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TANTALUM-NIOBIUM
INTERNATIONAL STUDY CENTER

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What are critical metals?

(and why their definition depends on who you ask)

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Tantalum capacitors in 5G infrastructure

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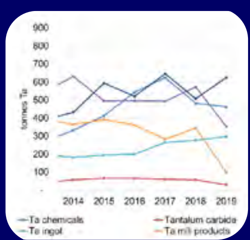

T.I.C.'s 62nd General Assembly

(conference and AGM) will take place in

Geneva, Switzerland,

September 19th - 22nd 2021

Non-members are welcome to attend this event. The T.I.C. General Assembly attracts industry leaders from around the world. Full details will be made available online at www.tanb.org. Our 2021 conference will explore issues such as mineral due diligence, capacitors, superalloys and superconducting magnets.

All questions about the General Assembly, including about sponsorship opportunities, should be sent to Emma Wickens at info@tanb.org. Full details will be published on www.TaNb.org and in future editions of the Bulletin.

CALL FOR PAPERS

Papers on relevant tantalum and niobium subjects are sought from members and non-members.

Welcome topics include:

- Raw materials and supply chain traceability
- Services to the Ta-Nb industry
- Primary processing and refining
- Secondary processing and metallurgy
- Capacitors, superalloys, HSLA steel and other key applications
- Research and development on new applications for tantalum and niobium

Talks are to be given in English and the general length of presentations is 20-25 minutes. Please submit your proposals for papers for the technical sessions by March 31st 2021. The final program is decided by the Executive Committee. Full papers must be submitted by September 1st 2021. All questions and requests for abstract submission forms should be sent to Emma Wickens at info@tanb.org.

The 62nd General Assembly will include the award ceremony for the 2021 Anders Gustaf Ekeberg Tantalum Prize, the annual award for excellence in tantalum research and innovation.

This year our field trip will be to CERN, one of the world's leading centres for scientific research (and a major user of niobium in superconducting magnets!).

President's Welcome

Dear Members and friends of the T.I.C.,

Let me start by wishing everyone a Happy New Year, realizing that this letter will most likely reach our Chinese friends before the Lunar New Year. I know we are all looking forward to getting back to a more normal environment in 2021. However, even with the emerging opportunities to receive Covid-19 vaccinations, we must all remain vigilant as there is a lot about this virus that remains a mystery and therefore, we must remain cautious and aware of our environment and the potential impact our actions may have on others.

The Executive Committee will be holding its quarterly conference call soon, on the agenda will be the usual update of the finances and recent Subteam activities. One item on the agenda will be a review of the virtual GA61 results as well as a discussion on the upcoming GA62. We are all working with the positive expectations of an in-person meeting in Geneva in September. Let's hope the world's environment cooperates with us on this endeavour.

In this Bulletin we will also report the results coming out of the Fall IAEA meetings, in particular the positive movement on the NORM initiative. Our efforts in this area remain a priority for the organization moving forward.

I am also happy to report on ITSCI's financial situation: while not totally resolved, they are financially stable at this time and their activities on the ground are meeting the needs of the tantalum community, according to the ITSCI Governance Committee. This is without ITSCI increasing 2021 membership fees or levy percentages. We will continue to engage with ITSCI, keeping a close watch on this situation, and report any changes in status that could impact our membership and the overall supply chain.

In closing, I look forward to hearing from you as we move through this year. I am eager to discuss your thoughts on what is most important to you individually and how the Executive Committee can work to serve you better.

Stay safe.

With sincere regards,

Daniel F. Persico, Ph.D., President

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主席致辞

亲爱的 T.I.C. 会员和朋友：

首先我在此祝大家新年快乐，相信这封信很可能会在农历新年之前送达我们的中国朋友。 我知道大家都期待2021年可以恢复到较正常的环境。 但是，即使现在已有可接种的预防冠状病毒（Covid-19）疫苗，我们仍必须保持警惕，因为这种病毒仍有很多地方是个谜。 因此，我们必须保持警觉性并了解我们的环境以及我们的行动可能对他人造成的潜在影响。

执行委员会将很快举行季度电话会议，议程内容将一如既往汇报最新财务状况和最近的小组活动。 议程上的其中一个项目是审视第61届虚拟会议（GA61）的效果以及讨论即将发布的第62届会员大会（GA62）。 我们都对9月在日内瓦举行的实体会议充满期待。 希望全球环境能在这一方面配合我们。

在本简报中，我们将报告国际原子能机构（IAEA）秋季会议的成果，特别是有关天然放射性物质（NORM）倡议的积极行动。 这个仍然是我们优先努力推进的事项。

我也很高兴向您报告 ITSCI 的财务状况： 虽然尚未完全解决，但他们目前的财务状况稳定，他们的实地活动也正在满足钽业的需求。 这是在我们不会增加2021年的会员费用或征费百分比而将继续与 ITSCI 保持联系，我们会密切关注他们的状况，并会向会员报告任何有可能影响我们会员资格和整个供应链的状态变化。

最后，我期待今年能听到您的回馈。 渴望与您讨论您个人最重要的想法，以及执行委员会如何为您提供更佳的服务。

请大家注意安全！

送上真诚的问候，

丹尼尔·佩尔西科博士（Daniel Persico），主席

Lettre du Président

Chers membres et amis du T.I.C.,

Permettez-moi de commencer par souhaiter à tous une bonne année, sachant que cette lettre parviendra très probablement à nos amis chinois avant le nouvel an lunaire. Je sais que nous avons tous hâte de revenir à une vie plus normale en 2021. Cependant, même avec les opportunités émergentes d'être vacciné contre la Covid-19, nous devons tous rester vigilants car il y a beaucoup d'aspects de ce virus qui demeurent un mystère et par conséquent, nous devons rester prudents et conscients de notre environnement et de l'impact potentiel que nos actions peuvent avoir sur les autres.

Le Comité Exécutif tiendra prochainement sa conférence téléphonique trimestrielle, avec à l'agenda la mise à jour habituelle des finances et les récentes activités des Groupes de Travail. Un point à l'ordre du jour sera un examen des résultats de la GA61 virtuelle ainsi qu'une discussion sur la prochaine GA62. Nous travaillons tous avec l'espoir d'une réunion en personne à Genève en septembre. Espérons que l'environnement mondial coopère avec nous dans cette entreprise.

Dans ce Bulletin, nous rendrons également compte des résultats des réunions d'automne de l'AIEA, en particulier le mouvement positif sur l'initiative NORM. Nos efforts dans ce domaine restent une priorité pour l'organisation.

Je suis également heureux de rendre compte de la situation financière d'ITSCI: bien que celle-ci ne soit pas totalement résolue, ils sont actuellement stables financièrement et leurs activités sur le terrain répondent aux besoins de la communauté du tantale. Ceci sans augmenter les frais d'adhésion en 2021 ni les pourcentages de prélèvement. Nous restons engagés avec ITSCI, surveillant de près cette situation, et signalerons tout changement de statut qui pourrait avoir un impact sur nos membres et la chaîne d'approvisionnement en général.

Pour terminer, j'ai hâte de vous entendre au cours de cette année. J'ai hâte de discuter de ce qui est le plus important pour vous individuellement et sur la façon dont le Comité Exécutif peut travailler pour mieux vous servir.

Prenez soin de vous.

Avec mes sincères salutations,

Daniel F. Persico, Ph.D., Président

社長のあいさつ

T.I.C.の親愛なるメンバーと友人様へ

明けましておめでとうございます。この手紙はお届けるできることは旧正月頃になるかと思い、新年快楽。2021年はもっと正常な環境に戻ることを期待しています。しかし、Covid-19ワクチン接種を受ける機会が生まれたとしても、このウイルスについては謎のままであり、したがって、私たちは自分の環境と自分の行動が他人に与える影響を注意深く認識し続ける必要があります。

実行委員会はまもなく第一四半期の電話会議を開催します。議題は、通常の財務と最近のサブチーム活動の更新にあわせて、新たな議題は1、仮想GA61の結果のレビューと、今後のGA62に関する議論です。私たちは、9月にジュネーブで開催されるように前向きな期待に取り組んでいます。この取り組みにおいて、世界の状況がその方向へ向かうことを願っています。

この会報では、秋に開催されたIAEA会合の内容、特にNORMイニシアチブの前向きな動きについても報告します。この分野での私たちの努力は、組織が前進するための優先事項であり続けます。　また、ITSCIの財政状況についても報告いたします。完全には解決されていませんが、現時点では財政的に安定しており、現場での活動はタンタルコミュニティのニーズを満たしています。これは、2021年の会費や課税率を上げることなく行われます。私たちは引き続きITSCIに関与し、この状況を注意深く監視し、メンバーシップとサプライチェーン全体に影響を与える可能性ある状況変化は報告していきます。

最後になりましたが、私は、メンバー皆様にとって何が最も重要であるか、そして実行委員会がより良いサービスを提供するためにどのように働きかけることがよいかを追及していきたく思いますので、いろんなご意見をお待ちしております。

今年もよろしくお願いいたします。

Stay safe

ダニエル・F・パースィコ、PhD、社長

Boas-vindas do Presidente

Caros membros e amigos do T.I.C.,

Gostaria de começar desejando a todos um Feliz Ano Novo, entendendo que esta carta provavelmente chegará aos nossos amigos chineses antes do Ano Novo Lunar. Sei que estamos todos ansiosos para retornar a um ambiente mais normal em 2021. Contudo, mesmo com o surgimento de oportunidades para recebermos vacinas contra a Covid-19, devemos todos permanecer vigilantes, pois há muito sobre esse vírus que ainda é um mistério e, portanto, precisamos permanecer cautelosos e conscientes de nosso ambiente e do potencial impacto que nossas ações podem ter sobre os outros.

O Comitê Executivo realizará sua teleconferência trimestral em breve, estando na agenda a habitual atualização das finanças e as recentes atividades das Subequipes. Outro item será a revisão dos resultados da GA61 virtual, assim como uma discussão sobre a próxima GA62. Estamos todos trabalhando com expectativas positivas de um encontro pessoal em Genebra, em setembro. Vamos torcer para que o ambiente mundial coopere conosco neste empreendimento.

Neste Boletim, também apresentaremos os resultados advindos das reuniões de outono da AIEA, em particular o movimento positivo sobre a iniciativa NORM. Nossos esforços nessa área continuam sendo uma prioridade para o avanço da organização.

Também estou feliz em relatar a situação financeira do ITSCI: embora ela não esteja totalmente resolvida, neste momento eles estão financeiramente estáveis e suas atividades de campo estão atendendo às necessidades da comunidade de tântalo. Isso sem aumentar as taxas de associação de 2021 ou os percentuais de contribuição. Permanecemos comprometidos com o ITSCI, acompanhando de perto esta situação e relatando quaisquer mudanças no status que possam impactar nossos membros e a cadeia de suprimentos em geral.

Por fim, gostaria de ouvir seus comentários à medida que avançamos neste ano. Estou ansioso para discutir suas ideias sobre o que é mais importante para vocês, individualmente, e sobre como o Comitê Executivo poderia trabalhar para atendê-los melhor.

Fiquem seguros.

Atenciosamente,

Daniel F. Persico, Ph.D., Presidente

The T.I.C.'s 61st General Assembly

The 61st General Assembly, including the 2020 general meeting, was held on October 12th online. The event was attended by leading tantalum and niobium participants from around the world and was generously sponsored by A&R Merchants Inc. (Gold sponsor) and held in association with MIRU, a leading Japanese news organisation and market analyst focused on metal markets.

In normal years the T.I.C. General Assembly is the world's leading international conference for tantalum and niobium. However, due to the ongoing Covid-19 global pandemic, the in-person conference that was originally planned to take place in Geneva, Switzerland, on October 11th – 14th 2020 was postponed to September 19th – 22nd 2021 and a virtual event arranged in its place. The safety of our delegates is our top priority and unfortunately the Covid-19 situation contained too many unknowable factors to allow us to proceed with confidence to hold an in-person conference in 2020.

The virtual event was attended by over 150 delegates and offered the same exclusive networking opportunities that an in-person conference provides, together with the high-quality presentations and panel discussions from industry leaders that you expect from the T.I.C.

General Meeting

During the meeting members passed motions including:

- Agreeing the minutes from the 2019 AGM held in Hong Kong, on October 14th 2019
- Approving seven corporate membership applications and two transfers of membership
- Electing 12 representatives from member companies to form the Executive Committee.

All documents pertaining to the General Assembly and meeting, together with the presentations and photos from the event, are currently available on the members' area of the Association's website or from the T.I.C. office.

Executive Committee elections

At the elections to the Executive Committee, held during the meeting, all ten current committee members stood for re-election and were re-elected. Mr Alex Bruno and Mr Dharam Kotecha were elected for the first time. Dr Daniel Persico, SVP Mergers & Acquisitions at KEMET Electronics Corporation, was elected President.

The Executive Committee 2020-2021 is (alphabetical by surname):

Alex Bruno	alex.bruno@hcstarcksolutions.com
Fabiano Costa	fcosta@amgmineracao.com.br
John Crawley	jcrawley@rmmc.com.hk
Silvana Fehling	silvana.fehling@taniobis.com
Ronald Gilerman	ronald.gilerman@armerchants.com
David Gussack	david@exotech.com
Jiang Bin	jiangb_nniec@otic.com.cn
Janny Jiang	jiujiang_jx@yahoo.com
Dharam Kotecha	dharam@halcyonmetals.com
Raveentiran Krishnan	raveentiran@msmelt.com
Candida Owens	candida.owens@btinternet.com
Daniel Persico (President)	danielpersico@kemet.com

The next AGM and elections will take place on September 20th 2021, during our 62nd General Assembly. The T.I.C. asks that Executive Committee members serve as individuals, not in their corporate roles.

New members

At the meeting seven new corporate members were elected and two companies transferred corporate membership. The transfers were from Specialty Metals Resources S.A. to Specialty Metals Resources Limited, and from Stapleford Trading Ltd to Stapleford Minerals and Metals Ltd.

Corporate membership of the T.I.C. is open to 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 academia, associations, government bodies and civil society.

Auxico Resources Canada Inc.

Address: 201 Notre Dame West, Suite 500, Montreal QC, H2Y 1T4, Canada
Website: www.auxicoresources.com
Delegate: Mr Christoph Ebeling
Email: christoph.ebeling@covemin.com

Central America Nickel Inc.

Address: 201 Notre Dame West, Suite 500, Montreal QC, H2Y 1T4, Canada
Website: www.centralamericanickeluaex.com
Delegate: Mr Christian Falk
Email: christian.falk@covemin.com

CONDOR Minerals Bolivia Srl

Address: Calle La Plata (8 este) No.11, Edificio Nano, DPTO: 314, Equipetrol Santa Cruz, Bolivia
Website: -
Delegate: Ms Candida Owens
Email: candida.owens@btinternet.com

Jiangxi Tuo Hong New Material Co., Ltd

Address: No. 3, Chunyi Road, Yichun Economic Development Zone, Jiangxi, China
Website: www.jxthxc.com
Delegate: Mr He Ji
Email: jxthxc@sina.com

Mister Oak Mining & Trading

Address: Padre Julio Maria Lombaerd Avenue, 1951, Macapá City, Amapá State, Brazil
Website: www.misteroak.com.br
Delegate: Mr Luis Cesar de Paiva Carvalho
Email: luis@misteroak.com.br

Rarus Mining

Address: Rua Vinte de Janeiro 1019, Boa Viagem, Recife, PE 51130 -120, Brazil
Website: www.rarusmining.com
Delegate: Ms Marina Cavalcanti
Email: marinacavalcanti@rarusmining.com

TAM International LP

Address: 1020-606 Spadina Cr. E, Saskatoon, SK S7K 3H1, Canada
Website: www.tamintl.ca
Delegate: Mr Kevin Loyens
Email: kevin.loyens@tamintl.ca

If you are interested in T.I.C. membership please visit https://www.tanb.org/view/join-today or contact the office for details on the benefits of membership and an application form.

