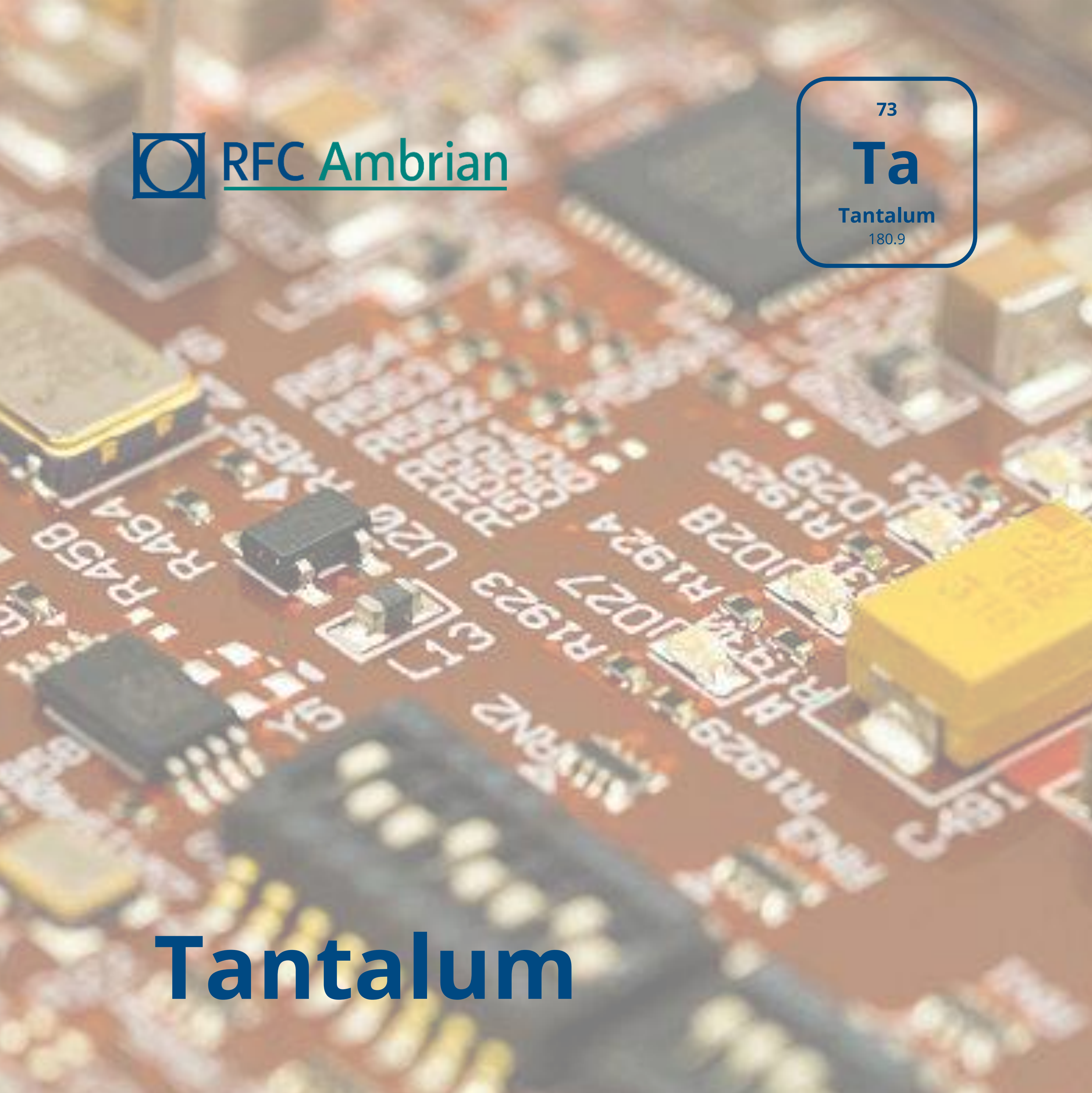

RFC Ambrian

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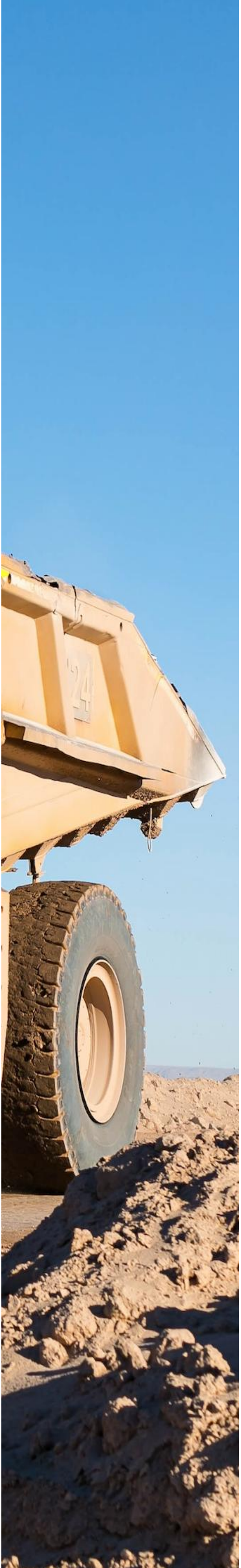
Tantalum

Central Africa More of a Threat Than China

Critical Minerals Commodity Report

October 2025



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Front picture: Circuit board – European Passive Components Institute

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Executive Summary

Introduction

This report on tantalum is the fifth in our 2025 series on critical minerals. Due to their use in clean energy technologies and semiconductors, critical minerals have gained prominence in government policy agendas and captured the public's interest. Many of these commodities face increased demand, supply chain bottlenecks, volatile price fluctuations, and geopolitical concerns. These markets are becoming increasingly complex, as China leverages its strong position as a supplier of many critical minerals by imposing certain export restrictions.

While many valuable reports are available on critical minerals more broadly, few concentrate on the actual market dynamics of individual commodities. This lack of coverage partially reflects the relatively small size of some of these commodity markets (many are primarily produced as a by-product), the limited number of mining and processing companies, and the scarce opportunities for equity investment. Access to data is challenging, and industry facts are hard to find, resulting in a lack of transparency in the supply and demand picture. Our reports aim to explore the available information and analyse some of the key risks to these commodity supply chains.

Critical Minerals

Critical minerals lack a universally accepted definition and are classified based on current technological requirements and the respective supply and demand dynamics applicable to different countries and markets. For example, the United States identifies 50 minerals as critical, the European Union 34, Japan 34, and Australia 31. Seventeen commodities are common to all these countries, including tantalum.

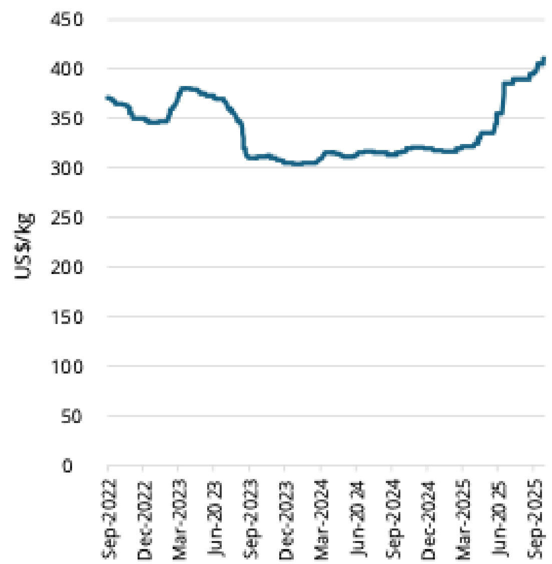
Tantalum is featured on the critical minerals lists due to its reliance on supply from Central Africa, where most of the mining is artisanal. Tantalum's role is also essential in the electronics industry, with products used in consumer, automotive, military, aerospace, and medical markets.

The tantalum market is very small, and its supply chain is relatively complicated and not very transparent. Its size characteristics compare suitably with those of the four critical minerals covered in our previous reports (antimony, gallium, germanium, and indium); however, the supply-demand dynamics of tantalum are more balanced, and China does not play a critical role in its supply, only accounting for 30% of metal production in 2024 (see Table 1).

Tantalum Resources are Significant

Tantalum-bearing minerals are widely distributed around the world, and the resource base is very large. However, data on global reserves and resources are fragmentary and incomplete, but resources are concentrated in Australia, Brazil, Canada, China, the DRC, Nigeria, and Rwanda. Known resources are equivalent to at least 100 years of supply at current consumption rates. While tantalum is considered a rare element, very few other commodities have a resource base as large, relative to anticipated future demand.

Figure 1. Tantalum Price 2022- 2025 (US$/kg)



Source: Bloomberg. China tantalum metal 99.95% FOB.

Detailed information on tantalum resources, mining, processing, and manufacturing is limited, and available data are sometimes contradictory.

ASM Dominates Tantalum Production

The largest producers of mined tantalum in 2024 were the DRC (42%), Nigeria (18%), Rwanda (17%), and Brazil (10%), collectively representing 87% of the total output. Tantalum raw materials come from various sources. In 2020, the Tantalum-Niobium International Study Center (TIC) reported that 1.62 kt of tantalum was produced from primary feedstocks (compared with 2.10 kt reported by the USGS): these comprised tantalum concentrates (62%), tin slag (22%), and other concentrates (16%).

About 60% of tantalum production originates from artisanal and small-scale mining (ASM) in Central Africa, from the DRC, Rwanda, Uganda, and Burundi. ASM recovery of tantalum also takes place in other countries around the world.

Tantalum mining has been linked to armed conflict and human rights abuses, particularly at the ASM operations in Central Africa, and is sometimes termed a conflict mineral. To address these concerns, much of the tantalum supply chain follows due diligence guidelines issued by international organisations for mineral traceability. However, ASM mining can also lead to social and environmental problems, including land-use conflicts, soil erosion, and deforestation. These factors are not included in this due diligence.

Despite increased oversight and due diligence in tantalum mining, Central Africa remains a politically unstable region and a threat to the resilience of the tantalum supply chain. The recent escalation of militia activity in the DRC and Rwanda has raised doubts about the legitimacy of supply from the region. It has prompted some Western smelters to cease sourcing from Central Africa altogether. However, many smelters in East Asia continue to buy from the region. Smelters have also faced pressure from downstream stakeholders, including original equipment manufacturers such as Apple, which are urging smelters to avoid sourcing from the region.

