given here is correct at the time of publishing, but T.I.C. reserves the right to alter the programme without prior notification.

A new address to the online statistics database

The T.I.C.'s statistics collection website, hosted and run by Miller Roskell Ltd, has transferred to a new address so that it can take advantage of enhanced security: https://www.ticstat.com/

The website structure and forms for data entry have not changed. The security of members' data is of core importance and the new website is highly secure and protected using 256-bit encryption. This means that there are 2^{256} different combinations that a hacker would potentially have to try to break the encryption. That is 115,792,089,237,316,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000 combinations. The T.I.C. takes members' data confidentiality very seriously indeed.

If you have any questions at all about statistics, how your data is handled, or the independence of Miller Roskell, then please email T.I.C.'s Technical Officer, David Knudson, david.knudson@tanb.org.



Field-portable X-ray fluorescence (FPXRF): an introduction

This article is indebted to Professor Alireza K. Somarin of the Department of Geology, Brandon University, Manitoba, Canada, (www.brandonu.ca) for his generous assistance, and also to Mr Ingo Steinhage and his colleagues at Spectrometer Technologies (www.ustech.co.za) for explaining the fundamentals of operating an FPXRF. This is the first in a series of articles which will examine some of the more essential tools used in the field by those in our industry. There are several manufacturers of FPXRF equipment; this article is for information only and does not constitute advice.

Introduction

Knowing the chemical analysis of minerals, chemicals and metals is an essential part of the tantalum and niobium industry. While a laboratory will provide unrivalled analytical accuracy, it takes time and can be difficult to arrange when one is out in the field. This is where field-portable X-Ray fluorescence (FPXRF) can provide a solution; small, portable and rugged XRF equipment can provide real-time, in-the-field analyses.

FPXRF is a technique that has gained momentum and application in various fields from geology/mineralogy to mining (grass root exploration to exploitation and ore grade control), environmental science, metallurgy, and even geo-archaeology. This non-destructive technique has the ability to produce fast and accurate results with little or no sample preparation once the machine has been calibrated correctly.

The X-ray fluorescence process:

1) A sample is irradiated with high energy primary X-rays (or gammas) emitted from the front end of the handheld XRF analyser .

2) The X-ray beam interacts with the atoms in the sample, displacing electrons from the inner orbital shells of atoms it hits (most atoms have several electron orbitals, of which the lowest three are K shell, L shell, M shell).

3) The vacancy in the lower orbital shell is immediately filled by electrons from higher orbital shells moving inwards. Since electrons in higher shells possess more energy than those in lower shells an electron from (e.g.) shell L moving to fill a vacancy in shell K must lose energy so that it can integrate. It does this by emitting energy as characteristic 'secondary' (or fluorescent) x-rays.

4) The amount of emitted energy is equivalent to the difference in energy between the two electron shells, which is determined by the distance between them. Each element has a unique spacing of orbital shells, giving it a unique 'fingerprint'. By measuring the type and strength of fluorescence emitted by a sample it is possible to determine not only which elements are present, but in what quantities too. The corresponding intensities are converted to concentrations and reported as percentages (%) or parts per million (ppm).

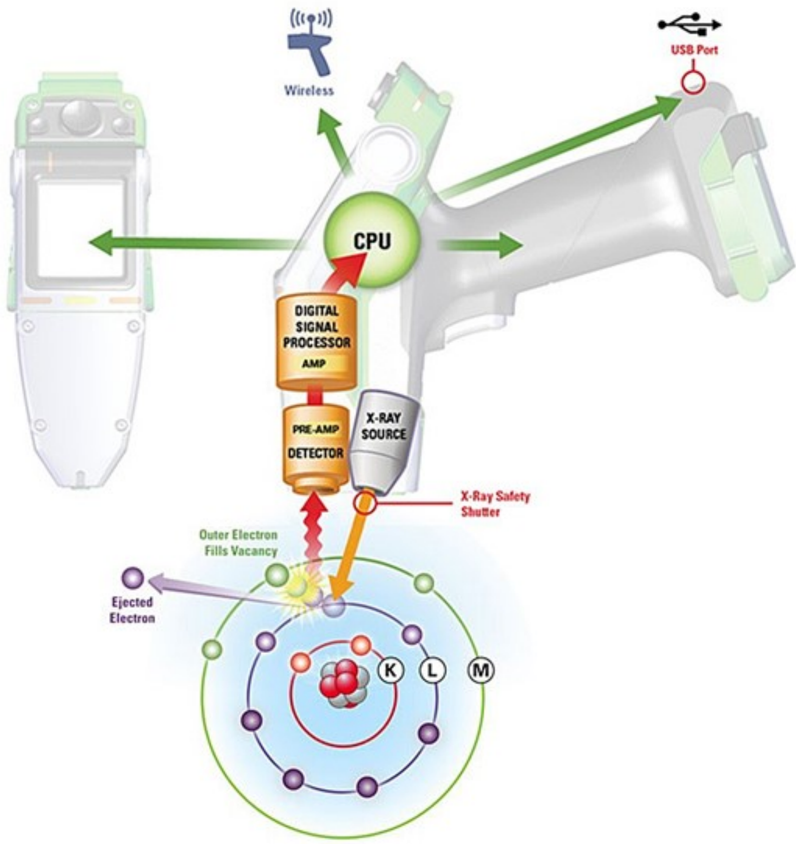


Diagram showing the operating process of X-ray fluorescence equipment
(picture: Thermo Fisher Scientific)

The entire fluorescence process occurs in small fractions of a second. A measurement using this process and a modern handheld XRF machine can be made in a matter of seconds.