Changes to the United States National Defense Authorization Act (NDAA) that may impact T.I.C. member companies

The United States *National Defense Authorization Act (NDAA)* authorizes funding and provides authorities for the US military and other critical national defense priorities.

With this in mind, the US National Defense Authorization Act of 2020 (NDAA 2020) includes a prohibition on the acquisition of sensitive materials from non-allied foreign nations. Section 849 of the NDAA 2020 expands the definition of **covered materials** described in 10 U.S.C. § 2533c: Prohibition on the acquisition of sensitive materials from non-allied foreign nations. Specifically, the Secretary of Defense may not procure any **covered material** melted or produced in any **covered nation**, or any end item that contains a **covered material** manufactured in any **covered nation**, except as provided by subsection (c).

Through the NDAA 2020, **"tantalum metals and alloys"** were added to the list of **covered materials** defined in 10 U.S.C. § 2533c. The list of previously covered materials was as follows:

A. samarium-cobalt magnets;
B. neodymium-iron-boron magnets;
C. tungsten metal powder;
D. tungsten heavy alloy or any finished or semi-finished component containing tungsten heavy alloy.

The **covered nations** include the Democratic People's Republic of North Korea, People's Public of China, Russian Federation and Islamic Republic of Iran. The applicability applies to prime contracts and subcontracts at any tier. The exceptions to the prohibition described in 10 U.S.C. § 2533c(c) are complex and subject to interpretation.

Further complicating the situation, the National Defense Authorization Act for Fiscal Year 2021 (NDAA 2021) was moved forward following Senate override of President Trump's veto. In approximately 5 years, Section 844 of NDAA 2021 will further revise and expand the prohibition at 10 U.S.C. § 2533c(a)(1) by replacing "material melted" by "material mined, refined, separated, melted" and further refining the definition of the COTS exception as below with regards to covered material content by weight. The forthcoming changes have been inserted in **[red]**.

§2533c. Prohibition on acquisition of sensitive materials from non-allied foreign nations

(a) **In General. -** Except as provided in subsection (c), the Secretary of Defense may not-

(1) procure any covered material mined **[material mined, refined, separated, melted]** or produced in any covered nation, or any end item that contains a covered material manufactured in any covered nation, except as provided by subsection (c); or

(2) sell any material from the National Defense Stockpile, if the National Defense Stockpile Manager determines that such a sale is not in the national interests of the United States, to-

(A) any covered nation; or

(B) any third party that the Secretary reasonably believes is acting as a broker or agent for a covered nation or an entity in a covered nation.

(b) **Applicability. -** Subsection (a) shall apply to prime contracts and subcontracts at any tier.

(c) **Exceptions. -** Subsection (a) does not apply under the following circumstances:

(1) If the Secretary of Defense determines that covered materials of satisfactory quality and quantity, in the required form, cannot be procured as and when needed at a reasonable price.

(2) To the procurement of an end item described in subsection (a)(1) or the sale of any covered material described under subsection (a)(1) by the Secretary outside of the United States for use outside of the United States.

(3) To the purchase by the Secretary of an end item containing a covered material that is-

(A) a commercially available off-the-shelf item (as defined in section 104 of title 41), other than -

(i) a commercially available off-the-shelf item that is 50% or more tungsten **[covered material]** by weight; or

(ii) a mill product, such as bar, billet, slab, wire, cube, sphere, block, blank, plate, or sheet, that has not been incorporated into an end item, subsystem, assembly, or component;

(B) an electronic device, unless the Secretary of Defense, upon the recommendation of the Strategic Materials Protection Board pursuant to section 187 of this title, determines that the domestic availability of a particular electronic device is critical to national security; or

(C) a neodymium-iron-boron magnet manufactured from recycled material if the milling of the recycled material and sintering of the final magnet takes place in the United States.

Based on the changes in NDAA 2020, and the forthcoming changes as a result of NDAA 2021, as described above, it is suggested that T.I.C. member companies that supply tantalum material to the US defense industry should take a deep dive into their supply chain and determine how such regulations potentially impact their business. TIC

A fresh examination of NORM transport regulations

The T.I.C. invests a lot of time working with regulators and other stakeholders on issues concerning Naturally Occurring Radioactive Materials (NORM). As reported in Bulletin #180 and Bulletin #182, currently the Association is part of the NORM Exemption Group within TRANSSC[1] at the International Atomic Energy Agency (IAEA). This group is charged with examining the regulations that apply to the transport of NORM. This is a rare opportunity to reconsider how best to regulate global NORM transport and the T.I.C. will endeavour to keep members and stakeholders informed of opportunities to provide their support so that the IAEA's working group can reach the best possible decision.

Safe transport of NORM

The safe transport of tantalum- and niobium-containing raw materials (which can be naturally radioactive) is essential to human life and health and the environment, and also to industry and society as a whole. The global nuclear industry has consistently supported the ALARA principle of seeking levels as low as reasonably achievable, all social and economic factors considered.

However, this principle would be misapplied if interpreted as necessitating efforts to eliminate the alleged individual risk arising from extremely low doses of radiation, since doses in this range fall well within the normal variability in levels of natural background radiation.

The safe transport of NORM is essential to human life and health and the environment, and also to industry.

The T.I.C. believes that the current cut-off (exemption) level of 10 Becquerels per gram (Bq/g) for transport of NORM is an example of the ALARA principle being misapplied to set the exemption level unrealistically low; a level that is unduly restrictive, unnecessarily cautious and deprives society of the many benefits that NORM can provide.

The IAEA NORM exemption group

The NORM Exemption Group at TRANSSC was set up a little over a year ago to look at the exemption regulations that apply to the transport of NORM. Within TRANSSC it forms part of TRANSSC's Technical Transport Expert Group (TTEG) on Radiation Protection (RP) and is led by Mr Tiberio Cabianca of Public Health England (interviewed in Bulletin #182). The group comprises technical experts from around ten national regulators and other global bodies, including the T.I.C.

The work of this group centres on examining the differences in the exemption provisions between the 'new Basic Safety Standards' (General Safety Requirements Part 3 (GSR Part 3)) and the transport regulations (Safety Standards Series 6 (SSR-6)). [GSR Part 3 is one of the core IAEA regulations which other IAEA regulations should be consistent with]. The group is also checking for inconsistencies in the guidance that comes with the transport regulations (SSG-26) too.

The transport regulations are unique and written in a different way to the new Basic Safety Standards because they deal with a particular activity that has specific requirements. Over time this has resulted in several inconsistencies appearing between the two sets of regulations, for example there is a particular clause in GSR Part 3 relevant to NORM which is not applied to transport of radioactive material in bulk, but most experts agree probably should apply.

1 - TRANSSC: Transport Safety Standards Committee of the International Atomic Energy Agency, the committee responsible for reviewing and revising the regulations for the transport of radioactive material.

2 - In 2018, Germany made a proposal at the International Maritime Organisation (IMO) Sub-Committee on Carriage of Cargoes and Containers (CCC) to increase the NORM cut-off from 10 Bq/g to 30 Bq/g, resulting in IMO asking IAEA for advice. IAEA delegated the decision to the Transport Safety Standards Committee (TRANSSC) and the NORM exemption group was created to address the subject (see Bulletins #180 and #182 for details).

The current situation and the path ahead

In November 2020 at the 41st TRANSSC meeting (held virtually due to the Covid pandemic) Mr Cabianca updated the delegates on the progress made by the NORM Exemption Group and informed them that the next steps would involve making exposure models and calculating the radioactivity which transport workers could experience, specifically a truck driver, a warehouse worker and a ship crew member.

Exposure modelling will allow TRANSSC to determine transport specific values for NORM that are based on relevant information and are robust enough to give confidence that people are not unduly exposed. This is a common methodology when examining radiation protection issues. The work will include a review of past studies and T.I.C. members can support this work by providing information on typical working practices in our industry; how is their material transported, what is the geometry, distances, how long for, and so forth?

It is expected that preliminary results will be presented at the 42nd TRANSSC meeting, scheduled to be held in June 2021. The whole purpose of the exemption group is ultimately to calculate new values for all naturally occurring radionuclides which will be more accurate (and less restrictive) than the current ones.

Looking further ahead, generating better data is not the end of the process, as Mr Cabianca explained to delegates of the T.I.C.'s 61st General Assembly. The new values will then need to be included in updated transport regulations to become effective; a process which may take some time. However, while change may still be some way off, the ground-breaking work of the NORM Exemption Group is "the biggest thing to happen in NORM for 20 years", according to a seasoned TRANSSC observer, and is likely to have a major impact on how NORM transport is considered for years to come.

This is a rare opportunity to reconsider how best to regulate global NORM transport and the T.I.C. will endeavour to keep members and stakeholders informed of opportunities to provide their support so that the IAEA's working group can reach the best possible decision. TIC

What is NORM?

NORM stands for *naturally occurring radioactive materials.*

Radioactivity is a natural phenomenon and some mineral raw materials contain traces of thorium (Th) and uranium (U), making them NORM.

This includes some niobium- and tantalum-containing minerals, uranium ores, monazite for rare earth elements, zircon concentrates, and phosphate fertilizers.

International sea transport of NORM is common since processing facilities are often far from mine sites.

The IAEA sets the international transport exemption level for defining radioactive and non-radioactive materials, and this level is often, but not always, adopted by countries for their internal transport regulations too.

Today the cut-off for sea transport is 10 Bq/g and materials below 10 Bq/g are considered to be normal non-radioactive cargo.

Materials over 10 Bq/g must be transported as "radioactive" in full compliance with the Class 7 regulations set out by the International Maritime Organisation's (IMO) International Maritime Dangerous Goods (IMDG) Code (see inset below on how to calculate Bq/g).

Measuring 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). The conversion factors applied are as follows:

For elemental Th/U:	For Th/U oxide:
1% Th = 40.6 Bq/g	1% ThO_2 = 35.6 Bq/g
1% U = 123 Bq/g	1% U_3O_8 = 104 Bq/g

Material below 10 Bq/g is exempt from radioactive transport Class 7 regulations and can be shipped as general cargo. Material above 10 Bq/g must be transported fully Class 7 compliant and the higher regulatory burden and the risks involved may deter a carrier or port from accepting NORM shipments, resulting in a denial of shipment (DoS). Over the last decade DoS has increased due to many shipping lines merging. Further guidance is available in 8 languages from the T.I.C. office or online at https://www.tanb.org/view/transport-of-norm.

The Anders Gustaf Ekeberg Tantalum Prize:

The Panel of Experts 2021

Recognising excellence in tantalum research and innovation

The Ekeberg Prize is the annual award for excellence in tantalum research and innovation in tantalum (Ta), and, while it is administered by the T.I.C., it is an independent Panel of Experts that is responsible for selecting the winning publication each year. The Panel plays a crucial role in the Ekeberg Prize and there can be no doubt that the rapid adoption in our industry of the Ekeberg Prize is due in large part to the gravity, reach and intellectual weight which the Panel provides.

Since 2018 the Panel's chair has been Richard Burt, a former T.I.C. President with over 40 years' experience in our industry, but after three groundbreaking years Richard has decided it is time to step down from both his role as chair and the Panel itself.

Richard's support of the Ekeberg Prize has been an important factor in its success and his contributions should not be underestimated. On behalf of everyone at the Association, we heartily thank Richard for everything he's done for the prize and the T.I.C. overall, and wish him all the best for the future.

Looking ahead, we are privileged to be able to announce that the new chair of the Panel of Experts will be Dr Axel Hoppe.


Richard Burt (left) and Dr Axel Hoppe, respectively the outgoing and incoming chair of the Panel of Experts

Dr Hoppe holds a doctorate in chemistry and has worked in the tantalum industry for many years. He has published several papers on the subject and holds various tantalum patents. For over 30 years Dr Hoppe worked at H.C. Starck, then a subsidiary of Bayer (since renamed TANIOBIS). He was a member of the T.I.C.'s Executive Committee for 10 years (1997–2007), including serving two terms as President (2001-2 and 2006-7). He has been a member of the Panel since 2018 and is well known and respected in our industry.

Joining Dr Hoppe on the Panel of Experts for 2021 will be:

- Professor Elizabeth Dickey, North Carolina State University, United States of America
- Magnus Ericsson, adjunct professor at Luleå University of Technology, Sweden
- Dr Nedal Nassar, U.S. Geological Survey (USGS), United States of America
- Professor Toru Okabe, Institute of Industrial Science, The University of Tokyo, Japan
- Tomáš Zedníček Ph.D., President of the European Passive Components Institute (EPCI), Czech Republic

The Anders Gustaf Ekeberg Tantalum Prize 2021:

The Ekeberg Prize is open to any published paper or patent that is judged to advance knowledge and understanding of tantalum. To be eligible the publications should be written in English and dated between September 2019 and March 2021. Submissions must be received by the T.I.C. office before May 31st 2021.

The winner of the Ekeberg Prize receives his/her award at the Association's annual General Assembly.

Full details will be posted at www.TaNb.org in due course.

Tantalum capacitors in 5G infrastructure

Paper written by Dr Tomas Zednicek of the European Passive Components Institute (EPCI) and based on a presentation given at the T.I.C.'s 61st General Assembly. All views and opinions in this article are those of the author and not the T.I.C.

Contact the author: tom@passive-components.eu

www.passive-components.eu

Introduction

Tantalum capacitors offer excellent stability in harsh conditions, high energy and power volumetric efficiency and low parametric shift with lifetime, properties which make them ideal in several applications for the fifth generation (5G) of telecommunications (telecom) equipment. 5G telecom networks are forecast to rapidly become the next standard, providing faster data and better connections for smart phones, industrial applications, autonomous vehicles and smart cities.

The result is that 5G phone networks are creating an exponential increase of global data traffic and mobile data that the electronic hardware and infrastructure must support.

For many years previous generations of telecom base stations, switchers and other internet networking hardware have been using tantalum capacitors due to their long life, stability and reliability in various applications, including for DC/DC converter filtering and coupling/decoupling. The hardware has a typical lifetime of 12-15 years that mostly excludes conventional aluminium electrolytic capacitors from bulk capacitance applications.

A short comparison between 4G and 5G

What is the difference between 5G and the current telecom system (4G)? The current system of equipment, called LTE, is capable of communicating much faster than, but remained recognisable to, previous generations of equipment. However, 5G is different. The aims of the new system are similar to previous generations – increased bandwidth, better connections, a higher data handling capability, increased speed – but to achieve them a higher frequency will be used and this requires a step change in equipment.

There are limitations when using higher frequencies, in particular a much smaller working range. For example, to achieve very high speed processing on the highest 5G frequencies (6-60 GHz) the range could be just 300m from the base station tower; a far smaller range than a 4G tower. Therefore, the 5G system will not only take over the existing 4G towers, but will also require many smaller additional towers to be constructed too, to capture the full potential of this new technology to create smart cities.

It is forecast that the new 5G system in smart cities will radically change the nature of generators and customers of mobile data since autonomous vehicles generate and use vastly more data than the total requirements of smart phones. In fact, the amount of data for a single autonomous (self-driving) vehicle could be over 4,000 GB per day.