A relatively small number of industrial mines account for the non-ASM share of tantalum output, produced mainly as a by-product of lithium, tin, and REE operations. Tantalum supply from hard rock has increased with the start-up of new lithium mines in Australia and Canada. This source of tantalum production is expected to grow further as more hard-rock lithium mines come online, although recent falls in the price of lithium have delayed or slowed many projects. China is a relatively minor producer of mined tantalum, and all Chinese mine output is used domestically.

Table 1. Critical Mineral Characteristics

Critical Mineral	Prodn 2024 tonnes	Price US$/kg 2024	Market Value US$m	China Metal Production 2024 %
Antimony	103,960	21	2,177	85
Gallium	762	220	168	98
Germanium	250	2,100	525	82
Indium	1,080	340	367	70
Tantalum	2,100	208	436	30

Source: USGS, RFC Ambrian.

There are other hard rock projects in the pipeline that contain a defined resource of tantalum and have the potential to recover and produce tantalum in the future, at least according to indications from the operating company. Potential tantalum production volumes are rarely discussed, and determining the timing of possible production from the projects is very difficult; some may never reach production. RFC Ambrian has identified 19 significant mining projects listed in the report.

Active tantalum smelters are located in Brazil, China, Estonia, Germany, India, Japan, Kazakhstan, Mexico, Rwanda, and Thailand. The Responsible Miners Initiative (RMI) provides a list of 33 active smelters. The US, Brazil, China, and Rwanda have both mines and processing facilities. Tantalum contained in tin slag (synthetic ore) is also shipped to these processing plants for smelting. China is the largest importer and refiner of tantalum concentrates, with Chinese imports accounting for approximately 30% of the global consumption of tantalum ore, concentrates, waste, and scrap.

Scrap is mainly recovered from intermediate manufacturing, which has high purity and can be easily collected. Tantalum recovery in consumer products is usually very low.

A Diverse Range of Demand

Primary products from tantalum processors are used to manufacture a diverse range of products. Major consumers of tantalum include the electronics, metallurgy, and carbide industries. In electronics, tantalum is used in capacitors, surface coatings for semiconductors, and SAW filters. In alloys, tantalum is used to increase the strength, ductility, and corrosion resistance of metals. Tantalum carbides are used in cutting tools, and superalloys are essential to the aerospace and turbine sectors. Secondary tantalum chemicals also have a wide range of applications.

The electronics industry accounts for approximately 52% of tantalum consumption (capacitors 34%, semiconductors 9%, hard disk drives 7%, and SAW filters 2%). The metallurgical industry accounts for about 34% of consumption (aerospace 15%, chemical processing 7%, industrial gas turbines 6%, medical 3%, industrial furnaces 3%). Carbides account for another 9% with the remaining 5% used in various chemical and other applications. In September 2020, the US banned the use of tantalum metal and alloys from China, Iran, North Korea, and Russia in US military projects.

Electronics is a Key Market

Capacitors are a vital component of nearly all electronic products. Capacitors store energy electrostatically in an electric field. Computing represents the most significant end market for tantalum capacitors (45%). China, Japan, and South Korea are major producers and consumers of electronic products, leading to strong demand for tantalum in this region.

Continuous improvements in tantalum capacitors have been made through the use of increasingly fine powder particles, which possess a higher surface area-to-volume ratio. Significant enhancements have also been achieved in anode sintering technology and in the dielectric formation process, enabling better capture of the high capacitance value of tantalum powder. Other advancements by tantalum capacitor manufacturers have led to further miniaturisation, lower internal resistance, improved reliability, and higher temperature resistance.

However, although the number of tantalum capacitors continues to increase each year, ongoing miniaturisation has reduced the size of individual capacitors, offsetting the potential growth in overall tantalum consumption. Simultaneously, tantalum is being replaced by other materials in manufacturing, partly due to the higher cost of tantalum-based capacitors. These alternative capacitor products have gained market share from tantalum capacitors.

Consequently, while the volume of capacitors produced has grown significantly in recent years, the amount of tantalum used in capacitors has grown much more slowly. Tantalum capacitors are primarily used in high-end applications where compact designs, the ability to handle higher currents, and zero tolerance for failure are required. Growth markets include electric vehicles, 5G telecommunication, AI computing, military, aerospace, satellites, and wearable devices. The US CHIPS and Science Act of 2022 is expected to play a crucial role in expanding the domestic chip manufacturing industry in the US, thereby increasing demand for materials critical to semiconductor production, including tantalum.

Long-Term Outlook Relatively Stable

The availability of data, both in quantity and quality, for participants in the tantalum market is limited. This creates a risk to the supply chain because, without dependable estimates of resources, supply, and demand, it becomes more challenging for participants to adapt to changing market conditions and maintain the long-term market balance for tantalum.

Fortunately, long-term supply issues are not anticipated to be significant, and demand growth appears likely to remain robust, albeit likely modest. Also, while Asia is a key consumer region, the tantalum market is not as heavily dominated by China as it is for many other critical minerals. As a result, the outlook for tantalum appears relatively steady, and the price will most likely be dominated by short-term fluctuations in output and/or sentiment in response to political events affecting supply in Central Africa.

1. The Industry Basics

Tantalum (element symbol Ta) is a silver-grey, high-density, hard transition metal. Tantalum possesses unique properties that make it essential in a wide range of products and applications. These include high conductivity, corrosion resistance, biocompatibility, a very high melting point, shape memory characteristics, and a high coefficient of capacitance.

The tantalum industry is very small compared with the scale of activity associated with most other metals. Total global mine production is about 2,100 t/y of contained tantalum, which is worth about US$436 m annually at the 2024 average price of approximately US$170/kg of tantalite ($Ta_2O_5$) [1]. Tantalite contains 81.9% tantalum.

Due to the small size of the industry, most industry participants (miners, processors, and refiners) are wary of providing information about their activities for competitive reasons. The industry is overseen by the Tantalum-Niobium International Study Center (TIC) [2], but production data from 2020 onwards is only available to members, and other sector data on its website is outdated. The lack of reliable data on resources, mining, processing, and manufacturing makes the tantalum market opaque. The involvement of (sometimes informal) traders who buy and sell tantalum concentrates and scrap is a further complication.

Approximately 60% of tantalum production originates from artisanal and small-scale mining (ASM) in Central Africa, with the remainder mainly produced as a by-product of lithium, tin, and REE mining. China is a relatively minor producer of tantalum but plays an important role as an importer of tantalum concentrate for further processing, holding an estimated 30% market share of refined products. Other notable producers of refined tantalum include Japan (24%), Germany (10%), Thailand (10%), and the United States (6%).

Data on the demand side of the tantalum supply chain is also limited. The main use of tantalum is in capacitors on circuit boards, which accounts for a very small percentage by volume of finished subcomponents and final products; as such, most cross-border trade in tantalum is not reported. The electronics industry accounts for approximately 52% of tantalum consumption, the metallurgical sector about 34%, carbides about 9%, with the remaining 5% used in various chemical and other applications.

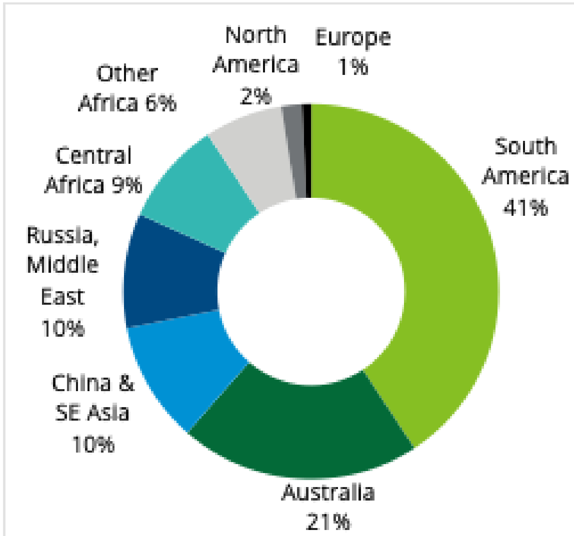
Tantalum Geology

Tantalum-bearing minerals are usually found within an igneous host rock where they form small grains of complex polymetallic oxides that typically amount to no more than 0.05% (Ta_2O_5) of the total mass. Most tantalum is refined from tantalite-columbite ore (colloquially called 'coltan' in Africa), but microlite, wodginite, and strüverite are also important minerals.

Tantalum Resources

Tantalum-bearing minerals are widely distributed around the world, but data on global reserves and resources of tantalum are incomplete.

Figure 2. Tantalum Resources by Region



Source: Burt, TIC Bulletin N° 141 - March 2010

Table 2 presents two different data sets: reserves reported by the USGS and reserves and resources reported by industry consultant Burt in 2010 [3].

Table 2: Global Reserves and Resources

Location	USGS Reserves Ta kt 2024	Burt* Reserves & Resources Ta kt 2010	Burt* R&R % of Total
Australia	110.0	53.9	20.7
Brazil	40.0	-	-
China	240.0	-	-
China & SE Asia	-	27.1	10.4
South America	-	105.9	40.8
Central Africa	-	23.4	9.0
Other Africa	-	17.5	6.7
Russia & Middle East	-	25.6	9.9
North America	-	4.5	1.7
Europe	-	1.9	0.7
Total	390.0	259.7	100.0

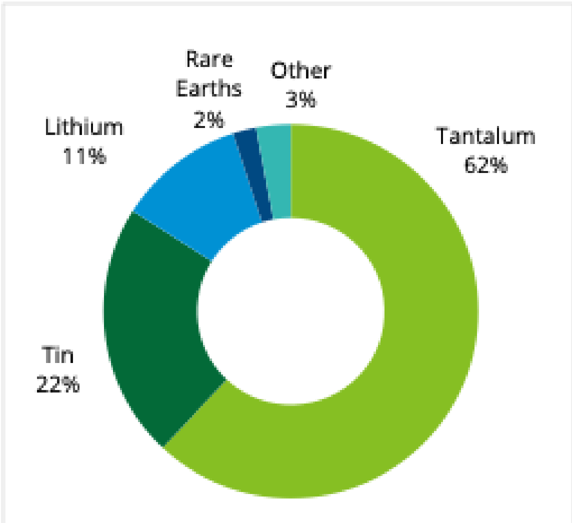
Source: USGS 2025, * Burt, TIC March 2010.

World tantalum resources and mining capacities are concentrated in Australia, Brazil, Canada, China, the DRC, Nigeria, and Rwanda. Tantalum is also found in Colombia, Bolivia, Burundi, Gabon, Greenland, India, Malawi, Namibia, Russia, Saudi Arabia, Uganda, and the United States.