Equipment

Today XRF is recognised as a mature and dependable technology, and FPXRF devices host this capability in a small handheld 1.5 kg ‘pistol’ package. This type of instrument has a number of salient features; as well as being light and portable, it is safe and user-friendly, with geologists and technicians requiring only a few hours training. It can analyse any type of geological or metal sample, from drill cores and cliff faces, to mineral concentrates and solid scrap. Readings are analysed on site, taking between 30 seconds and a few minutes depending on the level of precision that is required.

The modern FPXRF can measure up to 43 elements simultaneously, including the light elements such as aluminium (Al), phosphorus (P), silicon (Si), magnesium (Mg), and sulphur (S). Calibration factors can be adjusted by users to match their specific sample matrix type, with some instruments able to do this task internally by built-in type standardisation.

Some examples of field-portable X-ray fluorescence (FPXRF) equipment (photo: Thermo Fisher Scientific)

The handheld device uses a Li-ion battery, which lasts about eight hours, and a few models have built-in GPS, which records the coordinates for each sample that is analysed. Some of these devices can also be paired with external GPS/GIS devices in order to make geochemical maps in real time.

Some notes on using FPXRF

The two basic process innovations this technology affords the exploration industry are:

- Speed: The ability to see analytical results in real-time.
- Sample density: The ability to create many more data points in the same given amount of time.

However, while FPXRF is a remarkable technology it is not magic. To get the best results operator training, equipment calibration and sample preparation are essential.

Using FPXRF equipment on location
(photo: A.K. Somarin)

As with any specialist equipment, investing in operator training is strongly recommended, but with FPXRF analyzers it is advisable to also undergo radiation safety training prior to using the analyzer, due to the potentially harmful nature of x-rays.

Each instrument must be precisely calibrated in order to ensure the results are accurate. Calibration is the process where you confirm that your measurements are true by measuring against a standard. Usually calibration is done on the instrument before it gets shipped out of the manufacturer’s door, but as they are sometimes used in harsh environments regular recalibration is recommended.

It is important to also note that accuracy is increased considerably when a sample undergoes preparation such as pulverizing to generate a homogenous powder. The ideal sample for XRF analysis will have a perfectly flat surface. Irregular surfaces change the distance from the sample to the x-ray source and introduce error, potentially increasing or decreasing the apparent fluorescence levels of the various elements in the sample.

The re-birth of tantalum in Western Australia

Paper written by Ken Brinsden and Anand Sheth, Pilbara Minerals Ltd, and presented by Ken Brinsden on October 16th 2017, as part of the Fifty-eighth General Assembly in Vancouver, Canada. All views and opinions in this article are those of the authors and not the T.I.C.

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Introduction

In the past three decades, tantalum production from hard-rock resources in Western Australia carried the cost for lithium production, as a by-product, but this is now changing with the advent of e-transportation (electric vehicles and e-bikes) and energy storage solutions for the renewable energy sector, made possible by use of lithium batteries. The demand for lithium primarily in these new and burgeoning industries is expected to triple in the next decade. Lithium hard-rock deposits will become a significant supplier to this sector and several new lithium projects will be commissioned within the next two years in Western Australia and a few more in Canada.

Some of these new projects, including the existing largest lithium operations, have a significant capacity to produce tantalum as a by-product, at a very commercially profitable cost. These companies are located in risk free jurisdictions / countries, with operations that can produce and supply a high-quality product consistently at competitive prices. These operations will be sustainable and meet all the environmental and 'conflict-free' regulatory requirements. The presentation will discuss the production volumes and costs of tantalum concentrates as a by-product of several hard-rock lithium mines and shall provide an update on Pilbara's Pilgangoora lithium–tantalum project, soon to become one of the largest producers and suppliers of lithium and tantalum concentrates.

Disclaimer

A brief history of Australian tantalum

In the 1990s, Western Australian's (WA) share of the tantalum concentrates produced from mining operations globally was close to 75%, but this had dropped to approximately 65% by mid-2006, with advent of new tantalum operations and increasing artisanal mining. In these two decades, WA provided the stability of supply and pricing with high quality and consistent products to the major tantalum processors worldwide.

The two major mines in WA that were dedicated tantalum operations with lithium as a by-product were Greenbushes and Wodgina. However, the lithium demand and pricing were relatively low and therefore unable to economically support these operations prior to approximately 2015. These two mines were operated by Sons of Gwalia until 2004/05, when the company was split into Talison Minerals for lithium and Global Advanced Metals (GAM) for tantalum.

Greenbushes was shut down before 2004 as the demand and price fell and Wodgina alone could meet the global demand. By the end of 2010, with further deterioration in demand and pricing and increased artisanal production, Wodgina was put under care and maintenance. Although lithium demand growth commenced around 2005/06 it was not economical to sustain tantalum operations and WA lost its position as the World's leading supplier of tantalum concentrates (see figure 1).