Parameter	4G	5G	
	4G LTE	5G (Sub-6G)	5G (mmWave)
Frequency	2.1GHz	2-6 GHz	6-60GHz
Downlink Speed	1.2 Gbps	6.5 Gbps	18 Gbps
Latency	10-30ms	5-6ms	< 1 ms
Average Range (from a tower)	10km	1-6km	300m
Device Coverage Density	1 million devices per 500km^2	1 million devices per 100km^2	1 million devices per 1km^2
Implementation	Macro Base Stations	Macro Base Stations	Micro Base Stations & Small Cells

Figure 1: A comparison of key technology standards between 4G and 5G

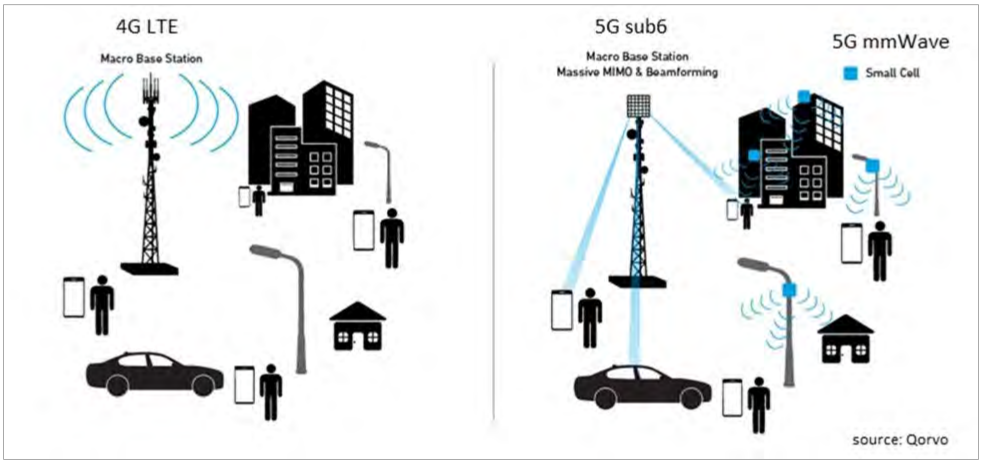


Figure 2: A visual comparison between 4G and 5G (picture: Qorvo)

Consequences on a component level

5G mmWave component requirements will include small dimensions, stable parameters in a wide range of operating temperatures and/or harsh environments, and long term reliability. It should also possess small dimensions. The high stability of electrical parameters and long term reliability are exactly what is required, while an additional benefit is the low profile design which supports small applications.

Ta Capacitors Key Features	Functionality	Circuit Benefit
High Stability of Electrical Parameters	Stability of parameters in harsh environment	Wide operating temperature; Stable performance at various working conditions (VAC,VDC, frequency)
Long Term Reliability	Long term reliable operation	
High Volumetric Efficiency	High energy density in small size and low profile	small size SMPS output filtering; Battery Back Up
		Battery back up; high energy bank / local storage

Figure 3: Tantalum capacitor benefits

Tantalum capacitors in telecom equipment: GaN semiconductors for 5G base stations

Another challenge related to the next generation of electronics for telecom base stations is an evolution from silicon semiconductors to gallium nitride (GaN) semiconductors. Compared with existing technologies (silicon LDMOS and gallium arsenide (GaAs)), GaN devices meet the requirements of 5G high-frequency telecom networks, offering higher switching frequency, higher efficiency and supply higher power in a smaller, thinner design. These units use tantalum capacitors which are capable of meeting the demanding performance requirements (see Bulletin #175 for a more in-depth discussion of GaN).

Figure 4: An example of a RF GaN power amplifier with a tantalum capacitor (circled) (photo: Cree)

Rack design for 4G and 5G base station circuit boards

On boards designed in 2014 by Ericsson and Nokia for use in a typical 4G base station there were respectively 58 and 115 tantalum capacitors. This included their use on the data handling board, system control power source, antenna control and the communication board.

Figure 5: The design of a BS NOKIA 4G rack (~2014) carrying 35 D/E tantalum capacitors (photos: Kaizer Power Electronics YouTube Channel)

While it may appear tantalum capacitors were well established on 4G boards, in 2016 cost-cutting by telecom equipment manufacturers saw the use of tantalum capacitors reduced considerably. Nokia Siemens even created a version containing no tantalum capacitors at all; on the power supply board tantalum capacitors were replaced by aluminium capacitors, while on the main CPU tantalum capacitors had been replaced by ceramic capacitors.

Will 5G boards use tantalum capacitors?

Most likely, yes, they will. The combination of low profile, high capacitance density and reliability in harsh environments makes tantalum capacitors a viable design choice. Although teardowns of the 5G hardware designs themselves have not been made public at time of writing, the latest designs for small 4G base stations by Huawei include at least 8 low-profile “D” tantalum capacitors and it is expected that the first generation of 5G base stations will follow a very similar design.

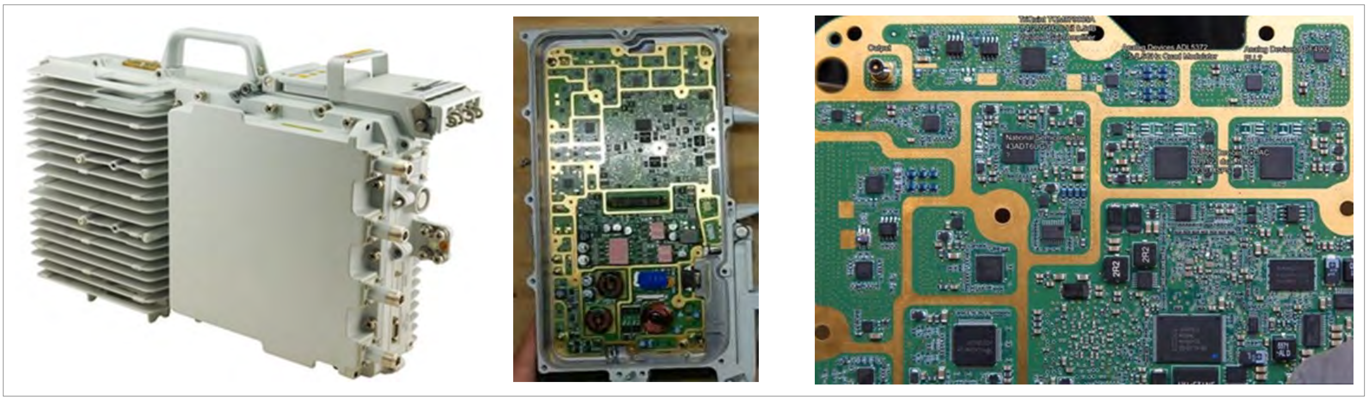


Figure 6: 2018 Small BS Huawei 4G LTE carrying at least 8x low profile D case tantalum capacitors (photos: Kaizer Power Electronics YouTube Channel)

Conclusion

Tantalum capacitors have been part of telecom base station designs for many years and look set to remain so for years to come.

While it is technically possible to create a 4G base station which doesn’t use any tantalum capacitors, the far more demanding operating requirements of 5G base stations mean that they will use tantalum capacitors. As the next generation of telecom networks are constructed there will be an increase in the consumption of tantalum capacitors in this application on both the main circuit boards and the GaN RF power amplifier.

Figure 7: Ericsson 5G micro base station in an urban environment (photo: Ericsson)

For a list of references and further information on this subject please visit www.passive-components.eu.

The 2020 Critical Raw Materials list for the EU

In September 2020 the European Union (EU) published its fourth Critical Raw Materials (CRM) list for the EU[1]. The list of 30 materials includes both niobium and tantalum, a position which is unchanged from the previous (2017) list.

The T.I.C. has followed this project closely through its membership of the TARANTULA Project (https://h2020-tarantula.eu) and the CRM Alliance (www.criticalrawmaterials.org). The Association was contacted for information by analysts working on this project on behalf of the European Commission, although the EU's methodology prevents industry stakeholders from proposing a position regarding the inclusion or exclusion of either element[2].

The 2020 list

The 30 raw materials listed below were chosen from a shortlist of 83 individual materials. Those on the list are deemed to be critical for the EU because risks of their supply shortage and impacts on the economy are higher than those of most other raw materials. According to the analysis behind the new list, since 2017 the supply risk for tantalum has increased, while niobium has seen an increase in both supply risk and economic importance.

Antimony	Cobalt	Heavy REEs*	Natural rubber	Silicon metal
Baryte	Coking coal	Indium	Niobium	Strontium
Bauxite	Fluorspar	Lithium	PGMs	Tantalum
Beryllium	Gallium	Light REEs*	Phosphate rock	Titanium
Bismuth	Germanium	Magnesium	Phosphorus	Tungsten
Borates	Hafnium	Natural graphite	Scandium	Vanadium

* REEs - rare earth elements

The 2020 list confirms 26 of the 2017 CRMs. Three CRMs in the 2020 list were not considered as critical in the 2017 list: bauxite, lithium and titanium. Conversely, helium, critical in the 2017 CRM list, is no longer in 2020. Strontium is the only material that appears for the first time in the 2020 list of CRMs.

All raw materials, even when not classed as critical, are important for the EU economy. The fact that a given material is classed as non-critical does not imply that availability and importance to the EU economy can be neglected. Moreover, the availability of new data and possible evolutions in EU and international markets may affect the list in the future.

Development of the CRM list

The EU's initial Raw Materials Initiative was first developed in 2008 to tackle the challenges related to what it saw as access to raw materials during a period commonly described as a Chinese-driven commodities 'supercycle', a period of relatively high commodity prices. The first list of 14 critical raw materials was produced by the European Commission in 2011 and included both tantalum and niobium. Tantalum was not a CRM in the second list but was in the third list. Niobium has been on all four lists.

Purpose of the EU's CRM list

The EU is one of many government bodies around the world that monitor the consumption and supply patterns of raw materials within their territory. For some the purpose is military in nature, but for the EU the primary purpose of the list is economic: to identify the raw materials with a high supply risk and a high economic importance to which reliable and unhindered access is a concern for European industry and value chains.

The list provides a factual tool for trade, innovation and industrial policy measures to strengthen the competitiveness of European industry in line with the renewed industrial strategy for Europe, for instance by:

- identifying investment needs which can help alleviate Europe's reliance on imports of raw materials;
- guiding support to innovation on raw materials supply under the EU's Horizon 2020 research and innovation program;

- drawing attention to the importance of critical raw materials for the transition to a low-carbon, resource efficient and more circular economy.

Although the list is only advisory (and doesn't give exemption to REACH or other EU legislation) the list is expected to encourage the EU member states to incentivise domestic production of critical raw materials through enhancing recycling activities and when necessary to facilitate the launching of new mining activities. It also allows to better understand how the security of supply of raw materials can be achieved by diversifying sources of supply and through increased substitution away from those materials on the CRM list. It is also used as a supporting element when the EU is negotiating trade agreements, challenging trade-distortive measures, developing research and innovation actions.

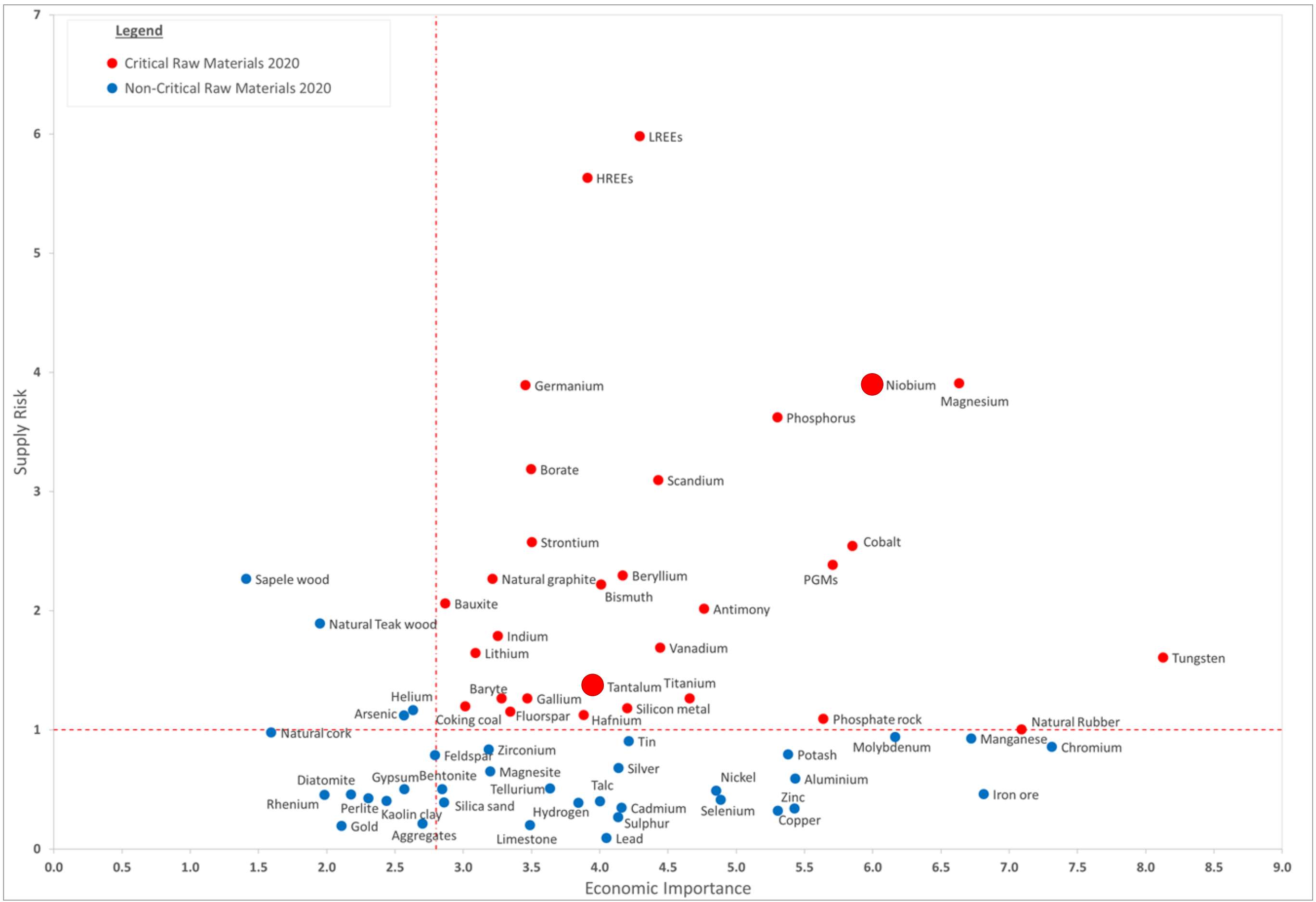


Figure 1: The materials assessed for criticality in 2020 clearly show that those with higher Economic Importance and Supply Risk are those that are considered to be critical. Materials on the new CRM list are red dots, while blue dots show non-critical materials. (Image: EU)

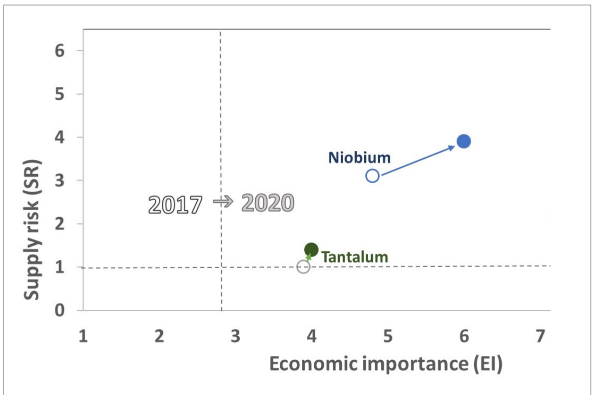


Figure 2: The criticality of tantalum and niobium in 2017 and 2020. However, the assessment methodology is revised in every list, making direct comparisons between the different lists potentially misleading. (Image: TARANTULA)

Methodology

To support the new CRM list the European Commission publishes a comprehensive guide to its methodology, a prescriptive document containing the guidelines and the 'ready-to-apply' methodology for the EU criticality assessment. Economic importance (EI) and supply risk (SR) remain the two main parameters used to determine the criticality of a raw material (see figure 1).

Economic importance aims at providing insight into the condition of a material for the EU economy in terms of end-use applications and the value added of corresponding EU manufacturing, and is corrected by a substitution index related to technical and cost performance of the substitutes for individual applications.

(continued)

Supply risk reflects the risk of a disruption in the EU supply of the material and is based on the concentration of primary supply from raw material producing countries, considering their governance performance and trade aspects.

Depending on the EU import reliance, consideration is given to the global pattern of production and also from which countries the EU sources its raw materials. Supply risk is measured at the ‘bottleneck’ stage of the material (extraction or processing) which presents the highest supply risk for the EU. Substitution and recycling are considered risk-reducing measures.