The USGS reports a tantalum reserve for China (240 kt), Australia (110 kt), and Brazil (40 kt) in its Mineral Commodity Summaries, but notes that identified world resources (most of which are located in Australia, Brazil, and Canada) are considered adequate to meet projected demand. It also states that the United States has about 55 kt of tantalum resources in identified deposits, most of which were deemed subeconomic at 2024 prices for tantalum.

The last published report specifically estimating global tantalum resources was released in the TIC Bulletin in early 2010. The report identified resources of approximately 317 kt Ta_2O_5 (equivalent to 260 kt tantalum). The largest resources were found in South America (principally Brazil) and Australia, which together accounted for 62% of global resources (Figure 2). The data underlying the TIC report did not meet the Australian JORC code or National Instrument 43-101 (NI 43-101) standards, and data from Central Africa were incomplete, suggesting that the bulletin underestimated total global resources. African tantalum production, which has historically been underreported and geologically underestimated, could account for up to 20% of the world's resources.

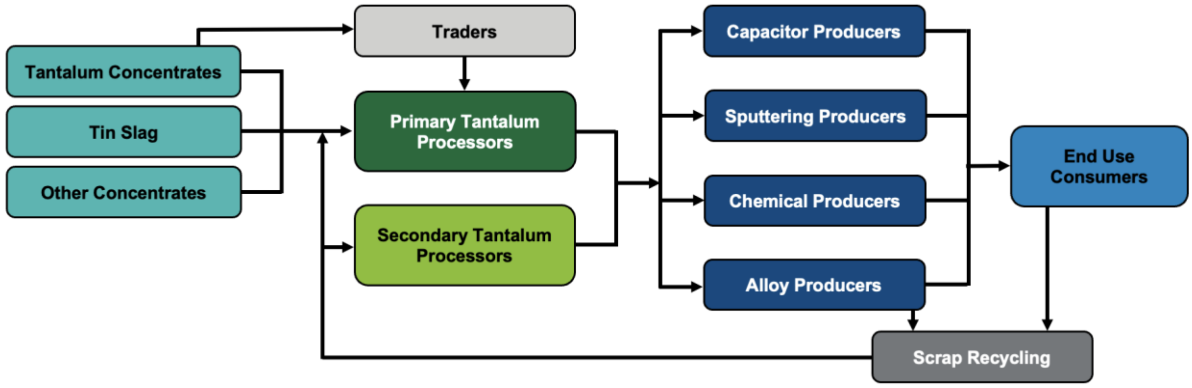
Figure 3. Tantalum Mine Production by Primary Commodity Type



Source: BGR –Tantalum Sustainability Information 2021

Based on the USGS data presented above, known tantalum reserves are equivalent to 74 years of supply at current consumption levels (using an estimated 40% overall recovery). This excludes the

Figure 4. Simplified Tantalum Supply Chain



Source: RFC Ambrian

extensive resources in Central Africa and other regions of South America. Tantalum is considered a critical mineral, but very few other commodities – critical or otherwise - have a relative resource base of this magnitude.

Tantalum Supply Chain Structure

The DRC, Nigeria, Rwanda, and Brazil are the largest producers of mined tantalum and together accounted for 87% of annual mine production in 2024 [(1)]. Production in the DRC and Rwanda is mainly from ASM. These two countries, along with two other African ASM-dominated sources of tantalum, Uganda and Burundi, accounted for 60% of global annual production in 2024.

However, ASM is inefficient in identifying, mining, managing, and processing mineral resources, and the practice remains a contentious issue across Africa, South America, and Southeast Asia. For ASM beneficiation, average recovery is 50% or less, compared with 70 to 95% for industrial mines. However, while political issues dominate, these factors remain secondary.

A relatively small number of industrial mines are responsible for producing the non-ASM remainder of the global tantalum supply, principally as a by-product of lithium, tin, and REE operations. The recent surge in lithium production for EV battery use has led to an increase in by-product tantalum output. China is a relatively small producer of tantalum, and all of its mine output is used domestically.

Worldwide, tantalum is primarily used in electronics to manufacture capacitors for electronic devices, as a surface coating for semiconductors, and in SAW (Surface Acoustic Wave) filters, which are designed to remove unwanted frequencies from a circuit. In metallurgy, it is used in alloys to increase strength, ductility, and corrosion resistance. Tantalum carbides are used in cutting tools, and tantalum-containing superalloys are essential to the aerospace industry. Tantalum-based chemicals also have a wide range of applications. Figure 4 illustrates a simplified supply chain for tantalum.

Supply Chain Governance

Tantalum is classified as a critical mineral due to its technological importance and the high risk of potential supply disruptions. The supply risk mainly arises from a significant portion of production coming from Central Africa, where tantalum mining has been linked to armed conflict and human rights abuses. To address these concerns, much of the tantalum supply chain follows due diligence guidelines issued by the Organisation for Economic Co-operation and Development (OECD) [(4)], the US Dodd-Frank Act [(5),] or supply chain compliance requirements outlined in EU Regulation 2017/821 [(6)]. Over 40 companies in the tantalum supply chain are audited annually to ensure compliance with relevant conflict-related legal and industry standards [(7)]. However, the ongoing political situation in the DRC and its neighbouring countries, including Rwanda, makes it challenging to mine and monitor tantalum production in this region.

2. Demand Fundamentals

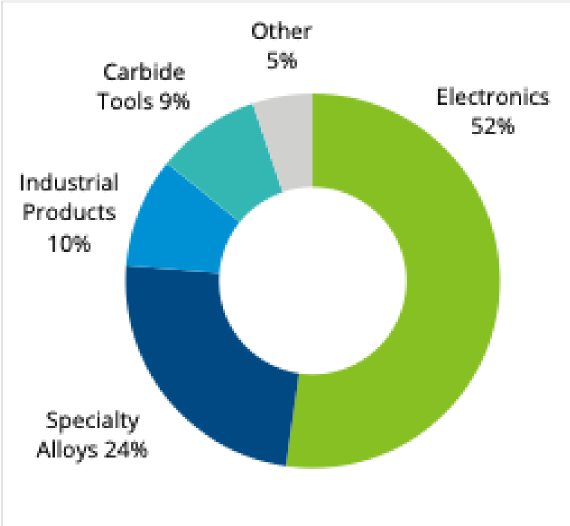
The existing literature on the demand side of the tantalum supply chain is limited. A high proportion of tantalum is not imported as a commodity; instead, it enters Europe and North America as a small component within finished subcomponents and final products. As a result, a significant portion of cross-border trade in tantalum remains unreported.

The USGS has devoted considerable attention to analysing the tantalum supply chain and recognises that quantifying tantalum consumption using trade data is problematic. A recent USGS report states that part of the problem is that two of the most important intermediate forms of tantalum – tantalum pentoxide (Ta_2O_5) and potassium tantalum fluoride (K_2TaF_7) – do not have unique tariff codes, resulting in a significant portion of the tantalum trade being undocumented. Furthermore, tantalum contained in semi-finished and finished goods is not recorded on trade ledgers as a commodity, but rather as a finished good.

As a result, tantalum consumption data is generally estimated and usually based on import data and guestimates from the end-use industry. Tantalum concentrate is mainly processed in Asia, Europe, or North America. China is the largest importer and refiner of tantalum concentrates, accounting for about 30% of global tantalum consumption. China, Japan, and South Korea are major producers and consumers of electronic products, leading to strong demand for tantalum in the region.

Primary products from tantalum processors are used to manufacture a diverse range of products. Major consumers of tantalum include the electronics, metallurgy, and carbide industries. In electronics, tantalum is used in capacitors, surface coatings for semiconductors, and SAW filters. In alloys, tantalum is used to increase the strength, ductility, and corrosion resistance of metals. Tantalum carbides are used in cutting tools, and superalloys are essential to the aerospace and turbine sectors. Secondary tantalum chemicals also have a wide range of applications.

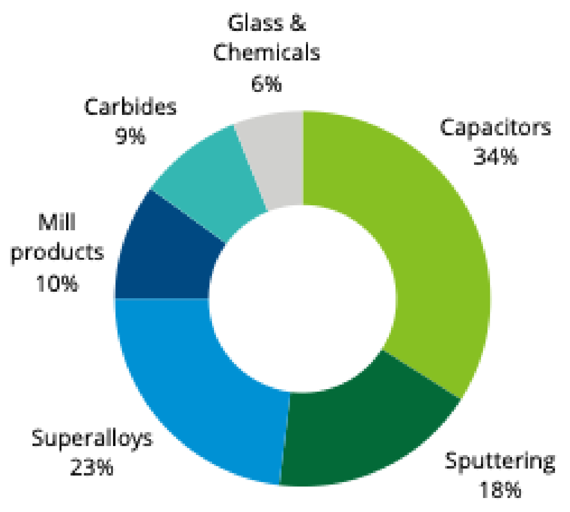
Figure 5. Tantalum End-Use Industries



Source: RFC Ambrian estimates, TIC, USGS.

The electronics industry accounts for approximately 52% of tantalum consumption (capacitors 34%, semiconductors 9%, hard disk drives 7%, and SAW filters 2%). The metallurgical industry accounts for about 34% of consumption (aerospace 15%, chemical processing 7%, industrial gas turbines 6%, medical 3%, industrial furnaces 3%). Carbides account for another 9% with the remaining 5% used in various chemical and other applications.

Figure 6. Tantalum End-Use Products



Source: RFC Ambrian estimates, TIC, USGS.

Figure 5 shows global tantalum end-use industries and Figure 6 shows global tantalum end-use products.

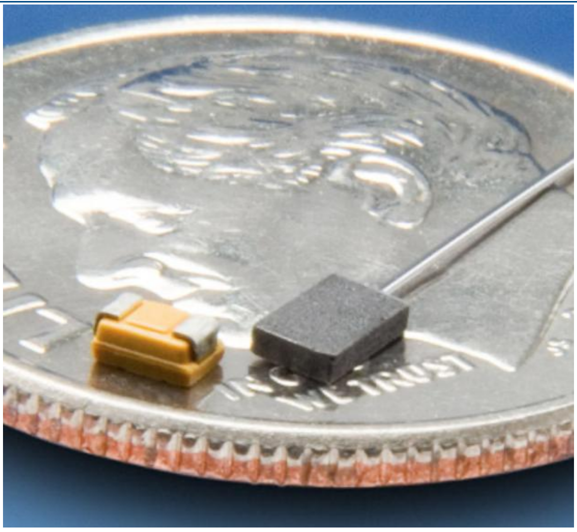
Tantalum Capacitors

Capacitors are a vital component of nearly all electronic products. Capacitors store energy electrostatically in an electric field. Computing represents the most significant end market for tantalum capacitors (45%), but they are also crucial in high-end applications, including telecommunications, data storage, military, aerospace, implantable medical devices, and, more recently, AI chipsets. Capacitors are also used in thermal battery management systems in EVs. In 2024, the global capacitor industry's revenue was approximately US$31 bn [8].