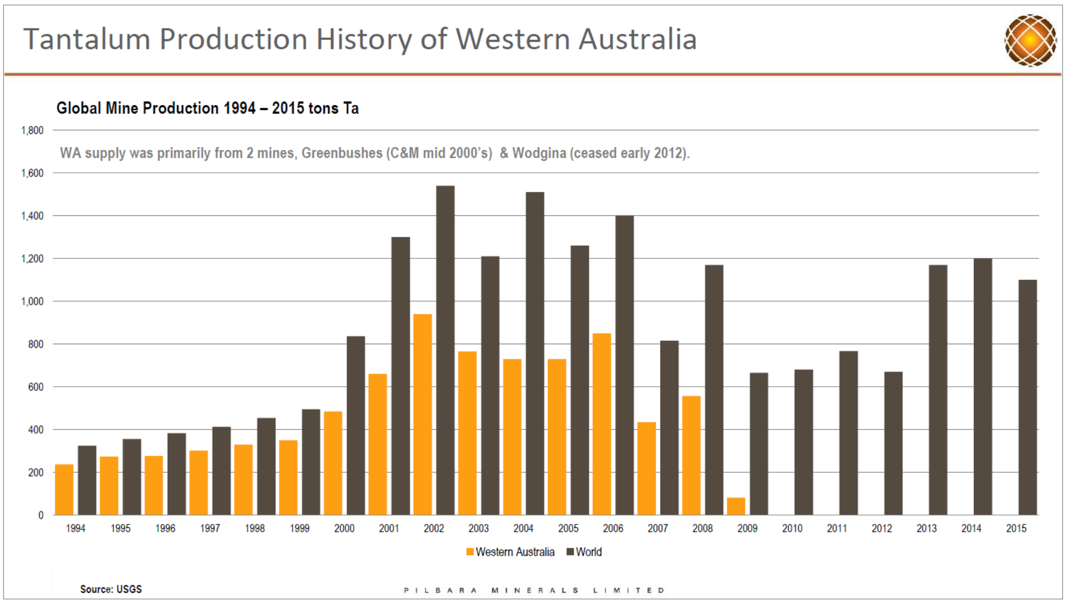


Figure 1: Global mine production 1994 - 2015 (tons Ta)

However, in the last 5 years, with the technology breakthrough and demand for cleaner air and reduction of greenhouse gas emissions (GHG) mandated by governments globally, lithium batteries have become the preferred choice of battery for e-transportation (electric vehicles and e-bikes) and energy storage solutions for the renewable energy sector. The demand for lithium raw material, mainly driven by the new and burgeoning lithium ion battery industry is expected to grow the lithium raw material supply base by a factor of 5 in the next 10 years.

Lithium hard-rock deposits will become a significant supplier to the battery sector as a result of their quality advantages and several new lithium projects will be commissioned within the next 2 to 5 years in Western Australia and a few more in Canada and Africa. Furthermore, low-cost hard-rock operations will be genuinely cost competitive to the brine sources of lithium raw material supply, as the industry overall is required to reposition its product quality to the dominant battery sector.

Tantalum, as a by-product of lithium operations, will become a major source of supply: stable, secure, consistent, high quality and competitively priced. Western Australia to once again become a major source of tantalum to underpin the future demand of the tantalum industry.

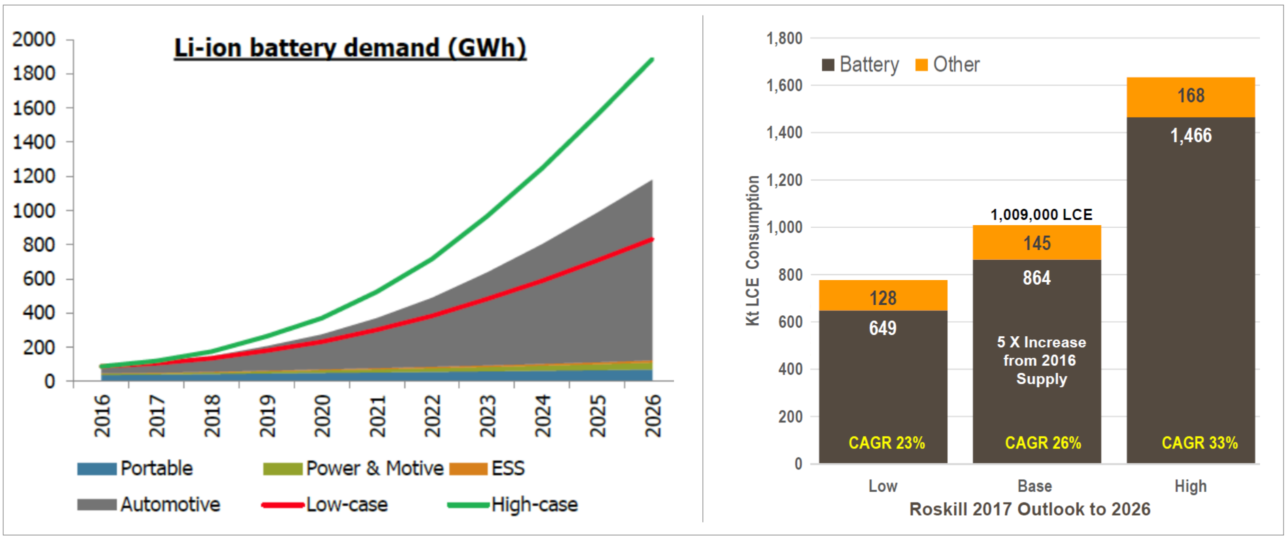


Figure 2: Forecasts of lithium battery demand (GWh) and lithium raw material consumption (Kt LCE) by Roskill

Demand for lithium raw materials is growing incredibly quickly, especially in China. The increase in demand is dominated by lithium rechargeable batteries.

There are two sources of lithium raw materials, brines and hard-rock, and demand is increasing for both. There are also two standard grades of lithium carbonate, technical-grade (~99%) and battery-grade (≥99.5%). In recent years the premium for battery-grade has ranged between US$1,200 to 3,500 per tonne. As a rule brines produce more technical-grade lithium carbonate. There are several implications from this development:

- Technical-grade vs battery-grade price variance is driven by segment demand
- The relative cost of achieving the higher battery-grade specification from input raw materials
- Spodumene concentrates are typically 'cleaner' than brine sources of supply and therefore can be readily upgraded to battery-grade lithium carbonate.

The net result is that hard-rock lithium raw material is a 'cleaner' source product, making it better suited to the new quality requirements of the battery industry. Economically, once the battery-grade quality adjustment is taken into account, hard-rock lithium raw material is a globally competitive product since the majority of brine production does not meet battery-grade specifications without additional investment.