CRMs and the Joint Research Centre (JRC)

The JRC is the European Commission's science and knowledge service which employs scientists to carry out research in order to provide independent scientific advice and support to EU policy. They regularly publish studies on strategic technologies and sectors in the EU, including one that focused on CRMs. CRMs are essential for the EU to deliver on the climate ambition of the European Green Deal, one of its major policies. The objective of no net emissions of greenhouse gases by 2050 will require electrification efforts and the diversification of our sources of energy supply which in turn requires a huge increase in raw materials.

The JRC published “*Critical Raw Materials for Strategic Technologies and Sectors in the EU - A Foresight Study*“ a foresight study, which accompanies the fourth list of CRMs for the EU and translates the climate-neutrality scenarios for 2030 and 2050 into the estimated demand for raw materials. Such a report provides a systematic analysis of supply chain dependencies for nine selected technologies used in three strategic sectors: renewable energy, e-mobility, defence and aerospace. This report carried considerable weight when the 2020 CRM list was being considered.

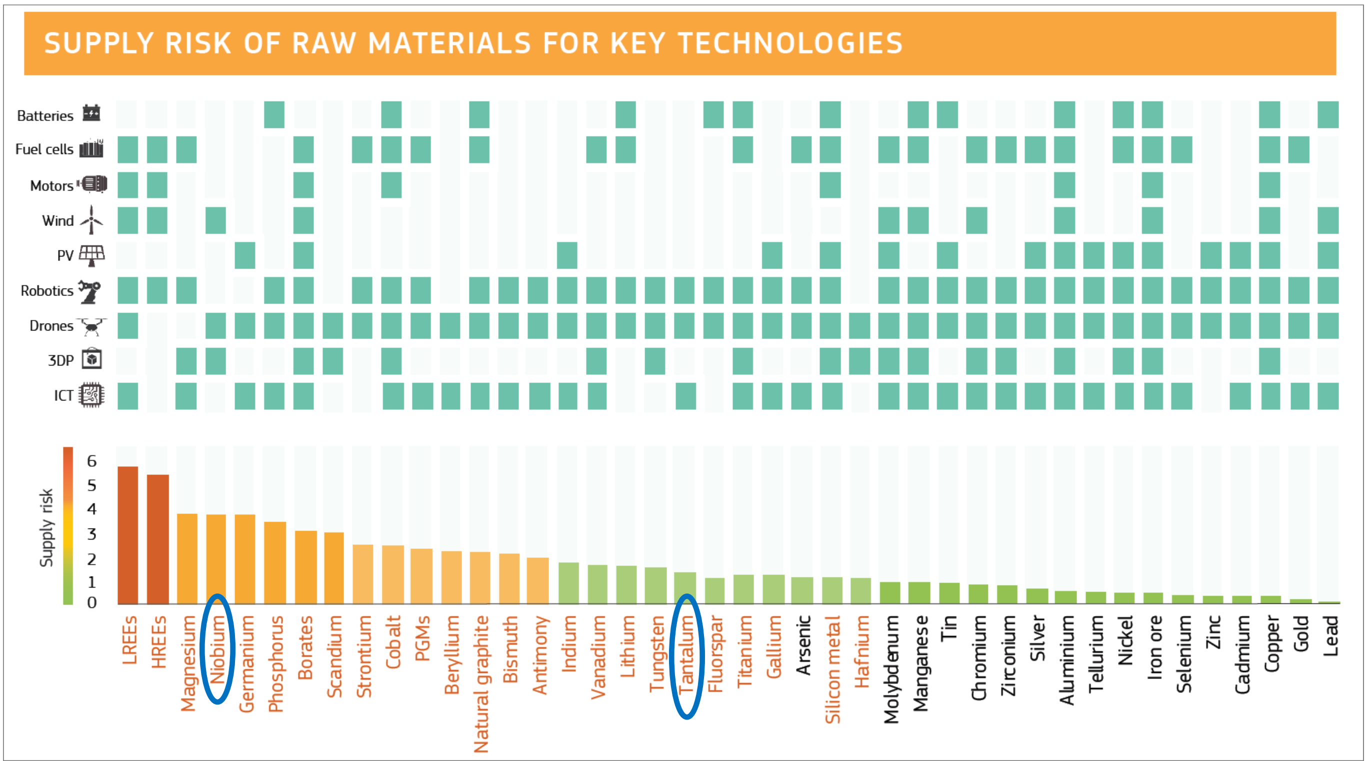


Figure 3: Showing the raw materials used in key technologies for the digital and green transitions, and their relative supply risk for the materials listed in the 2020 CRM list (image: JRC)

The JRC study indicates that for batteries for electric vehicles and energy storage, we would need up to 18 times more lithium and 5 times more cobalt in 2030, and almost 60 times more lithium and 15 times more cobalt in 2050, compared to the current supply to the whole EU economy. Demand for rare earths used in permanent magnets, e.g. for electric vehicles, robots or wind generators, could increase tenfold. For the EU’s Hydrogen Strategy to succeed, it would need a reliable supply of platinum group metals for fuel cells and electrolysers.

CRMs are also essential for shaping Europe’s digital future. According to the foresight study, 120 times the current EU demand of the rare earth neodymium could be required to provide data storage for the global data sphere in 2025.

The EU believes that a secure supply of raw materials, both from primary and secondary sources, together with continued research and innovation policies for substitution and more sustainable product design, is a sine qua non for competitive and resilient EU industries, their recovery from the COVID-19 crisis and transition towards green and digital industries.

Tantalum and niobium

Tantalum is considered to have low supply risk in the JRC study, although this risk has increased since the third CRM list was published. The critical stage for tantalum is extraction, since a considerable amount is sourced from the Democratic Republic of Congo and Rwanda, two countries with a very high ranking in the World Governance Index (7.6 and 5.2, respectively). On the other hand, the end-of-life recycling input rate for tantalum is said to be minimal and its economic importance is increasing in capacitors, electro-optical systems and gas turbine engines.

Niobium has seen significant increases in both supply risk and economic importance since the 2017 report was published. Niobium is mentioned as potentially becoming essential to electric batteries, which could make it a crucial technology with relevance in all strategic sectors considered by the EU, including Renewables, E-Mobility, Defence and Space (see Figure 3).

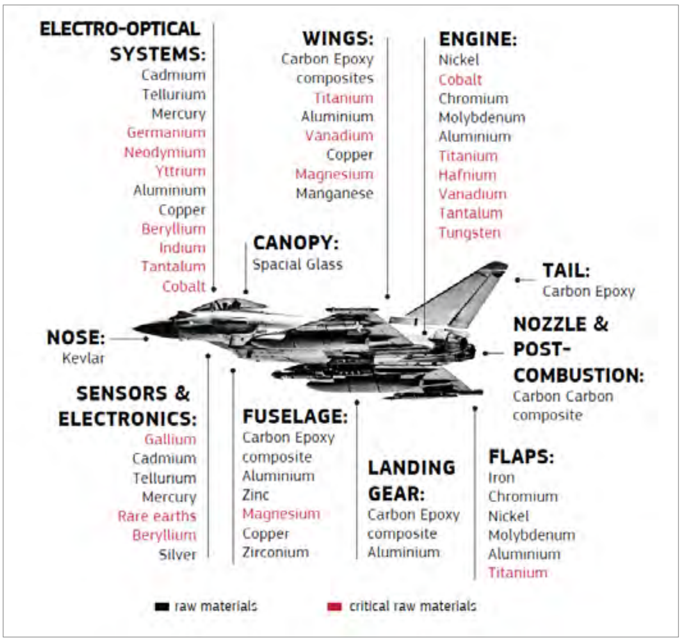


Figure 4: The JRC study looks at the use of CRMs in various sectors, for example a combat aircraft (image: JRC)

Conclusions

Raw materials, even if not classed as critical, are important for any economy, whether mined domestically or imported from aboard, since they are at the beginning of manufacturing value chains. Their availability may quickly change in line with trade flows or trade policy developments, geopolitical changes or force majeure events. The EU believes that these risks underline a general need of diversification of supply and the increase of recycling rates of all raw materials.

Defining “critical” raw materials is highly subjective[4] and depends on the interrelationships between raw materials, intermediate products and finished goods within the territory in question. What some consider critical may not be a concern for others in possession of different natural resources and consumption habits. However, while comparisons between CRM lists can be challenging, there can be no doubt that dispassionate, reasoned assessment of a market by fresh eyes can sometimes offer a new perspective or demystify an opaque corner of the market, offering food for thought to those of us who are involved in the global commodities markets. TIC

1. European Commission, Study on the EU’s list of Critical Raw Materials (2020), Publications Office of the European Union, Luxembourg, 2020. https://doi.org/10.2873/398823, https://rmis.jrc.ec.europa.eu/uploads/CRM_2020_Report_Final.pdf.
2. The methodology uses the following data priority for the calculations: official EU data; Member State authorities’ public data; public data from international organisations and non-EU authorities (e.g. USGS); and only “exceptionally, as a last option, and if duly justified” will they consider trade/industry associations’ public data and expert judgement.
3. “Critical Raw Materials for Strategic Technologies and Sectors in the EU - A Foresight Study (2020)”, available to download at https://rmis.jrc.ec.europa.eu/uploads/CRMs_for_Strategic_Technologies_and_Sectors_in_the_EU_2020.pdf
4. As a fictional example, if a dragon was asked to define ‘critical raw materials’ it would almost certainly say “Gold!” (hence the cover of this magazine), at least according to J.R.R. Tolkien (see *The Hobbit*).

tarantula

41 Nb niobium | 73 Ta tantalum | 74 W tungsten

The T.I.C. is part of a consortium studying innovative new ways to recover niobium (Nb), tantalum (Ta) and tungsten (W) from mine by-products and processing waste streams, materials which are currently uneconomical. If you are interested in learning more about this project visit https://h2020-tarantula.eu/ or to register your interest contact the T.I.C. at tech@tanb.org.

The TARANTULA project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 821159.

A century of Critical Raw Materials and the US

This paper is a shortened and updated version of a presentation given by Tom Butcher, a Director at Van Eck Associates Corporation ("VanEck"), to the German metal industry association, Verband Deutscher Metallhändler e.V. (VDM), in October 2019. The views and opinions expressed herein are the personal views of Tom Butcher and are not presented by or associated with VanEck, its affiliated entities or the T.I.C.

Introduction

In September 2020, the US Department of Defense purchasing division expanded its purchasing restrictions to include tantalum from North Korea, China, Russia, or Iran. The restriction is called DFARS[1] 225.7018 and it could have far-reaching impact on the aerospace sector[2].

This is not the first time that US policy (or that of its bodies) has become involved with critical metals; or should that be strategic, technical, minor, essential, or even deficient metals? One of the main reasons that the US is where it is today vis-à-vis critical minerals (and, in particular, critical metals) is because, even after over 100 years, it is still really not sure what it is talking about.

Over that time, they have been described using any one, and all, of the above terms and all too often tantalum and niobium have been among those being discussed. This paper will look back across a century of US governmental involvement in critical raw materials and explain how we got to this point.

Over the years there was no one, agreed upon, definition of what actually was "strategic, critical, vital, deficient, or strategic and critical." They have all meant different things, to different people, at different times.

What are they and how are they defined?

These minerals started to be classified in World War I, when the War Industries Board produced its first "unofficial" list of "strategic minerals." They numbered precisely *4* - and were industrial rather than defense oriented.

In 1921, the Supply Division of the General Staff (a different entity) produced its first "official" list of "strategic minerals." But there is no immediate indication of just how many there then were.

Between 1917 and 1939 some *15* different lists of "strategic" and "critical" minerals were produced, with their number in 1939 rising to *9* and then to *52* later during World War II.

A Problem of Taxonomy? Or Something Deeper?

- 1917 – War Industries Board: First "unofficial" list of "strategic minerals"
- 1921 – Supply Division of the General Staff: First "official" list of "strategic minerals"
- 1917-1939 – 15 lists of "strategic" and "critical" minerals
- 1974 – President's council on International Economic Policy list of "critical" materials
- 1982 – National Indicators System list of "critical minerals"

In 1974, the President's Council on International Economic Policy (yet another US government body) reported on a list of *19* critical materials, but provided no definition of critical. And, in 1982, the National Indicators System report on the domestic supply of critical minerals explained that classification of minerals as strategic or as critical changes over time across countries, industries and users and that the determination of which minerals were "strategic and critical" was made by the executive branch of the government.

For the purposes of that report, the *15* "critical" minerals chosen were based on one or more of several considerations, including the large amounts used and resulting importance to the economy, strategic importance to national defense, special properties not readily found in other materials, reliance on imports for domestic consumption and alloying properties. Over the years there was no one, agreed upon, definition of what actually was "strategic, critical, vital, deficient, or strategic and critical." They have all meant different things, to different people, at different times.

Some academics[3] were spot on when they observed that: "In wrestling over the question of "Which materials are 'critical' and which are 'strategic'?", misunderstanding, miscommunications and potentially misrepresentations can result from the lack of consistency in use of the terms 'critical' and 'strategic'." And that "Which materials are considered critical depends to a large extent on the priorities and objectives of the organization or country that commissions the study." It may well be the case that the confusion over the years has been a major contributing factor to the failure by the US to address successfully the issue of materials', or minerals', criticality.

Two game-changing studies

After that 1982 National Indicator System report, we then have to wait a quarter of a century before we see any serious signs of life in the world of “strategic”, “critical”, “essential” minerals.

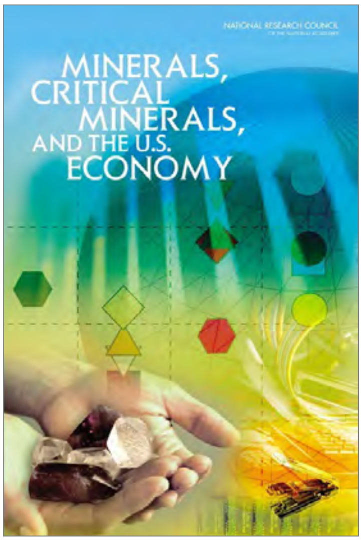
The question is, why? Perhaps one of the main reasons is that, with its wealth and, thus, significant purchasing power, together with its status as the dominant superpower, especially following the demise of the Soviet Union and subsequent regime changes throughout Africa, the US really felt there was no need to revisit the subject. It could now buy all the minerals it wanted, in all the quantities it wanted, when it wanted and pretty much anywhere it wanted.

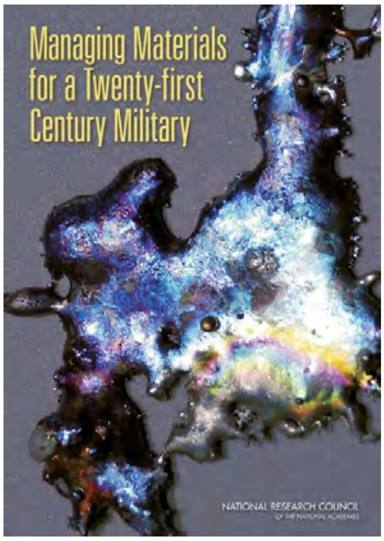
When money’s no object, why worry?

Things changed however in 2007 and the year following, with the publication of two game-changing and seminal works.

The first was *Managing Materials for a 21st Century Military* in 2007 and the second *Minerals, Critical Minerals, and the U.S. Economy* in 2008.

Both were, it can be argued, the result of the realization that the world had changed so radically in the previous couple of decades that these changes, and what they implied, really did need to be addressed.





“The globalization of materials production and supply has radically changed the ability of the United States to produce and to procure materials vital to defense needs. Yet, little has been done in the face of changed materials needs in the military nor have the methods of computing stockpile requirements or the means of assuring continued supplies been adapted to reflect these changes.”