Tantalum capacitors account for approximately 8% of the value but less than 1% of the market volume for industrial capacitors by dielectric type (Figure 8).

Tantalum capacitors have good stability and large capacities and, as such, are preferred in small form-factor circuits operating in harsh environments that are subject to large temperature fluctuations and in high-capacity applications (used in high-voltage and high-power electronic devices when good reliability and a small-component footprint are required).

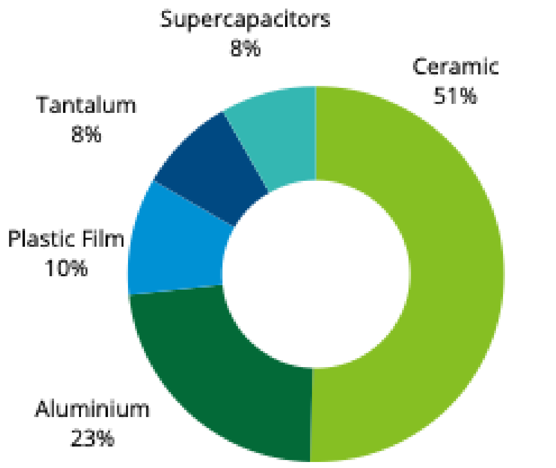
Figure 7. Tantalum Capacitors



Source: Global Advanced Metals

Continuous improvements in tantalum capacitors have been made through the use of increasingly fine powder particles, which possess a higher surface area-to-volume ratio. Major enhancements have also been achieved in anode sintering technology and in the dielectric formation process, enabling better capture of the high capacitance value of tantalum powder [9]. Other advancements by tantalum capacitor manufacturers have led to further miniaturisation, lower internal resistance, improved reliability, and higher temperature resistance.

Figure 8. Capacitor Market by Dielectric Value



Source: Thunder Said Energy.

The main raw materials used in tantalum electrolytic capacitors are capacitor-grade tantalum powder and tantalum wire, along with manganese dioxide or polymer cathodes. The processing of tantalum for capacitors mainly occurs in Japan, Germany, China, the US, and Kazakhstan. Key producers of tantalum capacitors include Kemet (YAGEO), Kyocera AVX, Vishay, and Panasonic. There are several tantalum capacitor manufacturers in China serving primarily the Chinese market [10].

There are two main factors decreasing demand for tantalum in the capacitor market: miniaturisation and substitution. Although the number of tantalum capacitors continues to increase each year, ongoing miniaturisation has reduced the size of individual capacitors, offsetting the potential growth in overall consumption. Simultaneously, tantalum is being replaced by other materials in manufacturing, partly due to the higher cost of tantalum-based capacitors. Substitutes include mass-produced high-capacitance multilayer ceramic chip capacitors (MLCCs – known for their low cost and reliable supply chain); conductive polymer, moulded chip aluminium electrolytic capacitors (solid polymer aluminium); and Nb_2O_5 moulded chip capacitors. These alternative capacitor products have gained market share from tantalum capacitors.

Tantalum Alloys and Superalloys

In addition to its corrosion resistance properties, tantalum also demonstrates excellent physical characteristics, including good ductility, which enables it to be formed into a variety of rolled products, such as wire, sheet, rod, and bar. Tantalum alloys can also be readily fabricated into various components, including high-end tubes, thermowells, heat exchangers, industrial chemical equipment, rocket and aircraft parts, and surgical instruments. Tantalum is frequently alloyed with other elements, such as niobium and nickel-based superalloys, to improve its strength and temperature resistance further.

Adding between 3 and 11% tantalum to nickel-based "superalloys" (used mainly in aerospace and turbines) helps stabilise creep deformation because of its exceptionally high melting point. Tantalum bonds with other metals on the crystalline grain boundaries within the superalloy, thereby reducing the potential for deformation/creep, increasing high-temperature tensile strength, and enhancing engine service life and performance.

The tantalum-tungsten alloy market is currently growing in China, Japan, South Korea, and India. Various factors, including technological progress, increasing demand across different industries, and the growing use of alloys in critical applications such as electronics, aerospace, and automotive sectors, drive this growth.

Tantalum in Semiconductors

Tantalum ingots are essential in semiconductor manufacturing. Using the physical vapour deposition (PVD) process, tantalum is "sputtered" onto semiconductor substrates to form a thin diffusion barrier film that prevents copper interconnectors from diffusing into the silicon wafer. The tantalum-based coatings exhibit high thermal stability, conductivity, and excellent corrosion resistance. Tantalum sputtering targets are also used in various other products, including magnetic storage media, inkjet printer heads, and flat-panel displays.

US-based Materion (HC Stark) [NYSE: MTRN] and TaniObis GmbH of Germany, owned by JX Nippon Mining and Metals, are the two leading companies manufacturing tantalum sputtering materials.

Tantalum Medical Devices

Tantalum implants are compatible with human tissue. Tantalum-based implants are often designed to be porous, enabling bone and blood vessels to grow through them, securing the implant and preventing loosening over time. Porosity also decreases weight. Tantalum capacitors are used in implantable hearing aids, neurostimulators, pacemakers, and insulin pumps.

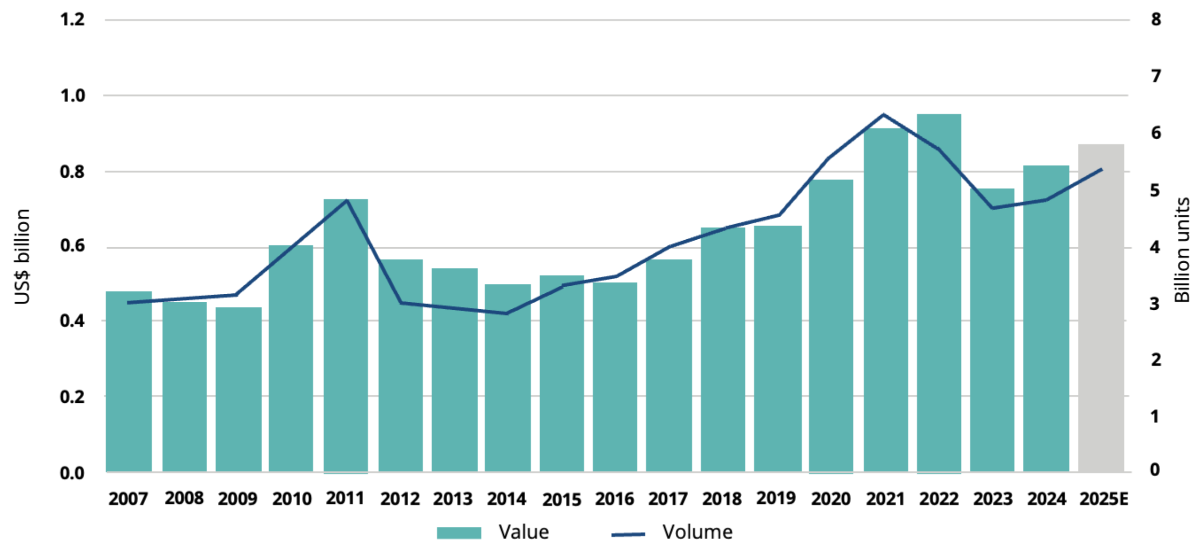
Tantalum in Chemicals

High-grade Ta_2O_5 is used in optical glass, such as camera lenses. However, in recent years, demand for such glass has declined, as consumers have shifted to camera-enabled smartphones that require less optical glass than traditional cameras. This reduction in tantalum demand for optical glass has been offset by increased demand from mobile phones, which use lithium tantalate in SAW filters to convert electrical energy into acoustic or mechanical outputs. Lithium tantalate enables better electronic signal wave damping and frequency control, thereby enhancing audio quality. Tantalum pentoxide is also used to apply a highly wear-resistant coating to critical components of mobile phones.

Tantalum Carbide

Tantalum carbide has an extremely high melting point - one of the highest known for any material. It is also very hard and is used in cutting tool bits. Tantalum carbide is widely employed as a sintering additive in ultra-high-temperature ceramics (UHTCs) or as a ceramic reinforcement in high-entropy alloys (HEAs) because of its excellent hardness, elastic modulus, thermal conductivity, thermal shock resistance, chemical stability, and high melting point.

Figure 9. Tantalum-Polymer Capacitor Demand



Source: YAGEO Group

Other Tantalum Applications

Tantalum is utilised in various other applications that demand strength, ductility, toughness, corrosion resistance, high thermal conductivity, and high melting points. Tantalum's excellent resistance to corrosion and heat makes it an ideal lining material for vessels, piping, valves, and heat exchangers in the chemical and pharmaceutical industries.

Tantalum is also used in the electronics industry in metal-oxide-semiconductor field-effect transistors (MOSFETS). Transistors form the core of any electronic device by amplifying and switching signals. In an integrated circuit, there are tens of thousands of transistors on a small chip. Individual transistors are now so small that they cannot be seen with the naked eye. Small transistors are the basis for the development of powerful mobile phones and laptops.

Substitution of Tantalum

Tantalum has been used continuously in various industries for decades, especially in defence and space electronics, and its performance and behaviour are well-documented. However, depending on relative prices, the industry has developed and employed multiple substitutes. For instance, tantalum provides the highest capacitance in the smallest form factor for electronics design engineers, but it has been gradually replaced by capacitors made from other materials. Consequently, while the volume of capacitors produced has grown significantly in recent years, the amount of tantalum used in capacitors has grown much more slowly, mainly employed in high-end applications. However, they remain essential for compact designs, higher currents, and situations where there is zero tolerance for failure [11].

Materials such as tungsten, molybdenum, and titanium could replace tantalum in the diffusion layer (sputtering) process used in semiconductor manufacturing. However, tantalum remains the preferred sputtering agent because of its high thermal and electrical stability with copper, good adhesion to silicon, minimal grain boundaries, strong bonding, and consistent grain thickness.

Tantalum carbide can be substituted with niobium carbide, depending on price considerations and relevant applications.