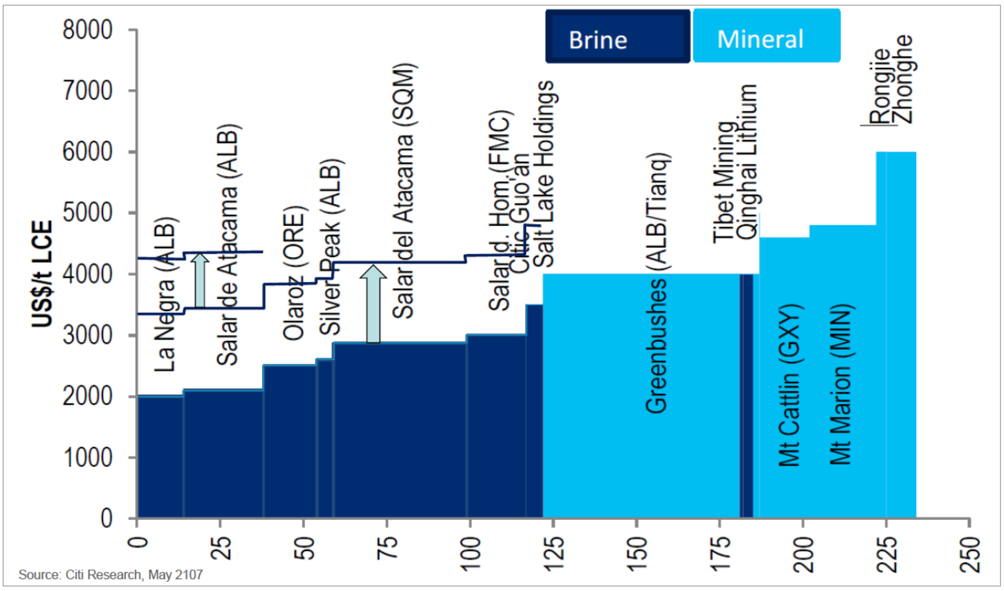


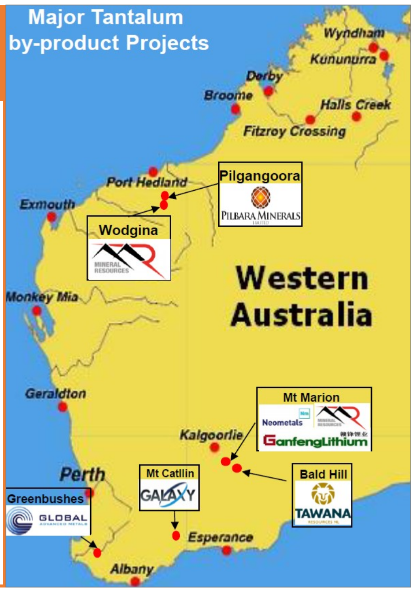
Figure 3: The cost curve for existing lithium operations

This means that conventional wisdom on the relative cost of brine versus hard-rock production is being broken down, and the growth in battery-grade demand favours further hard-rock supply to market because of its quality advantages (see figure 3). If, in the future, the battery industry demands still higher purity this could favour hard-rock production still more.

<u>How might this impact tantalum production?</u>

Due to increasing lithium demand from the battery industry lithium hard-rock mining is increasing. By 2020, the following projects are expected to be in production and can ramp or reduce supply based on market demand:

Company	Mine	Capacity[1] 2020, t Ta	Resource size and grade
GAM	Greenbushes	115	192Mt @157 ppm [2]
Pilbara Minerals Ltd	Pilgangoora	275[3]	156Mt @ 128 ppm
Minerals Resources Ltd	Wodgina	188	101Mt @ 171 ppm
AMA / Tawana	Bald Hill	110	12.8Mt @ 158 ppm
Galaxy	Mt Cattlin	37	16Mt @ 132 ppm
Neometals	Mt Marion	11	(tbc)
Total		**736**	
Forecast demand 2020[4]		2,181	
WA supply as % of total	demand	~34%	



1 - estimated from Roskill and company estimates; 2 - As of June 2003; 3 - Inclusive of stage 2; 4 - Roskill

Figure 4: Western Australian Tantalum Projects by 2020

According to Roskill the increased Australian tantalum production could result in a significant change in supply source of raw materials (see figure 5).