“Managing Materials for a 21st Century Military” National Research Council of the National Academies, 2007

1) Managing Materials for a 21st Century Military (2007)[4]

This report was written by the National Research Council of the National Academies under the aegis of retired Air Force Major General Robert Latiff in his role as Chair of the Committee on Assessing the Need for a Defense Stockpile and, subsequently, Chair of the National Materials Advisory Board. The National Research Council, or NRC, had been asked to carry out a study on the national defense stockpile - the US’ stockpile of strategic materials. In response, the NRC formed the committee to assess the continuing need for and value of the NDS and, if needed, to develop general principles for its operation and configuration.

The reason for this was seen, at the time, to be that: “The globalization of materials production and supply has radically changed the ability of the United States to produce and to procure materials vital to defense needs. Yet, little has been done in the face of changed materials needs in the military nor have the methods of computing stockpile requirements or the means of assuring continued supplies been adapted to reflect these changes.” In describing its remit at the start of the publication, its authors reported that, in response: “The committee has attempted to call attention to the dramatically different situation in which the country finds itself compared with 70 years ago, when much of the stockpile legislation and policy was originally conceived.”

Three of the report’s findings, in particular, remain pertinent to us today:

- The design, structure, and operation of the National Defense Stockpile render it ineffective in responding to modern needs and threats.
- The Department of Defense appears not to fully understand its needs for specific materials or to have adequate information on their supply.
- A lack of good data and information from either domestic or offshore sources on the availability of materials impedes the effective management of defense-critical supply chains.

2) Minerals, Critical Minerals, and the U.S. Economy (2008)[5]

This report was produced by the Committee on Critical Mineral Impacts on the U.S. Economy under the chairmanship of Professor Rod G. Eggert of the Colorado School of Mines. The study was intended to address non-fuel mineral issues in advance of a national crisis, with the idea that it is potentially prudent and cost-effective to determine policy and appropriate action before any such crisis occurs.

Once again, a number of the findings remain pertinent to us today, for example:

- "… the criticality of a specific mineral can and likely will change as production technologies evolve and new products are developed."
- "… import dependence by itself is not a useful indicator of supply risk."
- "…all minerals and mineral products could be or could become critical to some degree, depending on their importance and availability…"

The further gloss provided in the report on the third finding above is important: "Over the longer term, the availability of minerals and mineral products is largely a function of investment and the various factors that influence the level of investment and its geographic allocation and success.

"An important investment is that in education and research, and the committee suggests that the long-term availability of minerals and mineral products also requires continued investment in mineral education and research."

2007 - 2016: some "catalysts" of change

Whilst catalysts may not be quite the right word, the years 2007 - 2016 saw a number of events that kept strategic/critical metals, in particular rare earth elements (REEs), at least on the front pages of the media. Most prominently was the spat between China and Japan in September 2010, when Japan detained some Chinese fishermen. This led to China cutting off supplies of REEs to Japanese manufacturers and the price of REE oxides to soar. Whilst the actual "crisis" only lasted a number of days, the wake-up call was immediate and loud.

Both before and after this incident, however, the US had taken China to the World Trade Organization. First, in 2010, over manganese, magnesium and some other raw materials. And, then, in 2012 over its REE export quotas. In both instances the US "won". If you can really call either of them any sort of a victory. (See items marked with "*" in Figure 1). During the period, too, a number of reports were produced and briefings and hearings held by government in the US, both by the Government Accountability Office (GAO) and by the Congressional Research Service (CRS).

- April 24, 2009: Report – *Reconfiguration of the National Defense Stockpile Report to Congress*
- March 19, 2010: US submission to WTO against Chinese on manganese, magnesium, etc.*
- April 1, 2010: US GAO Report – *Rare Earth Materials in the Defense Supply Chain*
- December 2010: US Department of Energy – *Critical Materials Strategy*
- September 22, 2010: Chinese government blocks exports of REEs to Japan
- September 28, 2010: Chinese government lifts export "ban" of REEs to Japan
- March 12, 2012: US DoD Report – *Rare Earth Materials in Defense Applications*
- March 13, 2012: US submission to WTO against Chinese quotas on REEs*
- January 1, 2013: China removes export duties and quotas on manganese, magnesium, etc.*
- September 18, 2013: *National Strategic and Critical Minerals Production Act of 2013* introduced
- December 16, 2013: CRS Report – *Rare Earth Elements: The Global Supply Chain*
- January 5, 2015: China lifts all quotas on exports of REEs*
- February 11, 2016: US GAO Report – *Rare Earth Materials*

Figure 1: Some "catalysts" of change 2007 - 2016

2017 - 2019: a busy period

On December 19th 2017, the US Geological Survey (USGS) published *USGS Professional Paper 1802: Critical Mineral Resources of the United States - Economic and Environmental Geology and Prospects for Future Supply*. The forerunner to this paper, published in 1973, was USGS Professional Paper 820: United States Mineral Resources and was a review of the long-term U.S. resource position for 65 mineral commodities or commodity groups. Work on the 2017 paper kicked off in 2013.

The finished paper[6] presents updated reviews of 23 mineral commodities and commodity groups viewed as critical to a broad range of existing and emerging technologies, renewable energy, and national security. According to the USGS, all these commodities had been listed as critical and (or) strategic in one or more of the recent studies based on assessed likelihood of supply interruption and the possible cost of such a disruption to the assessor.

For some of the minerals, current production is limited to only one or a few countries. However, one thing the report notably did not attempt was to define the terms “critical,” “strategic,” etc. Just three days later, on December 20th 2017, President Donald Trump issued his *Presidential Executive Order 13817: A Federal Strategy To Ensure Secure and Reliable Supplies of Critical Minerals*. In it, the Secretary of the Interior, in coordination with the Secretary of Defense and in consultation with the heads of other relevant executive departments and agencies (agencies) was ordered to publish a list of critical minerals and disseminate such list to the appropriate agencies. It being the Federal Government’s policy to reduce the Nation's vulnerability to disruptions in the supply of critical minerals, which “constitutes ***a strategic vulnerability for the security and prosperity of the country***.” (Author’s bold and italics.)

Such policy would be furthered “for the benefit of the American people and in a safe and environmentally responsible manner”, by:

(a) identifying new sources of critical minerals;

(b) increasing activity at all levels of the supply chain, including exploration, mining, concentration, separation, alloying, recycling, and reprocessing critical minerals;

(c) ensuring that our miners and producers have electronic access to the most advanced topographic, geologic, and geophysical data within U.S. territory;

(d) streamlining leasing and permitting processes to expedite exploration, production, processing, reprocessing, recycling, and domestic refining of critical minerals.

At last there appeared to be a definition of “critical mineral”, with a critical mineral being a mineral identified by the Secretary of the Interior as: (i) a non-fuel mineral or mineral material essential to the economic and national security of the United States, (ii) the supply chain of which is vulnerable to disruption, and (iii) that serves an essential function in the manufacturing of a product, the absence of which would have significant consequences for our economy or our national security.

But it was soon obvious that, even with this seemingly watertight definition in hand, the issue of what was or was not really a critical mineral had yet to be settled.

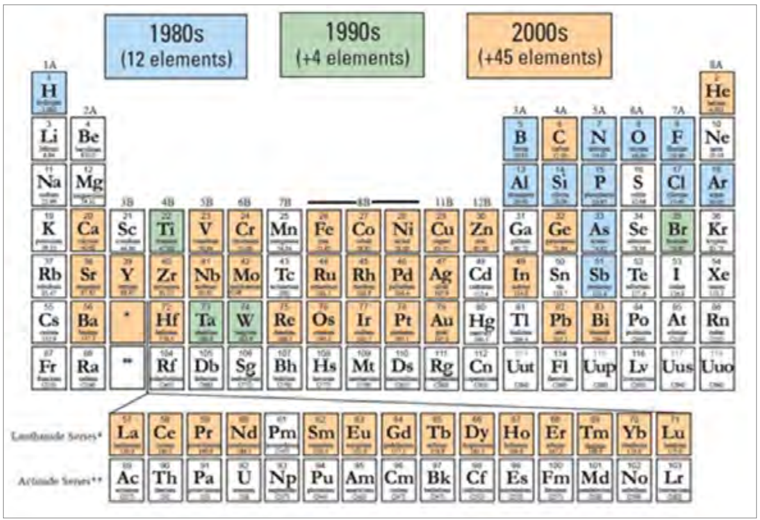
Mineral commodity	Sectors						Top producer	Top supplier	Notable example application
	Aerospace (nondefense)	Defense	Energy	Telecommunications and electronics	Transportation (nonaerospace)	Other			
Aluminum	X	X	X	X	X	X	China	Canada	Aircraft, power transmission lines, lightweight alloys.
Antimony	--	X	X	X	X	X	China	China	Lead-acid batteries.
Arsenic	--	X	X	X	--	X	China	China	Microwave communications (gallium arsenide).
Barite	--	--	X	X	--	X	China	China	Oil and gas drilling fluid.
Beryllium	X	X	X	X	--	X	United States	Kazakhstan	Satellite communications, beryllium metal for aerospace.
Bismuth	--	X	X	X	--	X	China	China	Pharmaceuticals, lead-free solders.
Cesium and rubidium	X	X	X	X	--	X	Canada	Canada	Medical applications, global positioning satellites, night-vision devices.
Chromium	X	X	X	X	X	X	South Africa	South Africa	Jet engines (superalloys), stainless steels.
Cobalt	X	X	X	X	X	X	Congo[1] (Kinshasa)	Norway	Jet engines (superalloys), rechargeable batteries.
Fluorspar	--	--	X	X	--	X	China	Mexico	Aluminum and steel production, uranium processing.
Gallium	X	X	X	X	--	X	China	China	Radar, light-emitting diodes (LEDs), cellular phones.
Germanium	X	X	X	X	--	X	China	China	Infrared devices, fiber optics.
Graphite (natural)	X	X	X	X	X	X	China	China	Rechargeable batteries, body armor.
Helium	--	--	--	X	--	X	United States	Qatar	Cryogenic (magnetic resonance imaging [MRI]).
Indium	X	X	X	X	--	X	China	Canada	Flat-panel displays (indium-tin-oxide), specialty alloys.
Lithium	X	X	X	X	X	X	Australia	Chile	Rechargeable batteries, aluminum-lithium alloys for aerospace.
Magnesium	X	X	X	X	X	X	China	China	Incendiary countermeasures for aerospace.
Manganese	X	X	X	X	X	X	China	South Africa	Aluminum and steel production, lightweight alloys.
Niobium	X	X	X	X	--	X	Brazil	Brazil	High-strength steel for defense and infrastructure.
Platinum group metals[2]	X	--	X	X	X	X	South Africa	South Africa	Catalysts, superalloys for jet engines.
Potash	--	--	X	X	--	X	Canada	Canada	Agricultural fertilizer.
Rare earth elements[3]	X	X	X	X	X	X	China	China	Aerospace guidance, lasers, fiber optics.
Rhenium	X	--	X	X	--	X	Chile	Chile	Jet engines (superalloys), catalysts.
Scandium	X	X	X	X	--	X	China	China	Lightweight alloys, fuel cells.
Strontium	X	X	X	X	X	X	Spain	Mexico	Aluminum alloys, permanent magnets, flares.
Tantalum	X	X	X	X	--	X	Rwanda	China	Capacitors in cellular phones, jet engines (superalloys).
Tellurium	--	X	X	X	--	X	China	Canada	Infrared devices (night vision), solar cells.
Tin	--	X	--	X	--	X	China	Peru	Solder, flat-panel displays (indium-tin-oxide).
Titanium	X	X	X	X	--	X	China	South Africa	Jet engines (superalloys) and airframes (titanium alloys), armor.
Tungsten	X	X	X	X	--	X	China	China	Cutting and drilling tools, catalysts, jet engines (superalloys).
Uranium	X	X	X	--	--	X	Kazakhstan	Canada	Nuclear applications, medical applications.
Vanadium	X	X	X	X	--	X	China	South Africa	Jet engines (superalloys) and airframes (titanium alloys), high-strength steel.
Zirconium and hafnium	X	X	X	X	--	X	Australia	China	Thermal barrier coating in jet engines, nuclear applications.

[1]Democratic Republic of the Congo.

[2]This category includes platinum, palladium, rhodium, ruthenium, iridium, and osmium.

[3]This category includes yttrium and the lanthanides.

Figure 2: The USGS draft list of US “critical” minerals created following Presidential Executive Order 13817. Both niobium and tantalum are on the list. It is striking how often China is listed as the top producer and/or top supplier.



A prime illustration of the growth in use of different elements: high speed, high-capacity computer chips required 12 elements in the 1980s and 16 in the 1990s, but more than 60 today. (Source: USGS)[7]

As required in Mr Trump's executive order, the draft critical minerals list was soon to follow, with the publication in February 2018 of *USGS: Draft Critical Mineral List — Summary of Methodology and Background Information —U.S. Geological Survey Technical Input Document in Response to Secretarial Order No. 3359*, together with a summary of the methodology used and background information. The finalized list (of the original "draft" 35) was published in May 2018. However, there were the following important provisos:

- The list of critical minerals, while "final," "is not intended as a permanent designation of criticality, but will be a dynamic list updated periodically to represent current data on supply, demand, and concentration of production, as well as current policy priorities."
- "This final list is based on the definition of a ''critical mineral'' provided in Executive Order 13817. The U.S. Government and other organizations may also use other definitions and rely on other criteria to identify a material or mineral as ''critical'' or otherwise important".

When it comes to the list's "finality", it will be interesting to see both how often this happens and what, if anything, triggers such updates. And, for those interested in not only the definitional aspects of the exercise, but also its defense aspects: "This final list is not intended to replace those related terms and definitions for minerals or materials that are deemed strategic, critical or otherwise important (e.g., National Defense Stockpile)."

With this second caveat, however, bang goes the definition as establishing the norm! In addition, it begs the question of just where these 35 minerals actually stand next to such "minerals or materials." But perhaps this is intentional.

Finally, perhaps somewhat belatedly (but of particular importance), the byproduct nature of some of these minerals receives specific mention: "Of the 35 minerals deemed critical, 12 are byproducts. Therefore, strategies to increase the domestic supply of these commodities necessarily consider the mining and processing of the host materials because enhanced recovery of byproducts alone may be insufficient to meet U.S. consumption."

Several important publications, marking moves up the "supply chain", followed in what was left of 2018 and in 2019. Two in particular are of note. On October 5th 2018, the US Department of Defense published an assessment entitled *Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States*. In brief, the assessment identified:

- Five macro forces … "shaping industrial base-wide trends and causing a deterioration in U.S. capabilities";
- Ten risk archetypes … "resulting from the macro forces, each of which contributes to insecurity in DoD's supply chain"; and
- Over 280 impacts … "across sectors, acutely affecting the vitality and resiliency of the industrial base".

In June 2019, fulfilling the requirement of President Trump in his executive order for the Department of Commerce to produce a report that would "describe specific steps that the Federal Government will take to achieve the objectives outlined in Executive Order 13817", the US Department of Commerce published a *Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*. The strategy contains six "Calls to Action", 24 "goals" and 61 "recommendations".

In the department's optimistic words: "When executed, this strategy will improve the ability of the advanced technology, industrial, and defense manufacturing sectors that use critical minerals to adapt to emerging mineral criticality issues; reduce risks for American businesses that rely on critical minerals; create a favorable U.S. business climate for production facilities at different stages of critical mineral supply chains; and support the economic security and national defense of the United States; all of which will reduce the Nation's vulnerability to critical mineral supply disruptions."

Perhaps not surprisingly, the grand caveat comes in the very last paragraph of the document: "Given the crosscutting nature of critical minerals issues, pursuing the goals and recommendations in this Strategy demands adaptive, coordinated efforts across the Federal Government.

Accordingly, this Strategy should be periodically evaluated to determine the efficacy and relevance of the recommendations given current U.S. Government priorities and challenges."