3. Supply Fundamentals

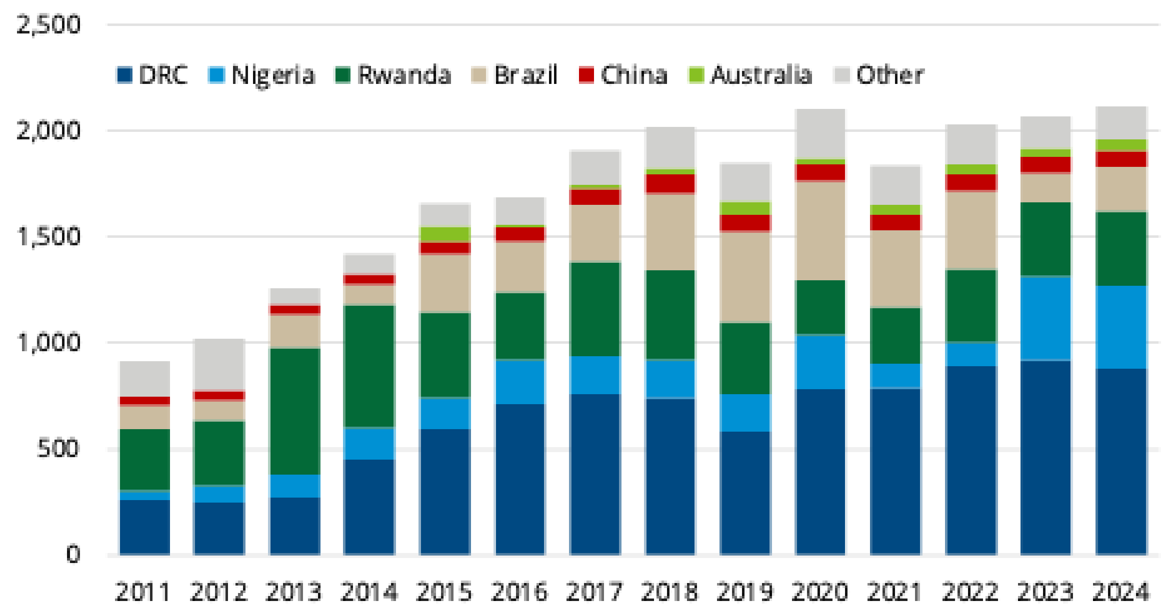
Supply-side data for tantalum is challenging to track because about 60% of production comes from ASM, and much of the rest comes from mining operations where tantalum is only produced as a by-product. The involvement of (sometimes informal) traders who buy and sell tantalum concentrates and scrap adds further complexity. The USGS reports tantalum mine production of 2.11 kt in 2024, compared with 2.07 kt in 2023. Figure 10 shows that supply has remained broadly flat since 2017, fluctuating around 2.0 kt per annum. Mine supply declined slightly in 2021, due in part to COVID-related disruptions to ASM operations.

The TIC also reports production data, although it is only publicly available up to 2020. It believes that its data covers most of the industry but excludes some artisanal mining operations. In 2020, the TIC reported primary annual production of 1.62 kt of tantalum (compared with 2.10 kt reported by the USGS). From 2010 to 2020, the TIC's primary production data typically consisted of tantalum concentrates (62%), tin slag (22%), and other concentrates (16%), growing at a 1.5% CAGR. The TIC also reports the consumption of secondary tantalum material (recycled scrap) by processors. In 2020, 0.46 kt of secondary material was reported. The volume of this material fluctuated between 2010 and 2020 but effectively declined significantly over the period, with a -5.1% CAGR.

The reported decline in scrap use by secondary processors may be partly due to the implementation of the Defense Federal Acquisition Regulation Supplement (DFARS) 252.2 in September 2020, an interim rule that prohibited the use of tantalum metal and alloys from China, Iran, North Korea, and Russia in US military projects. Additionally, increasing quantities of scrap are reportedly being used directly by some downstream manufacturers, especially by suppliers of sputtering products, rather than being sent back to secondary processors.

Pegmatite deposits currently represent the largest proportion of tantalum mine production (78%), followed by alkaline granite and syenite deposits (12%), and rare-metal granite deposits (5%) [12]. Figure 11 displays a map of the world's major tantalum and niobium mines and deposits.

Figure 10. Mine Production of Tantalum by Country 2011-2024 (tonnes)



Source: USGS data.

Figure 11. Location of Major Tantalum and Niobium Mines & Deposits

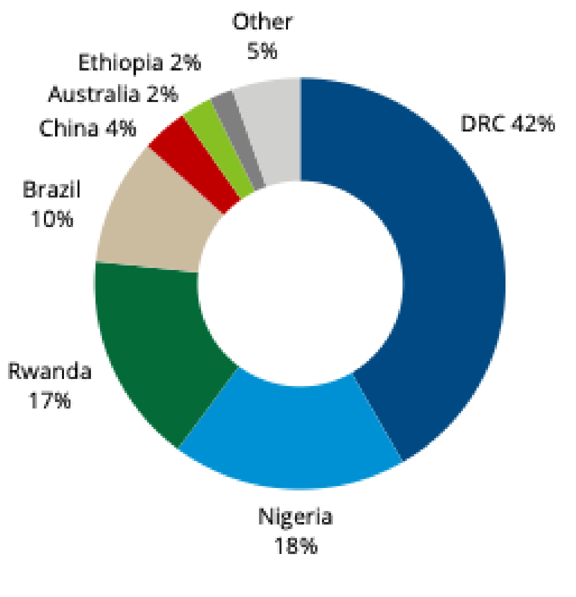
Source: RFC Ambrian. Positions are indicative only.

Tantalum Mine Production

Figure 12 displays mine production of tantalum by country. The leading producers are the DRC (42%), Nigeria (18%), Rwanda (17%), and Brazil (10%). Collectively, these four countries made up 87% of the annual production in 2024. Production from Central Africa (including the DRC, Rwanda, Uganda, and Burundi) mainly comes from ASM operations and accounted for nearly 60% of global output. China produces a relatively small amount of tantalum, with all domestic mine production used locally. Additionally, China is a major importer of tantalum concentrate for further processing.

The primary tantalum recovered from concentrates (Ta_2O_5) in Central Africa is mainly sourced from pegmatites. Ore beneficiation in ASM operations does not follow a standardised procedure, and these tantalum concentrates are more heterogeneous compared with those from industrial processing at non-ASM mines. Tantalum production from hard rock mining has recently increased, due to the association of tantalum with some lithium spodumene deposits, where mining of the lithium is taking place.

Figure 12. Tantalum Mine Production 2024



Source: USGS 2025.

Brief History of Tantalum Production

Until the late 1970s, tin mining was the main source of tantalum concentrate, although yields were low and much of the tantalum was discarded as waste slag. This resulted in the accumulation of large quantities of low-grade tantalum in waste tailings (tin slags), especially in Thailand, Brazil, and Malaysia. Today, tantalum concentrates are recovered from these tailings alongside slag produced by existing tin mining and smelting operations in these regions.

In the 1980s, hard rock tantalum mines in Australia, Canada, Brazil, Mozambique, and Ethiopia became the main sources of tantalum concentrates. Australia ultimately became the largest supplier of primary tantalum concentrate through the Greenbushes and Wodgina mines, gradually increasing supply to meet rising demand from mobile phones and other consumer electronics. This strong demand also caused prices to rise, leading to the emergence of ASM supply in Central Africa.

Primary tantalum hard rock operations continued until the 2008 global financial crisis, when many tantalum mines in Australia, Canada, and Mozambique ceased production due to poor economic conditions. Profitability at two major Australian mines, Greenbushes and Wodinga, declined as they transitioned from open pit to underground mining. Since 2010, production from mines in Mozambique and Australia has been sporadic, but an increasing amount of tantalum concentrate has been sourced from Central Africa, predominantly from ASM operations.

Artisanal Mining in Central Africa

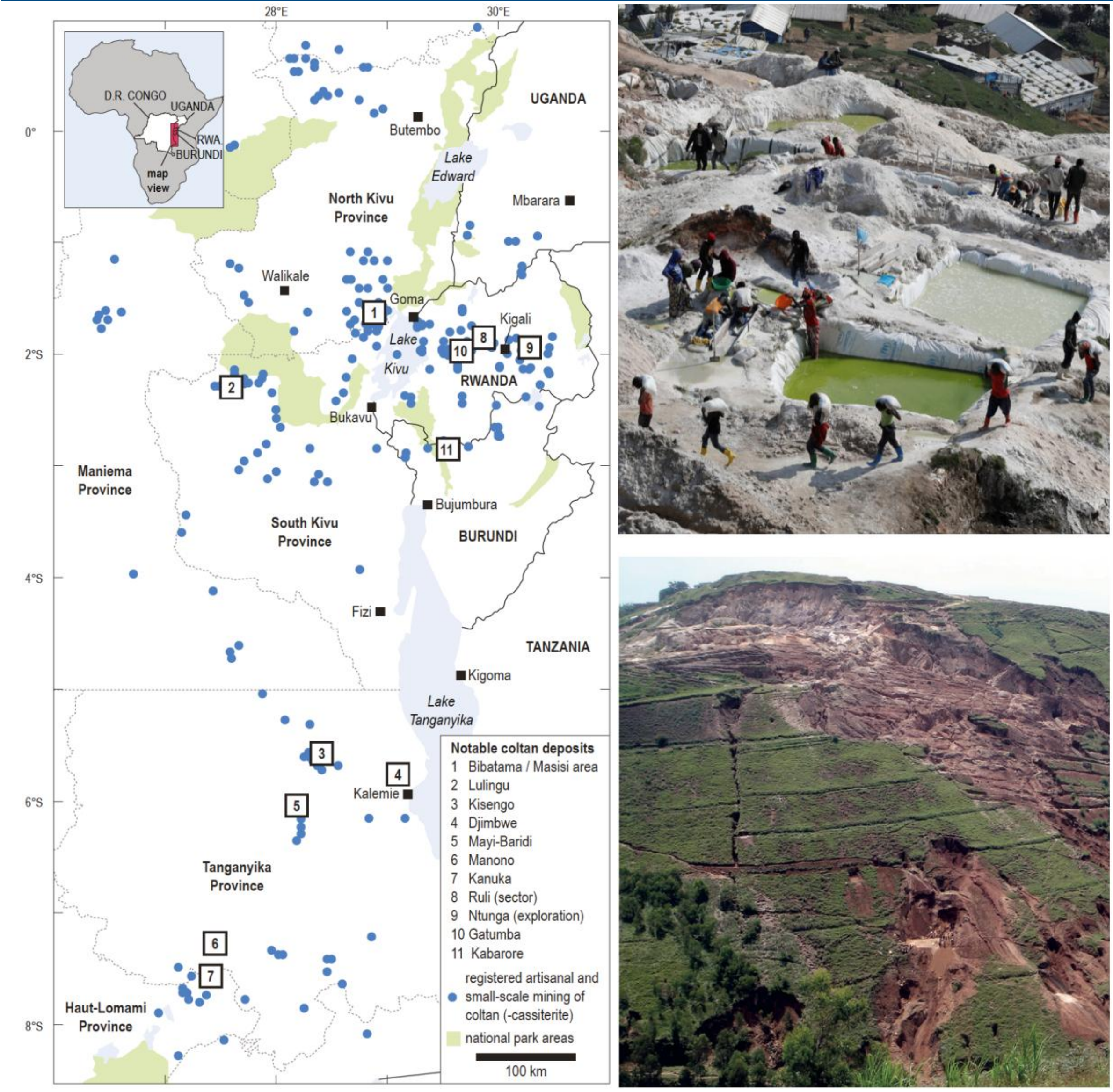
The increase in tantalum production in Central Africa from 2010 onward can be linked to the opportunities created by the passage of the Dodd-Frank Wall Street Reform and Consumer Protection Act in the United States. This legislation on conflict minerals prompted the development of mineral traceability programmes. Section 1502 of the Act defines 'conflict minerals' as minerals containing tin, tantalum, tungsten, and gold that originate in the DRC and neighbouring countries. Subsequent EU legislation in 2014 and the OECD's due diligence standards are based on the same four minerals but are not tied to specific geographic regions. The reporting obligations for these three regulations are substantial, but they have also opened a pathway for the region to supply certified, responsibly sourced tantalum to the market.