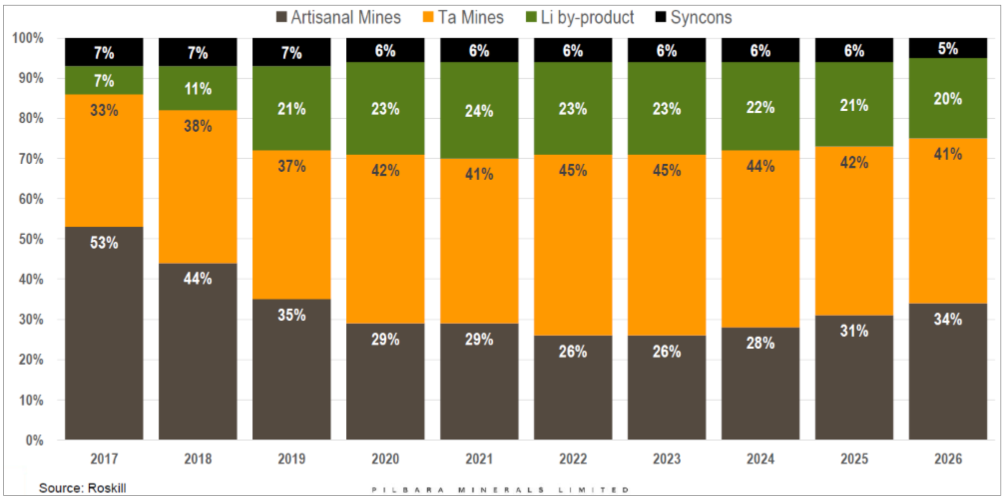


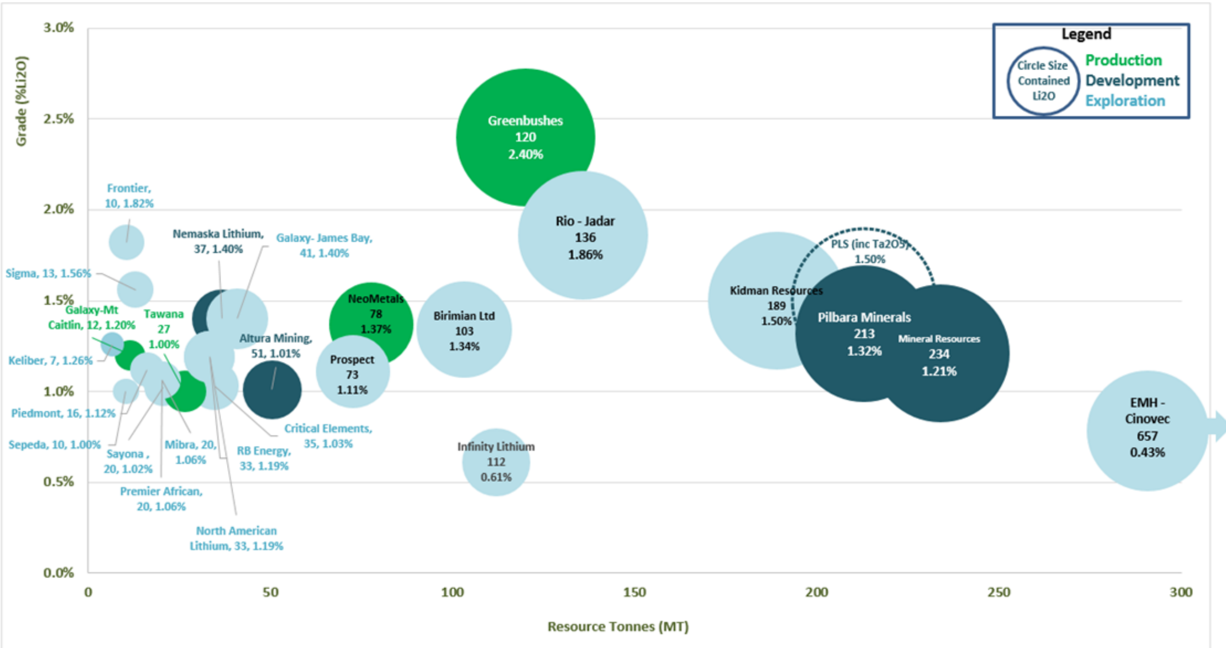
Figure 5: Tantalum by-product as an important new tantalum supply source

Some of these new projects, including the existing largest lithium operations, have a significant capacity to produce tantalum as a by-product, at relatively competitive costs. Furthermore, tantalum buyers should have some faith in the sustainability of this new tantalum by-product supply given the competitive overall cost and quality paradigm that is being newly established by the dominant battery demand for higher quality product.

The Pilgangoora Lithium-Tantalum Project

Pilbara Minerals' 100%-owned Pilgangoora Lithium-Tantalum Project, located 120km from Port Hedland in Western Australia's resource-rich Pilbara region, is one of the biggest new lithium ore (spodumene) deposits in the world, with a globally significant hard-rock spodumene resource. The Project is readily accessible by road, with relatively simple access to existing infrastructure (including downstream port facilities) at the existing port of Port Hedland. The latest global resource, as published in May 2018, incorporating all the results of a successful drilling program completed from January 2017 to April 2018, comprises a global measured, indicated and inferred resource of 213 million tonnes grading 1.32% Li_2O (lithia) and 116ppm Ta_2O_5 (tantalite) containing 2.82 million tonnes of Li_2O and 54.6 million pounds (20,000 t) of Ta_2O_5 (details at www.pilbaraminerals.com.au).

The most recent ore reserve estimate, published in June 2017, comprises a 'Proved and Probable Ore Reserve' of 80.3 million tonnes grading 1.27% Li_2O (lithia) and 123ppm Ta_2O_5 (tantalite) and 1.08% Fe_2O_3. Reserve estimation studies based on the 213Mt resource will be completed by December 2018.



Note: Tantalum adjusted resource size at Pilgangoora includes consideration of the spodumene equivalent revenue of tantalum by-product recovered and attributable to Pilbara Minerals over the LOM. Sources: Published resource estimates by project owners. Note that resources estimates for projects other than Pilgangoora may have been prepared under different estimation and reporting regimes and may not be directly comparable. Pilbara has not verified, and accepts no responsibility for, the accuracy of resources estimates other than its own. Readers should use appropriate caution in relying on this information.

Figure 6: Globally significant hard-rock lithium resources

The geology of Pilgangoora is a large pegmatite swarm and it will be exploited using conventional drill and blast and open pit mining, operating a 100 tonne mining fleet. Ore feed will be 2Mtpa, giving Pilgangoora an estimated mine life of 40 years. The LOM strip ratio of <4:1 (waste: ore tonnes) is attractive for the industry.