2019 - the present

Amongst the more publicly acknowledged initiatives on the critical minerals front in the first half of 2019 were the efforts by the Trump administration to corral various nations to join an international "critical minerals collaboration" and, domestically, the US Air Force's requests to the mining sector to provide it with their plans for developing mines and processing facilities in the US, and to manufacturers to provide details of their needs for rare earths. Then, on July 22nd 2019, President Trump issued *Five Presidential Determinations* relating to rare earth production and applications in which he outlined what "domestic production" capabilities he considered to be "essential to the national defense." The damning conclusion was that U.S industry "***cannot reasonably [be] expected to provide production capability … adequately and in a timely manner***" in either rare earth separation and processing or in the production of SmCo and NdFeB magnets or pure rare earth metals (Author's **bold)**.

Pretty much at the same time as the appearance of DFARS 225.7018 and its restrictions on the sourcing not only of tantalum metal and alloys, but also samarium-cobalt magnets, neodymium-iron-boron magnets, tungsten metal powder and tungsten heavy alloy or any finished or semi-finished component containing tungsten heavy alloy, on September 30th 2020, Mr Trump issued his *Executive Order on Addressing the Threat to the Domestic Supply Chain from Reliance on Critical Minerals from Foreign Adversaries*. In a short, seven-page, document, the executive order deals, amongst other things, with the deemed threat to the US stemming from its dependence on imports of some 31 of the 35 critical materials mentioned in figure 2. Perhaps not surprisingly, it specifically singles out the country's import dependence on China. (Quite obviously, therefore, an "adversary".)

Mr Trump did not mince words and stated in the order that "I therefore determine that our Nation's undue reliance on critical minerals, in processed or unprocessed form, from foreign adversaries constitutes an unusual and extraordinary threat, which has its source in substantial part outside the United States, to the national security, foreign policy, and economy of the United States. I hereby declare a national emergency to deal with that threat." The Secretary of the Interior is scheduled to report back to the president by January 1, 2021. Taken together it will be interesting to see just what everybody's plans add up to.

Conclusion

For the last 100 years or so confusion has reigned in the US (and to a certain extent, as we have seen, still does) as to what the "critical" minerals and/or metals are. Or whether they are, actually, "strategic" rather than "critical" (or some other definition altogether). And whatever they are, how they should be defined. Whilst it appears to be improving, there appears still to be insufficiently precise understanding of: 1) Which "mineral commodities" are being used? 2) For what? And, 3) From where are they sourced? There has, also, continued to be insufficient investment in, amongst other things, materials and manufacturing education and know how.

As a country, one may have more money than Croesus with which to buy raw "critical" minerals. But if people do not want to sell them to you, you really are, short of seizing them, flat out of luck. And the same can (and often does) go for manufactured and semi-manufactured goods made from them. These are just some of the reasons that the US is where it is today … playing an increasingly desperate game of "catch up."

References

1. The Defense Federal Acquisition Regulation Supplement (DFARS) to the Federal Acquisition Regulation (FAR) is administered by the US Department of Defense (DoD).
2. https://www.federalregister.gov/documents/2020/09/29/2020-21121/defense-federal-acquisition-regulation-supplement-restriction-on-the-acquisition-of-tantalum-dfars. The ruling appears to be extremely detailed when it comes to tantalum, stating "DFARS 225.7018-2, Restriction, to explain that the restriction on production of tantalum metal and alloys, including the reduction of tantalum chemicals such as oxides, chlorides, or potassium salts, to metal powder and all subsequent phases of production of tantalum metal and alloys, such as consolidation of metal powders."
3. Simandl, G.J., Akam, Carlee, and Paradis, Suzanne, 2015, *Which materials are "critical" and which are "strategic"?* Industrial Minerals, no. 578, December 2015, p. 57–59. Available to download for free from www.researchgate.net
4. *Managing Materials for a 21st Century Military (2007)* is freely available at many places online, including at https://www.researchgate.net/publication/257984531_Managing_Materials_for_a_Twenty-first_Century_Military
5. *Minerals, Critical Minerals, and the U.S. Economy* is available at https://www.nap.edu/catalog/12034/minerals-critical-minerals-and-the-us-economy
6. The 23 mineral commodities and commodity groups listed in *USGS Professional Paper 1802* (2017) were: antimony, barite, *beryllium*, cobalt, fluorine, gallium, germanium, graphite, hafnium, indium, lithium, manganese, niobium, platinum-group elements, rare-earth elements, rhenium, selenium, tantalum, tellurium, tin, titanium, vanadium and zirconium. It can be read at https://pubs.er.usgs.gov/publication/pp1802
7. USGS *Critical Mineral Resources of the United States – Economic and Environmental Geology and Prospects for Future Supply, Professional Paper* 1802, 2017

The T.I.C. annual statistics presentation

These statistics were provided as part of the 61st General Assembly. This report was written by the T.I.C.'s Statistics Subteam led by the Technical Officer David Knudson. The T.I.C. makes no claim as to the accuracy or completeness of these statistics and no liability whatsoever is accepted by the T.I.C. in connection with these statistics.

Introduction

Tantalum (Ta) and niobium (Nb) statistics are a core purpose of the T.I.C., as mandated by article 3.2 of our Charter. Each quarter, member companies submit their data to an independent third party and receive back an updated report. Annual summaries of this information are shared with non-members at our General Assemblies and thereafter in the Bulletin.

Since 2017 members' data has been augmented with international trade data to provide a fuller and broader understanding of the market. This paper provides a summary for the calendar years 2009 to 2019 inclusive.

Miller Roskell Limited
Chartered Certified Accountants

Members' data is collected by Miller Roskell Ltd, a fully independent accountant

Data sources and interpretation

Members' data forms the core of the T.I.C. statistics service. The data has been collected from members by a 100% independent chartered certified accountant, Miller Roskell Ltd, since 2015.

T.I.C. staff have no access to an individual member's data, only to the aggregate totals and international trade data.

The T.I.C. statistics service, based on members' quarterly data, has provided a useful guide to trends in the industry for many years. Table 1 shows the total number of T.I.C. members reporting in each data category in 2019.

Categories (2019)	Reporting members	Metric tonnes of
Ta raw materials: mining production and trading receipts	30	Ta_2O_5
Ta receipts by processors	42	Ta_2O_5
Ta product shipments by processors	42	Ta contained
Nb raw materials: mining production and trading receipts	32	Nb_2O_5
Nb product shipments by processors	44	Nb contained

Table 1: 2019 reporting members by category

Augmenting members' data with international trade data

The T.I.C. purchases international trade data from Global Trade Tracker (GTT) and uses it to complete occasional gaps in members' reporting, generate additional charts and as an analytical tool to provide deeper meaning for members.

All physical international trade is recorded according to categories that are defined by the Harmonized System (HS) set out by the World Customs Organization (WCO). All the main tantalum and niobium producing, trading and consuming countries participate in this system and use the HS codes to determine their tariff schedules.

Additional data sources are used to add additional depth and verify primary data whenever possible. In 2019 the primary data sources for T.I.C. statistics reports were member companies and Global Trade Tracker (GTT), but additional sources of international trade data studied by the Association included, but were not limited to, companies' annual reports, press releases and other publications; national governments; geological institutes; and international institutions (see Bulletin #176 for more details).

Some notes on the use of international trade data

It is essential to all statistics reports that the data can be defended and this means that we constantly check and cross-reference our statistics to create what we believe is the most robust data set possible. However, no statistics can claim to be infallible and when you use international trade data it is important to appreciate that:

- International trade data only records cross-border shipments. Domestic shipments are not recorded.
- Some HS codes cover several products, e.g. code 261590 includes Ta, V and Nb ores and concentrates.
- HS codes hold 6 internationally standardised digits; but many countries add unique additional suffix digits.
- Customs data may be presented in different units such as weight or monetary value.

In many cases informed assumptions have to be made as to being gross weight and the average grade, as well as the historical market price, in order to estimate the most probable net weight of Ta or Nb units contained. Given these and potentially other issues, care must necessarily be applied in using such data. Nevertheless these additional sources of data constitute a potentially useful source of information and we confidently report the following results.

Tantalum Raw Materials: Mining production and trading receipts

2019 saw a drop in production of 26.5% from 2018. Since the high mark reached in 2014, mining and trading receipts have dropped year on year by 61.2%. Annual volumes in 2019 nearly match the lowest volumes in this data set, which were seen in 2009. The statistical drop in production most likely reflects both poor market demand and a fall in T.I.C. membership in this category. While some mining and trading operations do not report to the T.I.C., the processors, who are mostly members of the T.I.C., are reporting their statistics accurately as seen in the input/output volumes reported by our processor members.

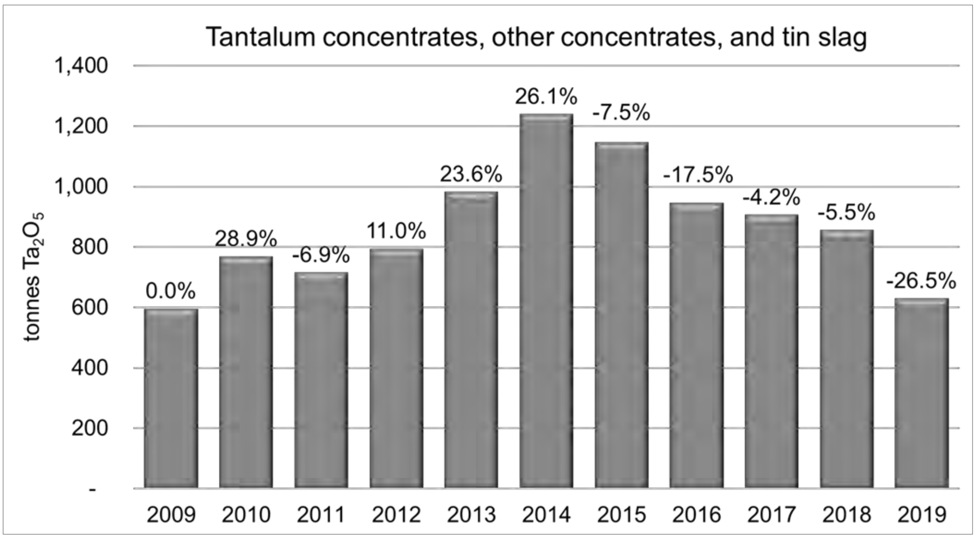


Figure 1: Tantalum raw materials: mining production and trading receipts (t Ta_2O_5)

Tantalum concentrates dropped 26.6% from 2018, to the lowest volumes since 2012. Other concentrates saw a 50.4% drop from 2018, to the lowest volumes in the 11-year dataset. Tin slags increased by 12.2% while maintaining a globally downward trend, seen since 2012.

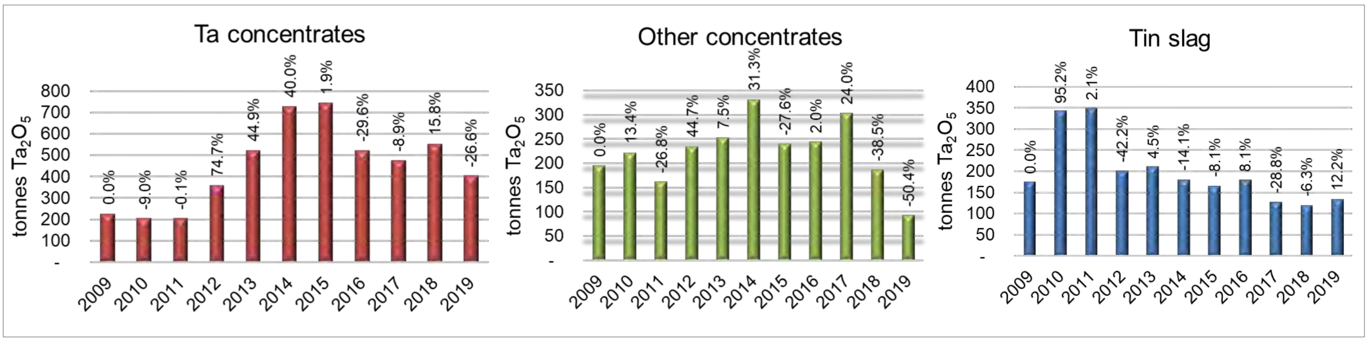


Figure 2: Subsets of tantalum raw materials: (left) Tantalum concentrates; (central) Other concentrates; (right) Tin slags

Tantalum Receipts by Processors

2019 saw receipts by processors drop their volumes by 18.7%, the largest reduction since 2009 (see Figure 3).

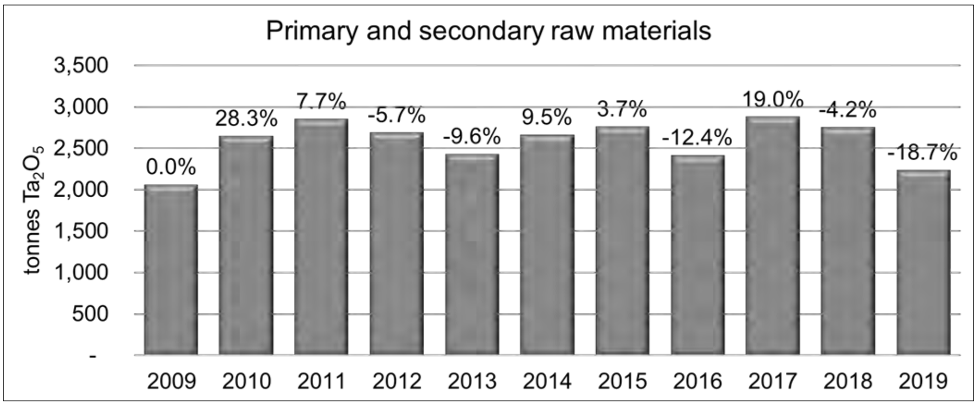


Figure 3: Tantalum receipts by processors (t Ta_2O_5)

This was mostly due to a 36.3% drop in secondary raw materials which include tantalum chemicals such as Ta_2O_5 and K_2TaF_7 along with scrap receipts. While secondary raw materials caused most of the reduction in processor receipts, primary raw materials also saw a 12.2% drop in volumes compared to 2018 (see Figure 4). The reduction in secondary raw material receipts is statistically abnormal, the change in primary raw material volume (which includes tantalite, columbite, struverite, tin slags and synthetic concentrates) appears to be a continuation of a cyclical trend that began in 2012.

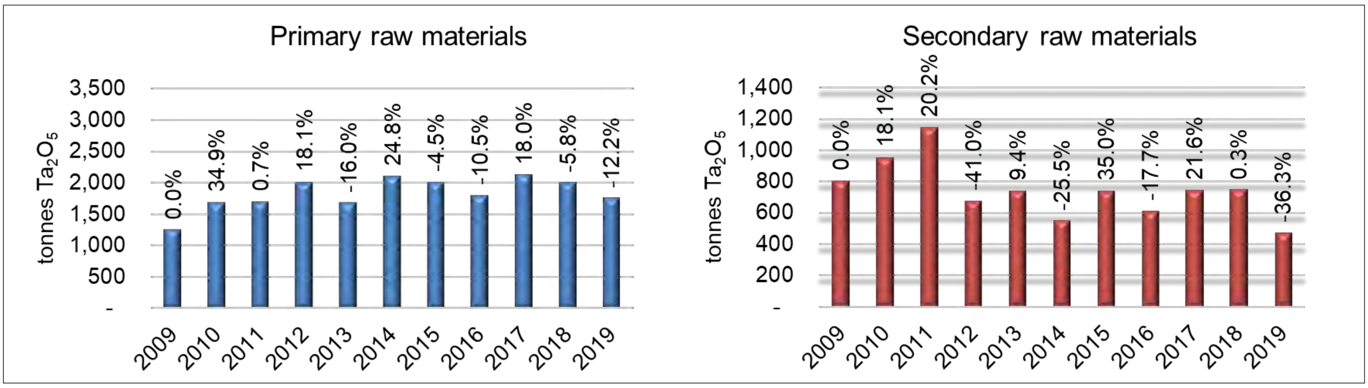


Figure 4: Tantalum receipts by processors (t Ta_2O_5), split between (left) primary and (right) secondary raw materials

Tantalum Product Shipments by Processors

Product shipments followed the same trend as processor receipts with a drop of 16.8% in volumes. This reduction was nearly identical to the reduction seen in processor receipts.