The Responsible Miners Initiative (RMI)[13], founded in 2008, has developed a comprehensive set of tools and processes to promote responsible and ethical mining and trading practices within the Central African tantalum supply chain. The International Tin Supply Chain Initiative (ITSCI) Program for Responsible Mineral Supply Chains has since become the largest ethical monitoring programme in Central Africa. It is overseen by the tin and tantalum trade associations (the International Tin Association and the Tantalum-Niobium International Study Centre) and managed locally by a network of government officials, civil society organisations, and business organisations. ITSCI is currently operational in Burundi, the DRC, Rwanda, and Uganda. Most of the additional costs for compliance and internal audits are primarily borne by the ASMs.

Tantalum deposits in Central Africa are highly weathered, making the ore relatively soft and suitable for extraction using hydraulic mining and gravity separation through simple washing. The BGR reports that artisanal beneficiation methods typically achieve a recovery rate of 50% or less, although there is considerable variation across the region. Recoveries at industrial mines generally range between 70 and 95%, depending on the grain size. In both cases, the concentrate is then exported for further processing.

ASM production provides some stability in the tantalum market, as it can be easily and quickly stopped/reduced when prices fall and restarted/increased when prices rise. ITSCI's goal is to create responsible mineral supply chains that do not contribute to conflicts, human rights abuses, or precipitate bribery. However, ITSCI's activities do not address the environmental issues often associated with ASM.

Figure 13. Registered Coltan and Coltan-Cassiterite Mines in Central Africa



Source: Map - Tantalum supply from artisanal and small-scale mining - Philip Schütte, Uwe Näher. Pictures – The Africa Report, BGR – Tantalum Sustainability Information.

Issues with ASM in Central Africa

The ASM coltan and cassiterite sector in Central Africa is linked to political turmoil and allegations of conflict mineral production. There are also a number of social and environmental issues, including land use conflicts, soil erosion, and deforestation. The BGR also reports poor health and safety conditions for artisanal miners. Water is crucial in beneficiation, and most ASM activities lead to severe soil erosion, harming the fauna and flora of the local rainforest ecosystem. Many ASM mining sites lack rehabilitation and reforestation programmes, and BGR notes that in densely populated areas, ASM and agriculture often compete for land and water access.

ASM is often inefficient in identifying, exploiting, managing, processing, and extracting mineral resources. Exploitation methods tend to be basic, and unskilled workers often rely on rudimentary tools and techniques. Mineral processing methods can be inefficient, resulting in low recovery rates. At the same time, poor site and waste management can lead to the mine being abandoned once near-surface minerals are depleted, despite the presence of further potential at depth.

Despite increased oversight and due diligence in coltan and cassiterite mining, Central Africa remains a politically unstable region and a threat to the resilience of the tantalum supply chain. More than 100 militias operate in the area, mostly local groups fighting over land and raw materials. In January 2025, M23, a large militia group backed by Rwanda, seized territory in the DRC, including Goma and Bukavu, the two largest cities in eastern Congo. A peace agreement between the DRC and Rwanda was announced in June 2025. However, the situation remains delicate, and in September 2025, the ITSCI reported that the situation remains concerning due to the ongoing presence of militias.

Argus Media [14] reports that the due diligence landscape has become complicated because warehouses in Goma and Bukavu have been raided, and M23's expanded control over parts of key mining areas and the border with Rwanda has increased the risk of cross-border smuggling and mineral fraud. It notes that the recent escalation has raised doubts about the legitimacy of supply from Rwanda and has prompted some Western smelters to cease sourcing from Central Africa altogether. However, many smelters in East Asia continue to buy from the region. Smelters have also faced pressure from downstream stakeholders, including original equipment manufacturers such as Apple, which are urging smelters to avoid sourcing from Rwanda and potentially supporting the conflict in the DRC. Apple has instructed its suppliers to halt sourcing of tin, tantalum, tungsten, and gold from the DRC and Rwanda.

Tantalum From Lithium Production

Tantalum production from hard rock mining has recently increased due to its association with certain lithium-rich spodumene deposits that are experiencing rapid development in response to the rising demand for lithium-ion batteries in EVs. Some lithium mines, such as Kathleen Valley, Greenbushes, Wodgina, and Pilgangoora, in Australia, are now recovering tantalum as a by-product. This tantalum is easily extracted with minimal additional environmental impact.

Table 3. Identified Industrial Mines Producing Tantalum

Mine/Plant	Primary commodity	Country	Owner	Capacity Ta t/y est.
Pitinga	Tin	Brazil	China Nonferrous Trade Co.	180
Kathleen Valley	Lithium	Australia	Liontown Resources	140
Yichun	Tantalum	China	Ningxia Non-Ferrous Metals	75
Mibra	Lithium	Brazil	AMG Brazil	65
Greenbushes‡	Lithium	Australia	‡Global Advanced Metals	60
Lovozero	REE	Russia	JSC Sevredmet	35
Mt Cattlin*	Lithium	Australia	Rio Tinto	20
Wodgina†	Lithium	Australia	†Global Advanced Metals	20
Penouta*	Tin	Spain	Energy Transition Minerals	20
Pilgangoora	Lithium	Australia	Pilbara Minerals	15
Tanco	Lithium	Canada	Sinomine Resources	na
Ulba	Uranium	Kazakhstan	Kazatomprom	na
Bikita	Lithium	Zimbabwe	Bikita Minerals	na
Arcadia	Lithium	Zimbabwe	Zhejiang Huayou Cobalt	na
Titan	Tin/Tantalum	DRC	Tantalex Lithium Resources	na
Blesberg	Lithium	South Africa	Marula Mining	na
Kazera	Tantalum	Namibia	Hebei Xinjian	na

Source: RFC Ambrian estimates, company reports. *Under care and maintenance. ‡GAM holds rights to tantalum production, mine owned by Mineral Resources and Albemarle. †GAM holds rights to tantalum production, mine owned by Tianqi Lithium, IGO, and Albemarle.

Tantalum minerals are concentrated using physical methods, usually gravity separation, at or near the mine site to increase the Ta_2O_5 and Nb_2O_5 fraction by weight. Resulting concentrates can contain between two and five different tantalum-bearing minerals from the same mine area. Sales of tantalum mineral concentrates are based on a certified analysis of the contained proportion of Ta_2O_5, which typically ranges from 20 to 60%, depending on the mine source.

Tantalum Industrial Mines

Information on tantalum production at individual mines is limited and seldom disclosed because tantalum is typically a by-product, and volumes are generally small relative to the mine's primary output. Additionally, around 60% of the production comes from ASM, which also creates transparency issues with data.

The single largest operating tantalum producer is reportedly the Pitinga tin mine in Brazil, owned by China Nonferrous Trade Company. After the tantalum concentrate is separated from Pitinga's tin concentrate, it is processed to remove the radioactive isotopes (uranium and thorium), and tantalum and niobium ferroalloys are produced. These are sold on the market as raw materials for the tantalum, niobium, and steel industries.

Kathleen Valley lithium mine in Australia began commercial operations in July 2024 and is operated by Liontown Resources [ASX: LTR]. The mine also produces a 30% tantalite concentrate. It is currently producing the equivalent of around 60 t of tantalum per quarter. However, the reported average capacity over the life of mine in the DFS is lower (as recorded in Table 2).

AMG Brazil [AMS: AMG] operates the Mibra mine in Brazil, which has recently transitioned from a primary tantalum mine to a primary lithium mine, with tantalum now produced as a secondary product. AMG Brazil processes its tantalum concentrates into refined tantalum chemicals in Brazil.

In Australia, the Greenbushes and Wodgina mines were reopened as lithium mines after being closed as tantalum mines in 2008. The Greenbushes mine reopened as a lithium operation in 2019 and is the largest pegmatite operation in Australia. It is owned by Albemarle [NYSE: ALB] (49%) and Tianqi Lithium [SHE: 002466] (26%). The Wodgina mine opened as a lithium operation in May 2022 and is owned by Albemarle (60%) and Mineral Resources [ASX: MIN] (40%).

Global Advanced Metals [private] is a fully integrated supplier of tantalum products and owns the lithium-by-product tantalum rights for the Greenbushes and Wodgina mines. Greenbushes secondary processing also upgrades primary tantalum concentrate received from Wodgina, as well as material obtained from other third parties.

Tantalum Primary Processing

Tantalum ore from ASM operations and from industrial mines is exported as concentrate and processed in Asia, Europe, and North America. The beneficiation of tantalum ore into concentrate is done both in industrial mines and in ASM operations by gravimetric, magnetic, and sometimes electrostatic methods.

The tantalum concentrate initially contains tantalum in the form of tantalite (Ta_2O_5) and potassium tantalum fluoride (K-salt). The extraction and refining of tantalum, including separation from niobium, is generally achieved by treating the ores with a mixture of hydrofluoric and sulphuric acids at elevated temperatures. This causes the tantalum and niobium to dissolve as complex fluorides, and many impurities present also dissolve. These are then processed into various forms of tantalum products and chemicals.

Other tantalum chemicals of industrial importance include tantalum chloride ($TaCl_5$), lithium tantalate ($LiTaO_3$), and tantalum carbide (TaC). Tantalum metal powders and ingots are typically produced from potassium tantalum fluoride.