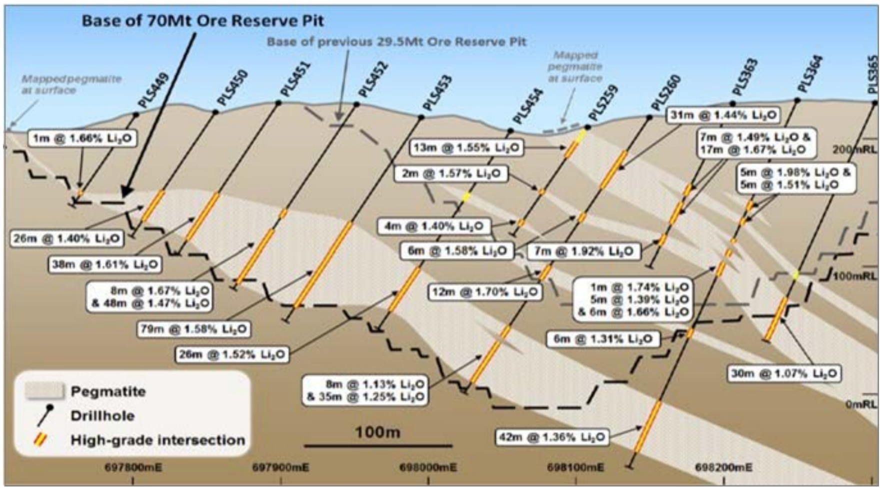


Figure 7: Cross-section (#7670300mN) of the Pilgangoora project

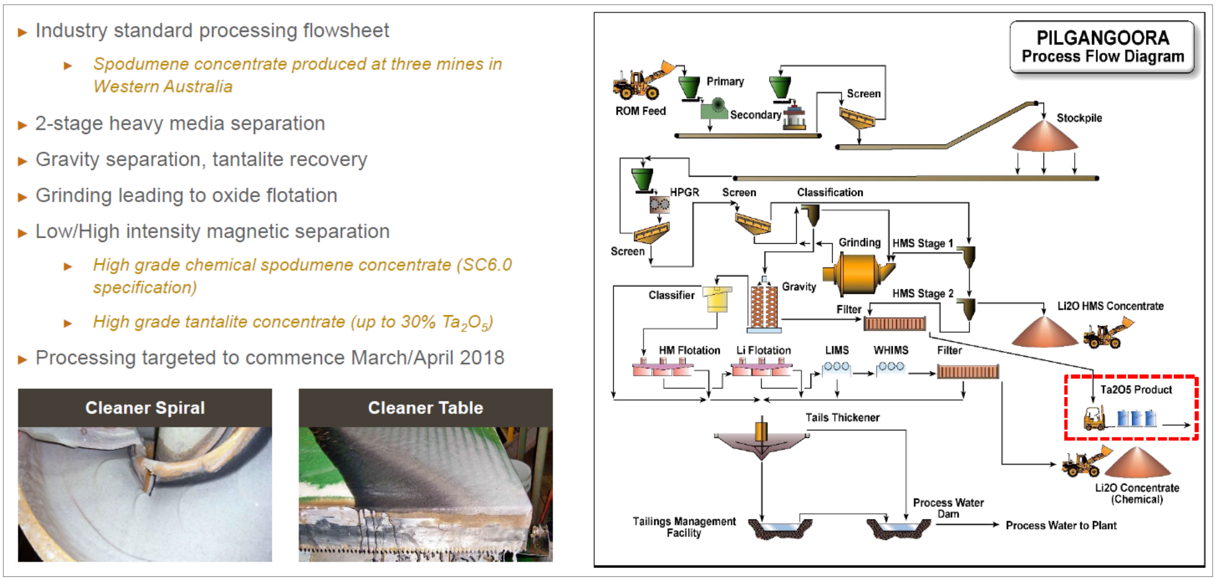


Figure 8: Pilgangoora processing: improved lithia and tantalite recovery

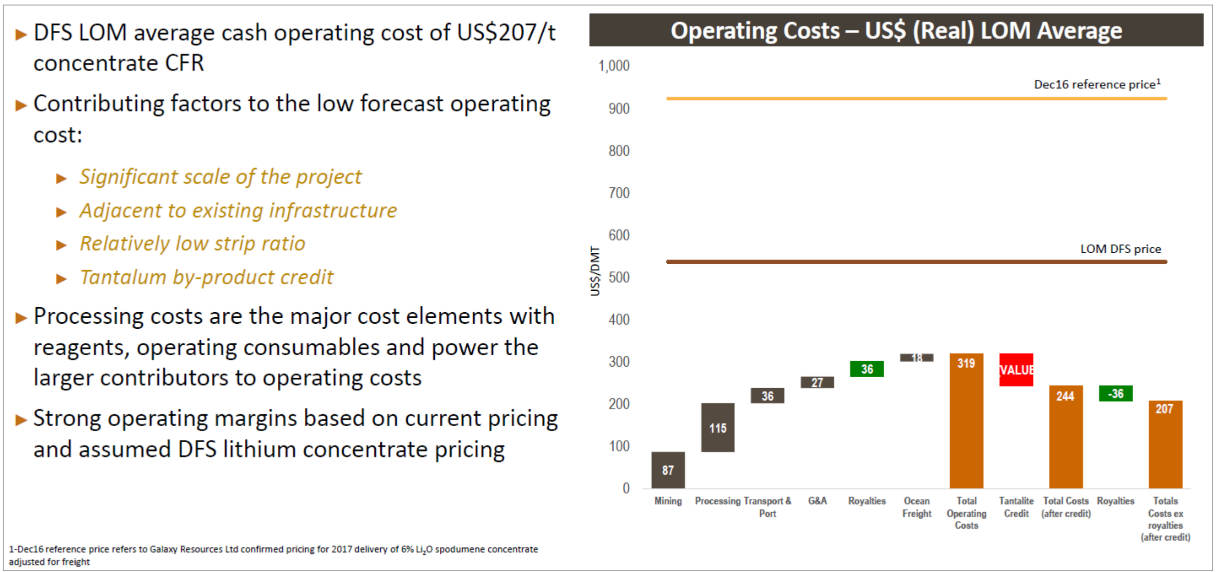


Figure 9: Pilgangoora's operating costs: Set to become one of the lower cost spodumene producers

Summary

Pilbara's Pilgangoora Project is expected to become one of the largest producers and suppliers of lithium and tantalum concentrates by 2020. Pilbara has committed to 40ktpa LCE from Stage 1 and an additional 72ktpa LCE from Stage 2 of chemical grade spodumene concentrate offtake sold to outstanding project partners for a minimum of 10 years to life of mine production. These are:

- Ganfeng Lithium, China for 41ktpa LCE
- General Lithium, China for 19ktpa LCE
- Great Wall Motor Company, China for 20kpta LCE
- POSCO, South Korea for 32ktpa LCE

Western Australia provides a risk free jurisdiction, with operations that can produce and supply a high quality product consistently at competitive prices. These operations will be sustainable and meet all the environmental and 'conflict-free' regulatory requirements. By combining large-scale, low-cost, high-quality lithium production with tantalum by-production there is every expectation that Western Australia will become an important source of tantalum in the foreseeable future.