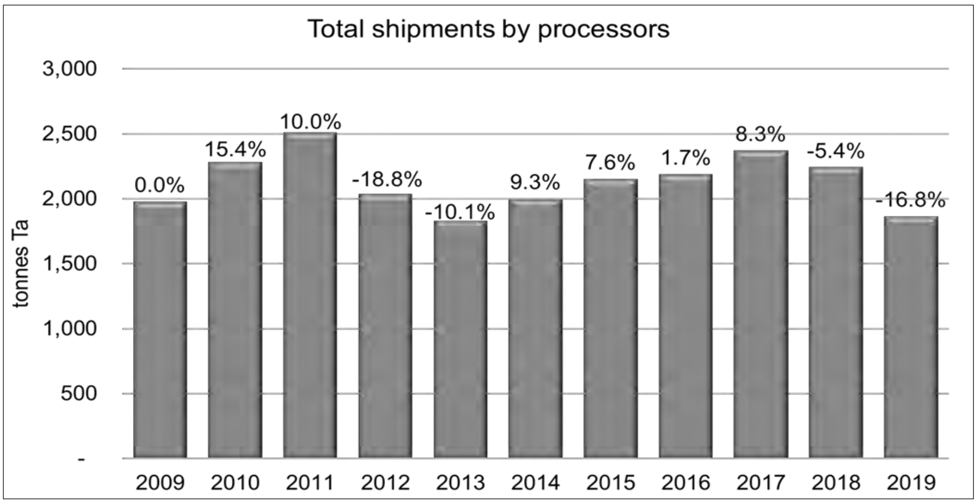


Figure 5: Tantalum product shipments by processors (t Ta)

Processor shipments contain six categories: Ta chemicals, Ta carbide, capacitor grade Ta powder, Ta ingot, Ta mill products and metallurgical grade Ta powder. The decrease in volumes was seen in 4 of the 6 categories: Ta mill products, Ta carbide, Ta chemicals and capacitor grade Ta powders.

Increase in volumes is seen in 2 categories: Ta ingot and metallurgical grade Ta powder. Tantalum mill products led the way in volume losses with a drop of 71.3%, with capacitor grade Ta powder experiencing the second largest drop in volumes in 2019 (38.2%). Ta carbides also experienced a large % drop, but this category represents a small part of the overall Ta shipments (3%). Ta chemicals saw a modest drop in volumes of 4.1%. The significant drop in volumes was seen in Ta mill products and capacitor grade powders representing a loss of 17% of the total tantalum market share. These losses were offset to some extent by increases in metallurgical grade powders (22.8%) and Ta ingot (7.2%) volumes and accounting for an increase of 17% in the total Ta market share.

The market segments that showed increased volumes could not offset those that decreased, as capacitor grade powders are the largest single market sector of the category.

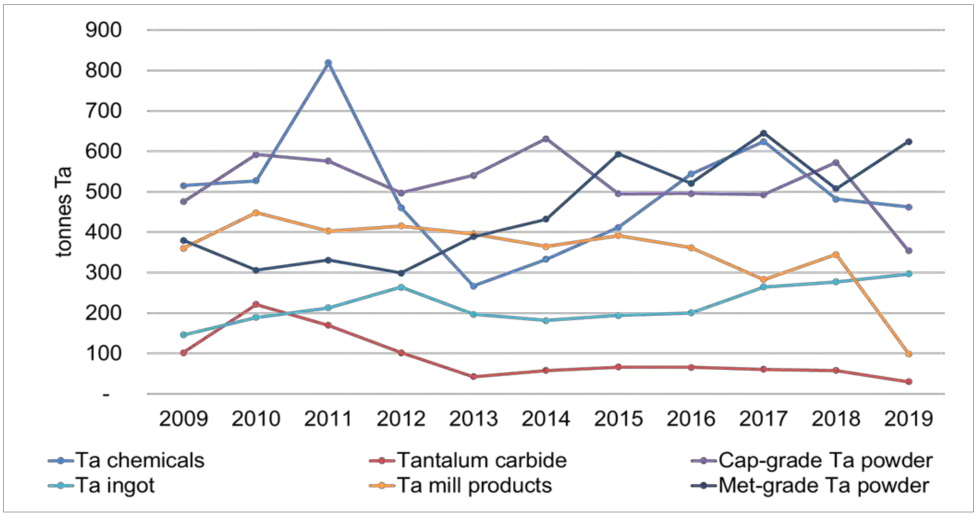


Figure 6: Tantalum product shipments by processors (t Ta) broken down by category (i)

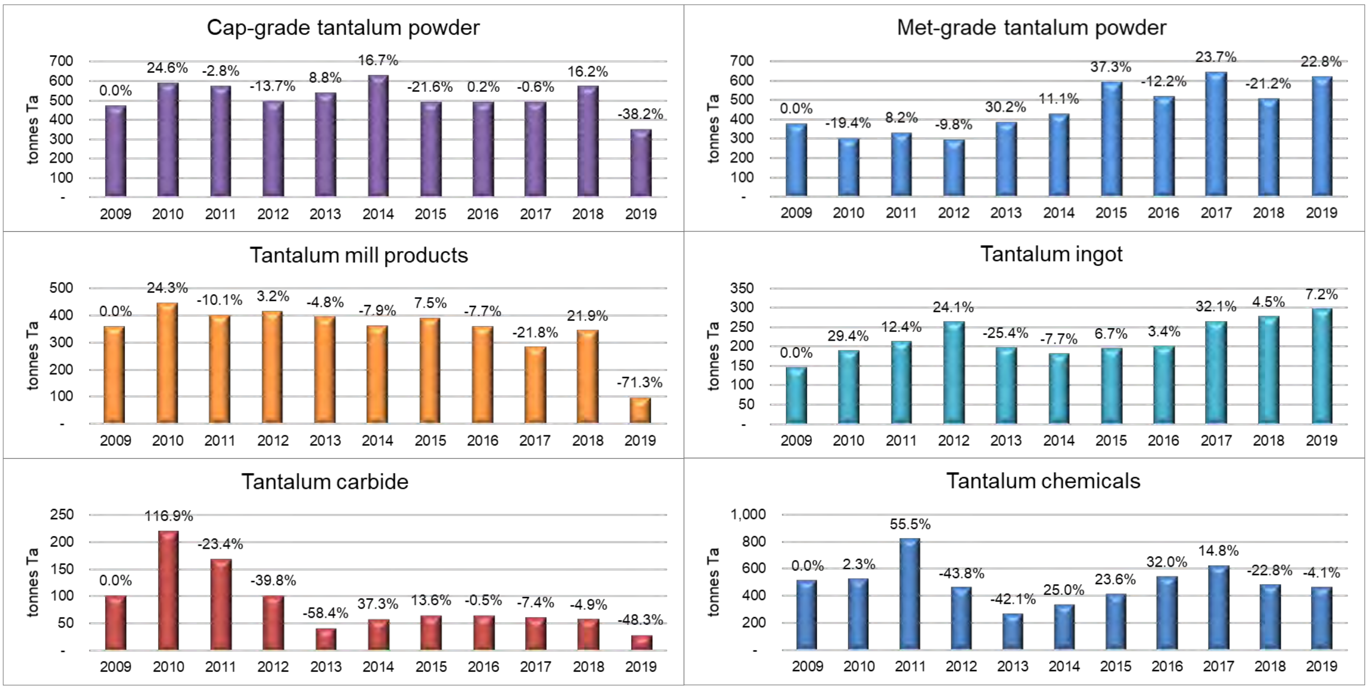


Figure 7: Tantalum product shipments by processors (t Ta) broken down by category (ii)

Statistics Collection Robustness

The general process diagram (see Figure 8) shows the receipts and shipments of tantalum processors reporting to the T.I.C. Processors receive Ta units, from a variety of sources, typically as either Ta metal or Ta oxides. The Ta units are digested in hydrofluoric acid and then processed mainly into K_2TaF_7 (~75%) or calcined into high purity Ta oxide (25 %).

K_2TaF_7 is reduced using sodium into capacitor grade and metallurgical grade powders. Metallurgical grade powder is used to produce ingot and mill products. Capacitor grade powders are produced from K_2TaF_7, with some high capacitance powders reduced from high purity Ta oxides. Tantalum oxide is used for production of tantalum carbide for carbide tool manufacture.

Figure 8: The general process diagram showing receipts and shipments of tantalum processors reporting to the T.I.C.

Over the past 11 years, a total of 23302 tonnes of Ta metal units were received by T.I.C. processor members and 23468 tonnes were shipped. The difference of 165 tonnes or <1%, can be explained by crossover calendar quarters and long-term contractual schedules as processing takes up to 45 days.

Monitoring this difference is a good indication of the robustness of the T.I.C. reporting procedures, reliability of the reported data and dedication of our reporting members. CY2019 fits these long-term observations and continues the trends, indicating the robust collection process of T.I.C. member data has been maintained for 2019.

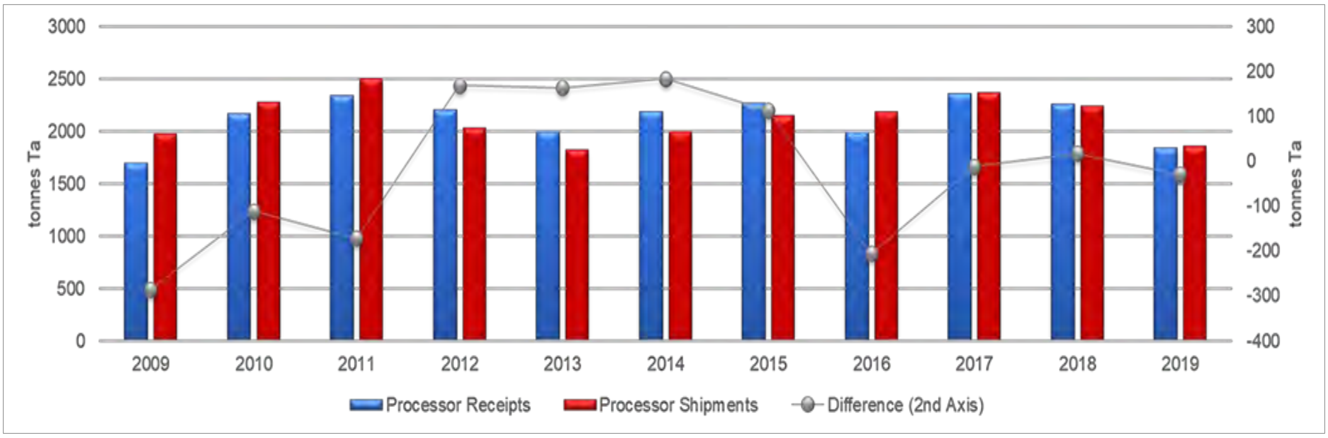


Figure 9: Annual receipts and shipments of tantalum processors reporting to the T.I.C.

Niobium Raw Materials: Mining production and trading receipts

In 2019, mining production and trading receipts of niobium raw materials reached a highpoint for the reported time period with a 16.6% increase from the previous highpoint in 2018 (see Figure 10). The increased volumes in this category are entirely attributed to niobium concentrates as other niobium-containing ore saw a drop in volumes of 5.3%, but this decrease represents only 27 mt.

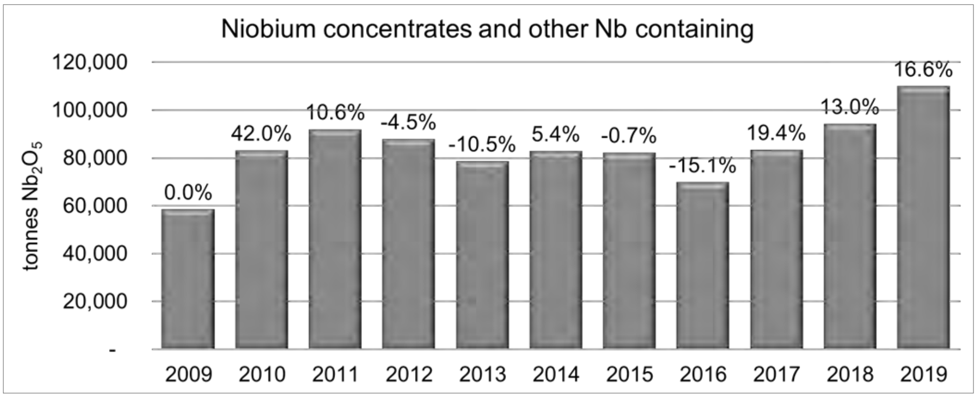


Figure 10: Niobium raw materials: mining production and trading receipts

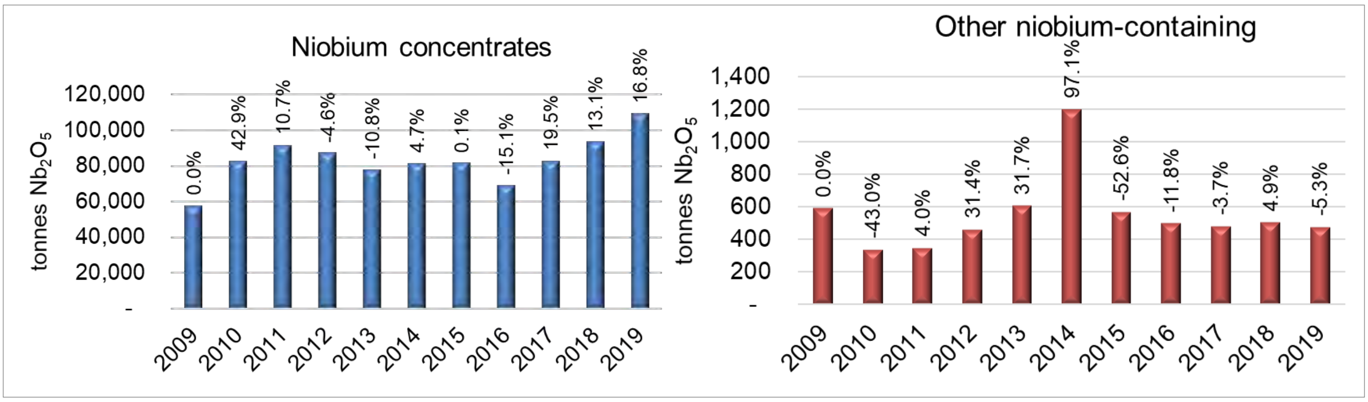


Figure 11: Niobium raw materials: mining production and trading receipts split between (left) niobium concentrates and (right) other niobium-containing materials

Niobium Product Shipments by Processors

The rapid growth of niobium-bearing products has been spurred by demand for ferro-niobium, an alloying agent, mainly used for producing high-strength low-alloy steels (HSLA). Various types of HSLA steels are used in the production of cars, trucks, cranes, bridges, roller coasters and other structures that are designed to handle large amounts of stress or need a good strength-to-weight ratio.

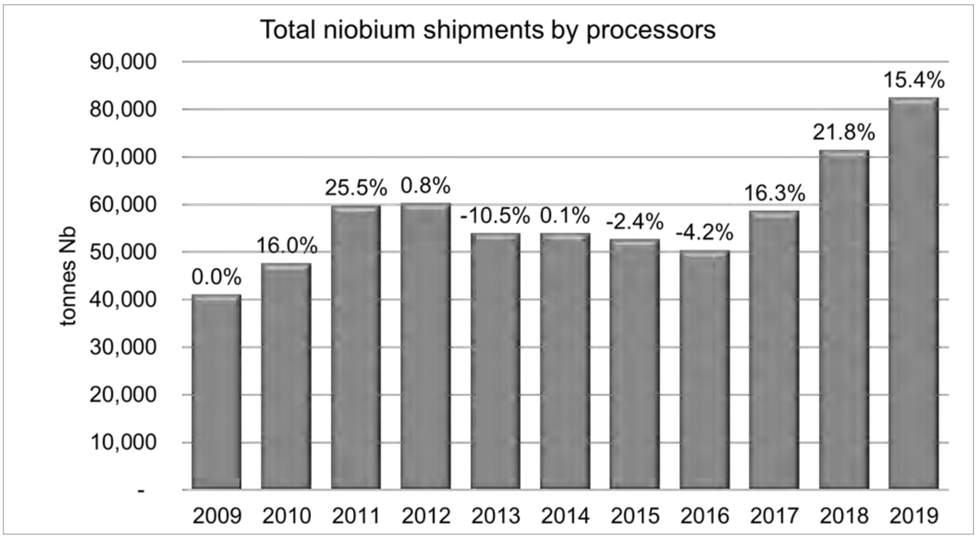


Figure 12: Niobium shipments by processors

In 2019, HSLA grade ferro-niobium saw a 17.3% increase over 2018, continuing a significant increase in demand which began in 2017. It should be noted that since 2016, the demand for niobium in the form of HSLA grade ferro-niobium has increased by over 18,000 mt annually.