These final products, also known as processor shipments, are primarily composed of metallurgical-grade tantalum powder (32%), tantalum chemicals (26%), and capacitor-grade tantalum powder (18%), collectively accounting for 76% of shipments in 2020. Shipments of ingots, rolled products, and tantalum carbide made up the remainder.

The RMI provides a list of 33 active tantalum smelters [13]. These are located in Brazil, China, Estonia, Germany, India, Japan, Kazakhstan, Mexico, Rwanda, Thailand, and the US. Brazil, China, and Rwanda have both mines and processing facilities.

Tantalum present in tin slag from Thailand, Brazil, Malaysia, and other tin-producing countries is also supplied to third-party processors for smelting. China remains the largest importer and refiner of tantalum concentrates. Chinese imports account for approximately 30% of tantalum ores, concentrates, and metal consumption.

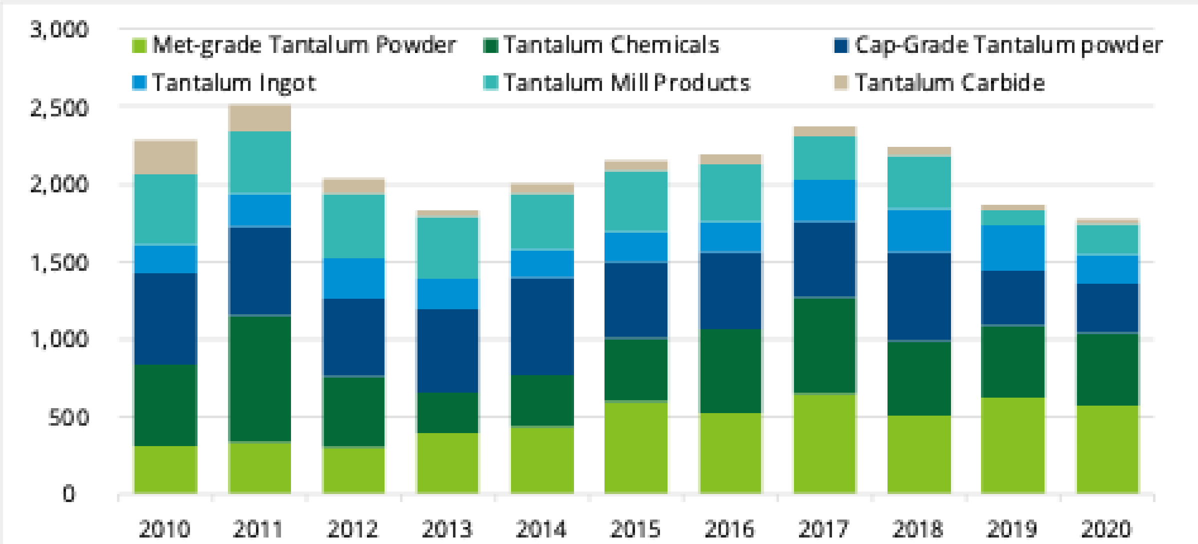
A primary tantalum processor can treat tantalum mineral concentrates and slags as raw materials. Usually, a primary facility also processes secondary concentrates (columbite or struverite), as well as synthetic concentrates. These are mainly scrap material consisting of nickel-based superalloy gas turbine engine components containing tantalum and hydrometallurgical residues. This material generally contains 2-20% tantalum.

The most recent publicly available data on tantalum shipments from processors (a proxy for end demand) is from the TIC and indicates that demand in 2020 totalled 1.77 kt. These data focus on primary product shipments by processors and are believed by TIC to be reasonably comprehensive.

The data in Figure 14 shows total demand for tantalum declining at a CAGR of 2.7% from 2010 to 2020. RFC Ambrian believes that this decline is partly due to substitution by other metals and products, especially in the capacitor market, where miniaturisation has also been a negative factor. The reduction in tantalum carbide use is also attributed to substitution by other materials, including niobium, in the tools industry. However, stronger market growth was observed in 2021, driven by a robust demand recovery and significant inventory restocking across the value chain, which was prompted by COVID-19 logistical constraints. Demand was robust in the aerospace and semiconductor sectors.

Confirmation of this essentially flat demand since 2010 comes from a tantalum report by BGR [12], which discusses moderate consumption growth (although no data is provided), and industry participants acknowledge that tantalum has experienced a long period without significant growth.

Figure 14. Tantalum Shipments from Processors by Product (tonnes)



Source: TIC data.

Figure 15 shows the typical product profile of a primary processor. The most common tantalum intermediate chemical is K-salt.

Some of the largest companies engaged in primary processing outside of China include:

- Taniobis (owned by JX Nippon Mining & Metals) with smelters in Germany, Thailand, and Japan;
- U.S.-based Global Advanced Metals with smelters in the United States and Japan;
- Netherlands-based Advanced Metallurgical Group [AMS: AMG] with a smelter in Brazil;
- Mitsui Mining [TYO: 5706] with a smelter in Japan;
- UMP JCS, which operates the Ulba plant in Kazakhstan;
- Canada-based Neo Performance Materials [TSX: NEO], which owns the Silmet smelter in Estonia; and
- Kemet [NYSE: KEM], which operates a smelter in Mexico.

There are other processing plants in the United States, China, Brazil, Germany, and Japan.

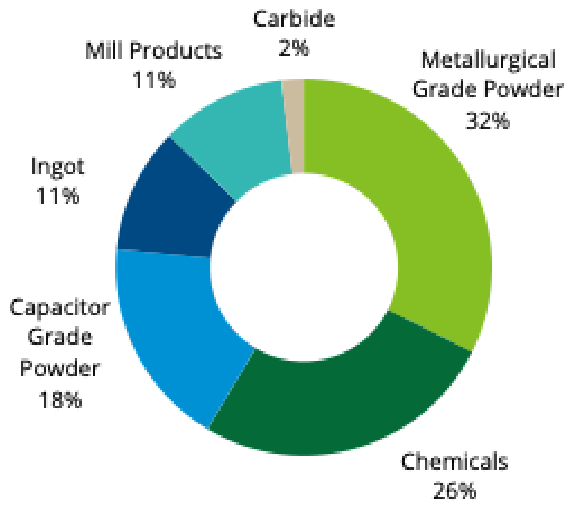
Secondary Processors

Secondary processors cannot process minerals or slags; instead, they handle tantalum intermediates, transforming them into final products. For example, a secondary processor might purchase K-salt, metallurgical-grade tantalum powder, or tantalum ingots, then undertake additional chemical and/or metallurgical treatments to produce final items such as oxides, capacitor-grade powders, or metal products, including tubes or wires. These processors are located in China, Brazil, India, Russia, and South Africa.

Tantalum Recycling

The recycling of scrap generated by various sectors of the tantalum industry has long been a crucial part of that metal's supply chain. Tantalum scrap is utilised as feedstock by tantalum processors in China, Europe, and the United States. Tantalum is typically extracted from scrap and slag through high-temperature digestion in sulphuric acid, resulting in a highly purified form of crystallised tantalum.

Figure 15. Tantalum Primary Products



Source: TIC, RFC Ambrian.

Tantalum recycling mainly depends on scrap or process materials from manufacturing, rather than recycled products containing tantalum. Scrap generated during intermediate manufacturing has high purity and can be easily collected and directly remelted for full recycling. Since the amount of tantalum in consumer products is usually very low and dismantling and processing them is costly (both in capital and operational expenses), only a limited portion of tantalum is recovered from end-of-life products. This is especially true for electronic devices, where recycling at the end of their life is uncommon [(15)].

There are two types of secondary tantalum scrap: material derived from nickel-based gas turbine engine parts and material derived from the processing of various raw materials using chemicals. Both types of secondary material are utilised by the tantalum industry, accounting for approximately 22% of the raw material supply in 2020. In 2016, the United States and Mexico accounted for 61% of secondary scrap recycling (more recent data are not available). In contrast, China uses only small amounts of scrap and supplies tantalum smelters mainly via mineral concentrates and other primary materials.

4. Tantalum Projects

Tantalum occurs in a variety of igneous rocks, including pegmatites, carbonatites, and granites. As a result, many mines and projects initially report tantalum as part of the mineral resource statement. This is particularly true for lithium, niobium, tin, and rare earth mines and projects. However, it is typically not the primary mineral, and a lot of these projects are unable to recover the tantalum economically due to the low grade. Where recovery does occur, it typically happens as a by-product, with low volumes.

Table 4 lists 19 significant mining projects identified by RFC Ambrian, where a defined resource contains tantalum and where the operation has the potential to recover and produce tantalum in the future, at least according to indications from the operating company. Potential tantalum production volumes are rarely discussed, and determining the timing of possible production from the projects is very difficult. For example, the two niobium projects, Kanyika in Malawi and Crevier in Canada, completed early-stage feasibility studies over a decade ago. However, these projects are active and have the potential to become tantalum producers, but these, like others, require further development work and/or financing, and production, if it is achieved, may be some way off.

Eleven of the operations in the table are primary lithium projects, four are tantalum projects, two are rare earth projects, and two are niobium projects. The geographical spread of these projects is relatively broad.

Table 4. Significant Mining Projects Identified with Potential for Tantalum Production

Project	Primary Commodity	Country	Development Stage	Operator
Swanson	Tantalum	Namibia	Constr. started	Arcadia Minerals
Kenticha	Lithium	Ethiopia	Constr. started	Abyssinian Metals
Rose	Lithium	Canada	Constr. planned	Critical Elements Lithium
Kanyika	Niobium	Malawi	Constr. planned	Globe Metals & Mining
Manono Tailings	Lithium	DRC	Constr. planned	Tantalex Lithium Resources
Bald Hill	Lithium	Australia	Mine on C&M	Mineral Resources
Muiane	Tantalum	Mozambique	Mine on C&M	Unidentified
El Benton	Tantalum	Bolivia	Former mine	Auxico Resources
Beauvoir (Emili)	Lithium	France	DFS underway	Imerys
Manono	Lithium	DRC	Feasibility compl.	AVZ Minerals
Nechalacho	REE	Canada	Feasibility compl.	Avalon Advanced Materials
Crevier	Niobium	Canada	Pilot plant	Niobay Metals
Blue River	Tantalum	Canada	PEA completed	Capacitor Metals
Uis	Lithium	Namibia	Former mine	Andrada Mining
Motzfeld	REE	Greenland	Resource	Elemental Rare Metals
Yinnetharra	Lithium	Australia	Resource	Delta Lithium
Mt Ida	Lithium	Australia	Resource	Delta Lithium
Sirmac	Lithium	Canada	Resource	Vision Lithium
Buldania	Lithium	Australia	Resource	Liontown Resources

Source: S&P Global, Company reports.