Tantalum and niobium intellectual property update

Historically the T.I.C. reported those patents and papers that were relevant to the tantalum and niobium industries (2000-2007, available in the members' area at www.TaNb.org). Information here is taken from the European Patent Office (www.epo.org) and similar institutions. Patents listed here were chosen because they mention "tantalum" and/or "niobium". Some may be more relevant than others due to the practice by those filing patents of listing potential substitute materials. Note that European patent applications that are published with a search report are 'A1', while those without a search report are 'A2'. When a patent is granted, it is published as a B document. Disclaimer: This document is for general information only and no liability whatsoever is accepted. The T.I.C. makes no claim as to the accuracy or completeness of the information contained here.

Title		
Publication #	Applicant(s)	Publication date

TANTALUM

Title / Publication #	Applicant(s)	Publication date
Method for etching of tantalum thin films		
KR20180031228 (A)	UNIV INHA RES & BUSINESS FOUND [KR]	2018-03-28
Sputtering target		
WO2018058158 (A1)	PLANSEE SE [AT]	2018-04-05
Process for producing tantalum alloys		
UA116640 (C2)	ATI PROPERTIES LLC [US]	2018-04-25
Hydrogen phosphate ion sensor comprising a mixed oxide catalyst of ruthenium oxide and tantalum oxide		
EP3312601 (A1)	THE DOSHISHA [JP]	2018-04-25
Recovery method of high purity tantalum from tantalum scrap		
KR101853115 (B1)	RESEARCH INSTITUTE OF INDUSTRIAL SCIENCE & TECH [KR]	2018-04-27
Method for passivating tantalum metal surface and apparatus thereof		
IL228504 (A)	NINGXIA ORIENT TANTALUM IND CO LTD [CN]	2018-04-30
Implant for bone fixation		
US2018132914 (A1)	LIFE SPINE INC [US]	2018-05-17
Tantalum powder, anode, and capacitor including same, and manufacturing methods thereof		
US2018144874 (A1)	GLOBAL ADVANCED METALS USA INC [US]	2018-05-24
Tantalum capacitor including an anode lead frame having a bent portion and method of manufacturing the same		
US2018144875 (A1)	SAMSUNG ELECTRO MECH [KR]	2018-05-24
Tin oxide, electrode catalyst for fuel cells, membrane electrode assembly, and solid polymer fuel cell		
US2018175398 (A1)	MITSUI MINING & SMELTING CO [JP]	2018-06-21

NIOBIUM

Title / Publication #	Applicant(s)	Publication date
Anode materials for lithium-ion electro-chemical cells and methods of making and using same		
WO2018051290 (A1)	3M INNOVATIVE PROPERTIES CO [US]	2018-03-22
Method of depositing niobium-doped titania film on a substrate and the coated substrate made thereby		
US2018108457 (A1)	VITRO S A B DE C V [MX]	2018-04-19
Niobium-based alloy that is resistant to aqueous corrosion		
US2018127854 (A1)	AIMONE PAUL [US], YANG MEI [US]	2018-05-10
Catalysts for hydrogen evolution reaction including transition metal chalcogenide films and methods of forming…		
WO2018098451 (A1)	UNIV NORTH CAROLINA STATE [US]	2018-05-31
Method of forming a superconductor interconnect structure		
WO2018097925 (A1)	NORTHROP GRUMMAN SYSTEMS CORP [US]	2018-05-31
Method of obtaining wire from titanium-niobium-tantalum-zirconium alloys with the form memory effect		
RU2656626 (C1)	BAIKOV INSTITUTE OF METALLURGY AND MATERIAL SCIENCE [RU]	2018-06-06
Methods for forming a transition metal niobium nitride film on a substrate by atomic layer deposition…		
US2018158688 (A1)	ASM IP HOLDING BV [NL]	2018-06-07
Piezoelectric element and piezoelectric element device		
US2018175277 (A1)	SEIKO EPSON CORP [JP]	2018-06-21
Niobium silicide composite material, high-temperature component using same, high-temperature heat engine		
EP3339458 (A1)	MITSUBISHI HITACHI POWER SYS [JP]	2018-06-27
High-strength cold rolled steel sheet having high formability and a method of manufacturing thereof		
WO2018116155 (A1)	ARCELORMITTAL [LU]	2018-06-28

Member company and T.I.C. updates

Changes in member contact details

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

- **MMTA** is now at 1st Floor, 33 Queen Street, London, EC4R 1BR, UK. All other details are unchanged.
- **Mitsubishi Corporation RtM Japan Ltd** has appointed a new delegate, Mr Hajime Morimoto. He can be contacted at hajime.morimoto@rtm.mitsubishicorp.com.
- **Mitsui Mining and Smelting Co. Ltd:** the email of the nominated delegate has been changed to d_nakayama@mitsui-kinzoku.com, all other details are unchanged.
- **Pilbara Minerals Ltd:** the delegate's email has changed to awoolcock@pilbaraminerals.com.au, all other details are unchanged.
- **Vishay** has appointed a new delegate, Mr Efi Ben Baruch, Senior VP Division Head Tantalum Division. Mr Ben Baruch can be contacted at Efi.BenBaruch@vishay.com.