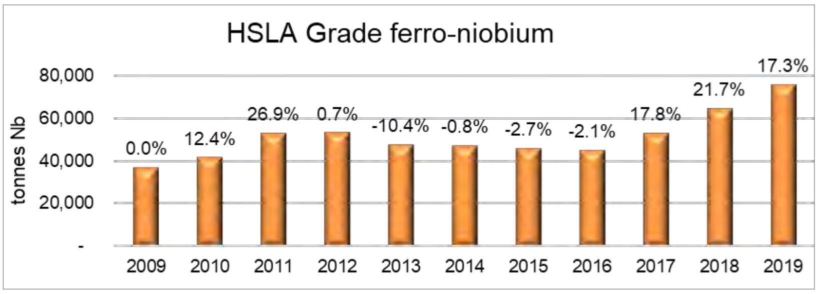


Figure 13a: Niobium shipments by processors broken down by category

While demand for ferro-niobium enjoyed significant increases, all other reported niobium products either held steady or saw slight decreases in volumes in 2019. Most notably, vacuum grade niobium saw a 10.1% decrease in volume over 2018. Niobium chemicals (-0.6%) and niobium alloys (-2.4%) also saw slight decreases in demand. Pure niobium metal (2.0%) is the only niobium product other than HSLA ferro-niobium to see an increase in demand for 2019. Together the decrease in demand for these niobium products offsets the gains in HSLA ferro-niobium by 1.9%.

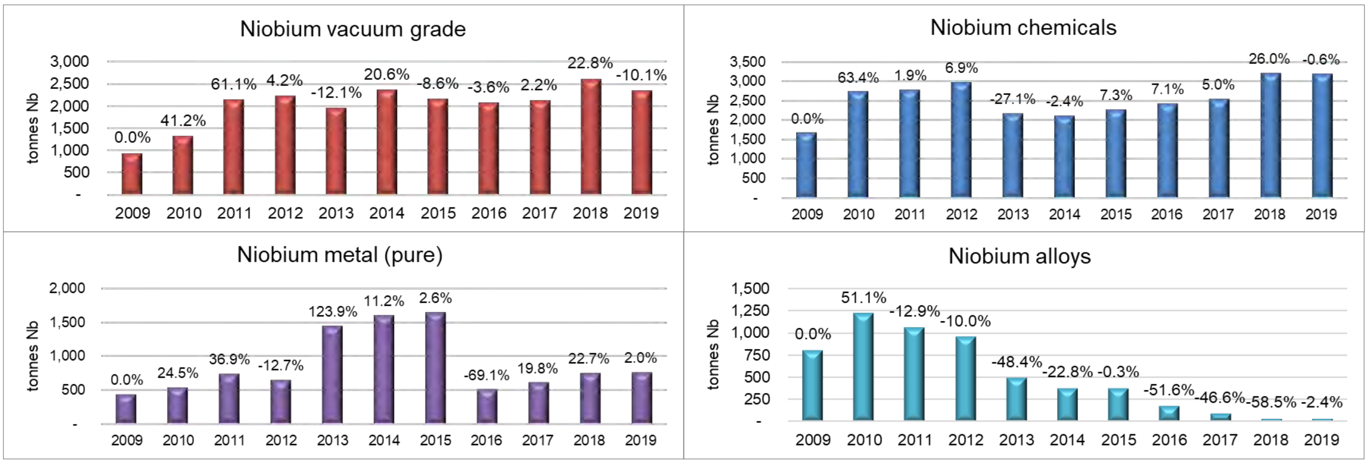


Figure 13b: Niobium shipments by processors broken down by category

Closing remarks

From the T.I.C.'s statistical analysis for the period in question there were mixed results. While the niobium market grew by a significant amount, mainly due to shipments of HSLA grade ferro-niobium, the tantalum market showed an alarming drop in processor shipments. This is almost entirely due to reporting of tantalum capacitor grade powders and tantalum mill products, a trend which appears to begin with CY2018. Unfortunately, with the COVID pandemic beginning early in CY2020, this trend could continue and is likely to affect the niobium market as well.

Adding comparative analysis and confirmation of members' data with international trade data in 2017 was well received by our membership. But we do not want to stop there. The T.I.C. Statistics Subteam continually strives to improve and add value for our membership, targeting to provide the most accurate and trusted industry statistics. As such we encourage and welcome all feedback. TIC

Tantalum and niobium intellectual property update

This information is taken from the European Patent Office (www.epo.org) and similar institutions. Patents listed here were chosen because of their apparent relevance to tantalum and/or niobium. Some may be more relevant than others. 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 herein.

Title		
Publication #	Applicant(s)	Publication date

TANTALUM

Dielectric film and electronic component
TW202035332 (A) — TDK CORP [JP] — 2020-10-01

Oxide sintered body and transparent conductive oxide film
US2021002755 (A1) — TOSOH CORP [JP] — 2021-01-07

Tantalum chloride and method for producing tantalum chloride
US2021002143 (A1) — TOHO TITANIUM CO LTD [JP], JX NIPPON MINING & METALS CORP [JP] — 2021-01-07

Reflective mask blank, reflective mask, and methods for manufacturing reflective mask and semiconductor device
WO2020256064 (A1) — HOYA CORP [JP] — 2020-12-24

Method of applying bioinertic tantalum coatings modified with nitrogen ions on titanium implants
RU2737912 (C1) — FEDERALNOE GOSUDARSTVENNOE BYUDZHETNOE OBRAZOVATELNOE... [RU] — 2020-12-04

Nickel-based heat-resistant wrought alloy and article made from it
RU2737835 (C1) — AKTSIONERNOE OBSHCHESTVO OBEDINENNAYA... KORPORATSIYA AO ODK [RU] — 2020-12-03

High specific capacitance capacitor-grade tantalum powder with improved electrical properties and process…
IL242043 (A) — NINGXIA ORIENT TANTALUM IND CO LTD [CN], NATIONAL ENGINEERING RES CENTER FOR SPECIAL METAL MATERIALS OF TANTALUM AND NIOBIUM [CN] — 2020-11-30

Tantalum capacitor
KR20200132621 (A) — SAMSUNG ELECTRO MECH [KR] — 2020-11-25

Carbonated tantalum coating material
TW202031591 (A) — TOKAI CARBON KOREA CO LTD [KR] — 2020-09-01

Solid electrolytic capacitor for a tantalum embedded microchip
TW202034357 (A) — AVX CORP [US] — 2020-09-16

Personalized 3d-printed porous titanium-based tantalum-coated bone plate and preparation method therefor
WO2020237705 (A1) — ZHAO DEWEI [CN], MA ZHIJIE [CN] — 2020-12-03

NIOBIUM

Niobium sputtering target
TW202035727 (A) — JX NIPPON MINING & METALS CORP [JP] — 2020-10-01

Niobium metal alloy
US10844464 (B1) — SPACE EXPLORATION TECH CORP [US] — 2020-11-24

Nanometer niobium carbide/carbon nanotube reinforced diamond composite and a preparation method thereof
US2020361777 (A1) — UNIV JILIN [JP] — 2020-11-19

Niobium oxide doped materials as rhodium supports for three-way catalyst application
US2020347763 (A1) — BASF CORP [US] — 2020-11-05

Method of producing a niobium oxide monocrystal
RU2734936 (C1) — FEDERALNOE GOSUDARSTVENNOE BYUDZHETNOE UCHREZHDENIE... [RU] — 2020-10-26

500 mpa niobium-containing ribbed reinforcing bar and manufacturing method therefor
WO2020206743 (A1) — UNIV NORTHEASTERN [CN] — 2020-10-15

Method for decomposing leaching tantalum and niobium from sodium-reduced tantalum-niobium metallic scraps
CN111719055 (A) — JIANGXI TUOHONG NEW MAT CO LTD [CN] — 2020-09-29

Modified niobium-titanium oxide and preparation method and application thereof
CN111725493 (A) — QINGTAO KUNSHAN ENERGY DEV CO LTD [CN] — 2020-09-29

Nitrogen-doped carbon-coated ultrafine niobium pentoxide nano composite material & preparation method thereof
CN111725490 (A) — WUHAN INST TECHNOLOGY [CN] — 2020-09-29

Smelting system for niobium-zirconium alloy
CN211564492 (U) — V&D NEW MAT JIANGSU CO LTD [CN] — 2020-09-25

Diary of industry events*

- Investing in African Mining Indaba Virtual, February 2nd - 3rd 2021
- Argus Metals Live – Virtual Conference, March 16th - 18th 2021
- IAEA Technical Meeting on Denials of Shipment, March 23rd - 26th 2021
- OECD Forum on Responsible Mineral Supply Chains, Paris, France, (tbc) April 2021
- Tarantula (Month 24) (virtual), (tbc) May 2021
- MMTA International Minor Metal Conference, Charleston, South Carolina, USA, June 28th - 30th 2021
- IAEA's 42nd TRANSSC meeting, (tbc) June 2021
- **T.I.C.'s 62nd General Assembly and 2021 AGM, September 19th to 22nd 2021**
- IAEA's 43rd TRANSSC meeting, (tbc) November 2021

* correct at time of print

Member company updates

Successful applications for membership

At the 61st General Assembly the following corporate membership applications were approved: Auxico Resources Canada Inc., Central America Nickel Inc., CONDOR Minerals Bolivia, Jiangxi Tuo Hong New Material Co., Ltd, Mister Oak Mining & Trading, Rarus Mining, and TAM International LP.

There were no associate membership applications in 2020.

Full details of the new member companies can be found on page 7.

Transfers of membership

At the 61st General Assembly the following membership transfers were approved:

- from **Specialty Metals Resources S.A.** to **Specialty Metals Resources Limited**;
- from **Stapleford Trading Ltd** to **Stapleford Minerals and Metals Ltd**.

Changes in member contact details

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

- **Guangdong Rising Rare Metals-EO Materials Ltd** has a new delegate, Mr Zheng Huiquan. He can be contacted at zh_ctns@126.com.
- **Guangdong Zhiyuan New Material Co. Ltd** had changed name to **Ximei Resources (Guangdong) Ltd**. The contact email and website have changed to market@ximeigroup.com and www.ximeigroup.com, respectively.
- **International Conference on the Great Lakes Region (ICGLR)** has a new acting delegate, Mr Gerard Nayuburundi. He can be contacted at gerard.nayuburundi@icglr.org.
- **Jiangxi TuoHong New-Raw Co. Ltd** had changed name since the time it applied for membership to **Jiangxi Tuo Hong New Material Co. Ltd**.
- **Minor Metals Trade Association** has moved offices to 3-4 Bower Terrace, Tonbridge Road, Maidstone, Kent, ME16 8RY, UK. All other details remain the same.
- **Roskill Information Services Ltd** has a new delegate, Ms Alison Saxby. She can be contacted at alison@roskill.com.

Terminations of membership

The Executive Committee terminated the following companies' corporate memberships due to non-payment of membership invoices: Alita Resources, Strategic Minerals Spain S.L. and Tantalex Resources.

Resignations of membership

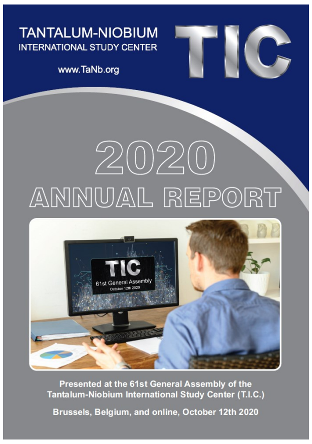
The following corporate members resigned from the Association at the 2020 AGM: A&M Minerals and Metals Ltd, Cronimet Central Africa AG, Heraeus Deutschland GmbH & Co. KG, Minerals Resources International AG, Neometals Ltd, Niobras Mineração Ltda and Standard Die International.

Editor's Notes

London, UK

Dear T.I.C. Members and stakeholders,

I hope that you, your family and friends are well and getting through these difficult days. Let's hope that 2021 is considerably less "interesting" than the year just ended and will allow us to meet in person once again. In an industry such as ours, conferences, trade shows and visiting customers play a critical role in building relationships and helping businesses run smoothly. Over the last year or so, not spending time face-to-face with business partners and colleagues has been quite a challenge and I can't wait to get on the road again later this year.



The 2020 Annual Report is available to download from www.TaNb.org

You can keep informed of T.I.C.'s work digitally, of course, including through the 2020 Annual Report (left), published last quarter, and in the four forthcoming Bulletin Reviews which will be published in Chinese, French, Japanese and Portuguese (to advertise in the Bulletin Reviews please contact info@tanb.org).

Finally, I was saddened to hear of Albert Hayoun's passing. I first met Albert about a decade ago and as with so many friends in this industry, we regularly met at metals conferences around the world. When we last talked face-to-face it was at a conference in Florida, USA, in October 2018; Standard Resources had recently resigned from the T.I.C. after 16 years and we talked for a long time about how the metals industry was changing and what challenges the future might bring.

Take care of yourself and those close to you.

Kind regards,

Roland

In memoriam of Albert Hayoun (1949-2020)

It is with sadness that the Association has learned of the passing of long-time T.I.C. member Albert Hayoun.

Albert was born on June 24th 1949 in Cairo, Egypt and grew up in the Jewish community on the edge of the city, within sight of the pyramids at Giza. While still a child he emigrated with his family, first to Marseille, France, where they lived for about five years, and then, at the age of 11, to the New York borough of Brooklyn, in the United States. It was in New York that he met his wife of 46 years, Rochelle, while they were both attending Brooklyn College, and over the decades their family grew to include three daughters and three grandchildren.

Aside from Standard Resources and his family, Albert was passionate about sharing the story of his immigration and helping others in need to settle into more peaceful lives.

To that end he was on the board of the immigrant aid organization HIAS for many years, a role which held special meaning for Albert since it was HIAS that first brought both his family and Rochelle's (and so many others) to America.

Albert started his metals career at Metallurg, before founding his own company, Standard Resources, in 1994. Standard Resources was an active member of the T.I.C. from 2002 to 2018 and in the tributes to Albert from our community two themes stand out - he was one of the nicest individuals in the tantalum/niobium industry and was of the highest integrity. Besides being a member of the T.I.C., Albert was also active at metals conferences worldwide over the years.

Albert was always a kind and polite member of the T.I.C. community and a staunch supporter of this Association for four decades, attending no less than 31 T.I.C. General Assemblies between 1983 and 2017. He passed away on December 1st 2020 from a sudden stroke. He will be missed.

The Executive Committee and staff of the T.I.C. extend condolences to Albert's family.

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The T.I.C. can be contacted at info@tanb.org; www.tanb.org; +32 2 649 51 58, or at the registered address: Chaussée de Louvain 490, 1380 Lasne, Belgium.

The T.I.C. is an international, non-profit association founded in 1974 under Belgian law that represents around 90 members from over 30 countries involved with all aspects of the tantalum and niobium industry. The T.I.C. is managed by an Executive Committee elected from the membership and representing all segments of the industry. Corporate membership costs EUR 2750 per year and full details of benefits are available at www.TaNb.org


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