Diary of forthcoming events attended by T.I.C. staff

- CRM Alliance "Critical Raw Material Day" in Brussels, Belgium, September 27th
- London Metals Week 2018 in London, UK, October 8th to 10th
- **T.I.C.'s 59th General Assembly and annual general meeting in Kigali, Rwanda, October 14th to 17th**
- CRU-Ryan's Notes, Orlando, FL, USA, October 21st to 23rd
- RMI's Annual Conference in Santa Clara, CA, USA, October 31st to November 1st
- Raw Materials Week, Brussels, Belgium, November 12th to 16th
- IAEA's 37th TRANSSC meeting in Vienna, Austria, November 26th to 30th

Members of the Executive Committee of the T.I.C. 2017-2018

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

Conor Broughton	conor@amgroup.uk.com
John Crawley (President)	jcrawley@rmmc.com.hk
David Gussack	david@exotech.com
Jiang Bin	jiangb_nniec@otic.com.cn
Janny Jiang	jiujiang_jx@yahoo.com
Kokoro Katayama	kokoro@raremetal.co.jp
Raveentiran Krishnan	raveentiran@msmelt.com
Ben Mwangachuchu	bmwangaceo@smb-sarl.com
Candida Owens	owens.candida@cronimet.ch
Daniel Persico	danielpersico@kemet.com
Alexey Tsorayev	tsorayevaa@ulba.kz

Of these eleven, Mr John Crawley was elected President of the T.I.C. until October 2018.

The T.I.C. currently has the following subteams (chaired by): Marketing (Daniel Persico), Meetings (Candida Owens), Statistics (Alexey Tsorayev) and Supply Chain (John Crawley).

We are always looking for enthusiastic T.I.C. members to join the Executive Committee or one of our subteams. If you are interested in doing so and have a couple of hours each month spare, please contact director@tanb.org.

The Anders Gustaf Ekeberg Tantalum Prize: Shortlist 2018

The Anders Gustaf Ekeberg Tantalum Prize ('Prize') is awarded to the lead author(s) of the published treatise, paper or patent that is judged to have made the greatest contribution to advance the knowledge and understanding of the element tantalum (Ta). To be eligible for consideration the publication must be in English and be made between October 2016 and April 2018.

The winner will be chosen by the independent panel of experts and the Prize medal, made from pure tantalum metal, will be awarded at the 59th General Assembly in Kigali, Rwanda, in October 2018.

For further details about the Prize, please visit www.tanb.org/view/prize.

Title:	**Tantalum and niobium-based capacitors**
Author(s):	Yuri Freeman
Organisation(s):	Kemet Electronics Corp., South Carolina, USA
Full article at:	https://www.springer.com/gp/book/9783319678696
Title:	**Multistate memristive tantalum oxide devices for ternary arithmetic**
Author(s):	Wonjoo Kim[1], Anupam Chattopadhyay[3], Anne Siemon[2], Eike Linn[2], Rainer Waser[1,2], Vikas Rana[1]
Organisation(s):	1: Peter Grünberg Institut, Germany; 2: RWTH Aachen University, Germany; 3. Nanyang Technological University, Singapore.
Full article at:	https://www.nature.com/articles/srep36652.pdf
Title:	**A niobium and tantalum co-doped perovskite cathode for solid oxide fuel cells operating below 500 °C**
Author(s):	Mengran Li[1], Mingwen Zhao[2], Feng Li[2], Wei Zhou[3], Vanessa K. Peterson[4], Xiaoyong Xu[1], Zongping Shao[3], Ian Gentle[1] & Zhonghua Zhu[1]
Organisation(s):	1: University of Queensland, Australia; 2: Shandong University, China; 3: Nanjing Tech University, China; 4: Australian Nuclear Science and Technology Organisation, Australia.
Full article at:	https://www.nature.com/articles/ncomms13990.pdf
Title:	**Towards sustainable processing of columbite group minerals: elucidating the relation between dielectric properties and physico-chemical transformations in the mineral phase**
Author(s):	Sergio Sanchez-Segado[1], Tamara Monti[2], Juliano Katrib[2], Samuel Kingman[2], Chris Dodds[2], Animesh Jha[1]
Organisation(s):	1: University of Leeds, UK; 2: University of Nottingham, UK.
Full article at:	https://www.nature.com/articles/s41598-017-18272-3.pdf
Title:	**Evaluation of an artificial vertebral body fabricated by a tantalum-coated porous titanium scaffold for lumbar vertebral defect repair in rabbits**
Author(s):	Faqi Wang[1], Lin Wang[2], Yafei Feng[1], Xiaojiang Yang[1], Zhensheng Ma[1], Lei Shi[1], Xiangyu Ma[3], Jian Wang[1], Tiancheng Ma[4], Zhao Yang[1], Xinxin Wen[3], Yang Zhang[1], Wei Lei[1]
Organisation(s):	1: The Fourth Military Medical University, China; 2: First Affiliated Hospital of Xi'an Jiaotong University, China; 3: The 463 Hospital of Chinese Peoples' Liberation Army, China; 4: The company of 31681 Army, China.
Full article at:	https://www.nature.com/articles/s41598-018-27182-x.pdf
Title:	**Single-crystalline nanomesh tantalum nitride photocatalyst with improved hydrogen-evolving performance**
Author(s):	Mu Xiao, Bin Luo, Miaoqiang Lyu, Songcan Wang, and Lianzhou Wang
Organisation(s):	University of Queensland, Australia
Full article at:	https://onlinelibrary.wiley.com/doi/epdf/10.1002/aenm.201701605