Two projects, the Swanson tantalum project and the Kenticha lithium project, have started construction; however, both are facing difficulties in advancing development.

Swanson is a small tantalite project located in Namibia and is 80% owned by **Arcadia Minerals** [ASX: AM7]. The development at the Swanson project slowed significantly in October 2024, following a lack of funding from Hebei Xinjian Construction, which had been earning a 38% interest in the project. In January 2025, Arcadia terminated the agreement with Hebei and is seeking other interested parties to advance the project and secure the construction financing estimated at US$9.8m. The mine plans to produce 46t of Ta_2O_5 in the final concentrate, equivalent to a 65% recovery, over an 8-year mine life.

The Kenticha lithium project is situated in Oromia State, Ethiopia. **Abyssinian Group** [private] holds a 51% interest, and Oromia Share Mining Company (OMSC) has 49%. OMSC is a State-owned enterprise of Oromia State of Ethiopia. Production of a spodumene concentrate is planned at the mine which was scheduled to commence construction in 4Q 2024. However, Oromia State officials seized a director of the company, and a notice of dispute has been issued to the federal government. The disagreement concerns measures taken against the Abyssinian Group's investments in the Kenticha lithium project. An attempted reverse takeover by Medcaw Investments [LSE: MCI] was cancelled in April 2025, partly due to the unresolved dispute with the Ethiopian authorities.

There are three projects where construction is planned, and the development towards production is ongoing.

Critical Elements [TSXV: CRE] is well advanced in the development of the Rose lithium project in Quebec, Canada. The company reports that it is evaluating ongoing interest from potential capital providers and strategic partners. Rose has initial capital expenditure of US$471m, with production of 116 t/y of Ta_2O_5 and a mine life of 17 years.

Globe Metals & Mining [ASX: GBE] operates the Kanyika niobium project in Malawi. The company is continuing to advance the project; however, there are outstanding infrastructure projects, including road access, electricity infrastructure, and local resettlement, which are primarily the government's responsibility. These are essential before substantial mining operations can commence. The project has a Phase 1 capital expenditure of US$46m, with production of 14 t/y Ta_2O_5 and a mine life of 23 years.

Tantalex Lithium Resources [CSE: TTX] is actively exploring funding and/or strategic partnerships for the development and construction of a lithium processing plant at the Manono tailings project in the DRC. Initial capital expenditure for Phase 1 is estimated at just US$7m with a six-year mine life.

Investment decisions for the other commercial-scale projects where tantalum is not the primary commodity are not linked to the tantalum market dynamics but are influenced by market conditions for lithium, and, to a lesser degree, tin, REE, and niobium. More lithium projects that also produce tantalum could come into production over the next few years, once the price of lithium recovers.

5. Tantalum Markets & Prices

Tantalum Trade

Tantalite concentrate on the international market usually contains at least 30% Ta_2O_5, although lower-grade concentrates may be traded with a minimum of 20% Ta_2O_5. The commercial payable value is determined solely by the Ta_2O_5 content, and any associated amounts of Nb_2O_5 are generally disregarded. Tantalum and niobium raw materials often have slightly elevated levels of naturally occurring thorium and uranium, typically at concentrations that necessitate classifying them as radioactive for handling and transportation. These NORM raw materials may be subject to certain shipping restrictions.

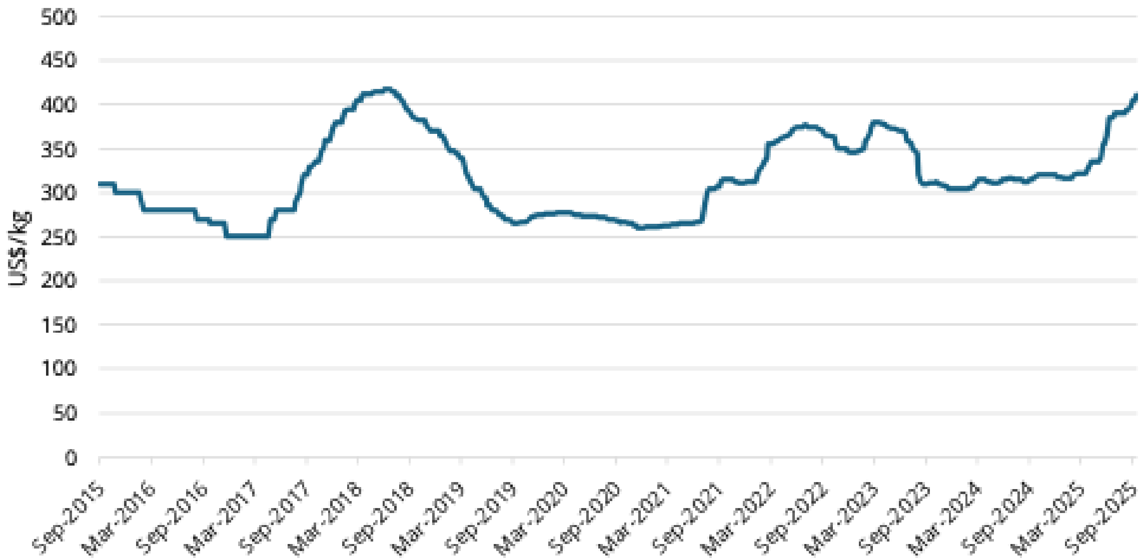
Despite the technical parameters mentioned above, there is no standalone trade data or transparent market information available for tantalum concentrates. Overall, according to the Observatory of Economic Complexity (OEC), global trade in tantalum metal was valued at US$859 m in 2020. The OEC stated that the leading exporters of tantalum were the US (US$227 m), China (US$187 m), and Japan (US$113 m). The main importers of tantalum were the US (US$223 m), China (US$94.4 m), and El Salvador (US$73.8 m).

Tantalum Prices

There is no official market price for tantalum because it is not traded on a metal exchange. The price is determined solely through negotiations between buyers and sellers, and most contracts between tantalum producers and processors are long-term and confidential. ASM producers, as well as some miners who produce tantalum as a by-product, occasionally trade on a spot basis or with short-term contracts. Data on such spot prices are obtained from specialist subscription trade databases; S&P publishes market data on intermediary products such as tantalum pentoxide.

Figure 16 shows the spot price of Ta_2O_5 over the past decade, which has ranged from US$250 to US$410/kg. The tantalum price increased from 2020 to 2023, reportedly due to supply constraints, including ASM production cuts due to COVID-19 and higher freight rates. In addition, demand was impacted by the implementation in September 2020 of a US ban on the use of tantalum metal and alloys from China, Iran, North Korea, and Russia in US military projects. From the end of 2023 to mid-2025, prices traded around US$300/kg until recently moving higher due to political turmoil in the DRC.

Figure 16. Tantalum Price 2015 to 2025 (US$/kg)



Source: Bloomberg. China tantalum metal 99.95% FOB

6. Market Outlook

The tantalum industry is small, and its supply chain is very opaque. This lack of supply transparency is particularly acute for tantalum, as over 60% of the metal is produced by ASM in Central Africa, and much of the remaining output is produced as a by-product. On the demand side, the number of participants is relatively small, and information is often limited for competition reasons.

Supply Side Issues

The DRC has been a dominant source of tantalum for many years. However, the region's political instability, particularly due to the M23 group's control over mine sites and trade routes, is threatening the global supply of tantalum. According to the TIC President, Ms Silvana Fehling: "The situation in the DRC is disturbing and concerning, both from the perspective of the safety and livelihood of those locally affected as well as from a commercial perspective. The continued incursions by the M23, their control of mine sites and trade routes, in combination with the undisciplined approach of the DRC government, do not bode well for the expectation of a reasonable solution any time soon. As such, responsible sourcing from the region will only become more complicated moving forward." [16]

Concern over events in Central Africa is prompting some consumers to source tantalum from alternative sources to avoid potential conflict minerals. Argus Media reports that this is widening the price spread, depending on the origin. However, given the dominance of Central Africa in the tantalum market, it is difficult for many customers to avoid sourcing material from this region. Even the militia in the DRC recognises the importance of sustained production.

Tantalum supply from hard rock has increased with the start-up of new lithium mines in Australia and Canada. This source of tantalum production is expected to grow further as more hard-rock lithium mines come online. However, the exact details of this increase in tantalum supply remain opaque, and the recent sharp fall in the lithium price is delaying some of the projects and new tantalum output.

Demand Side Factors

Electronics is a key area for tantalum demand, and the outlook for the electronics sector remains strong. However, history has shown that the demand for tantalum for electronics has experienced periods of stagnation due to substitution and miniaturisation. These factors are likely to remain headwinds; however, tantalum capacitors remain essential components in many high-end electronic applications.

There is a growing need for efficient, high-performance materials, including tantalum, in next-generation dielectrics and technology. Growth markets include electric vehicles, 5G telecoms, AI computing, military, aerospace, satellites, and wearable devices. The US CHIPS and Science Act of 2022 is expected to play a crucial role in expanding the chip manufacturing industry in the US, increasing demand for semiconductor materials, including tantalum. However, the current administration has criticised the act, and it now faces political uncertainty, although a significant part of the funds has already been allocated.

Market Balance for Tantalum

The availability of data, both in quantity and quality, for participants in the tantalum market is limited. This creates a risk to the supply chain because, without dependable estimates of resources, supply, and demand, it becomes more challenging for participants to adapt to changing market conditions and maintain long-term market balance for tantalum. Fortunately, long-term supply issues are not anticipated to be significant, and demand growth appears likely to remain robust, albeit likely modest. Also, while Asia is a key consumer region, the tantalum market is not as heavily dominated by China as it is for many other critical minerals. As a result, the outlook for tantalum appears steady, and the price will most likely be dominated by short-term fluctuations in output and/or sentiment in response to events in Central Africa.

Appendix 1 – Tantalum Resource Types

Tantalum-bearing minerals are usually found within an igneous host rock. The major geologic host environments for tantalum mineralisation are:

- Pegmatite-related tantalum deposits
- Carbonatite-hosted deposits.
- Alkaline granite and syenite deposits.

Pegmatite-Related Tantalum Deposits

Concentrates from most pegmatite-related tantalum deposits (both hard-rock and weathered varieties) are dominated by minerals in the columbite-tantalite ($Fe(Nb,Ta)O_4$) series; however, other tantalite minerals may also be present in smaller quantities. These deposits contain tantalum and lesser amounts of niobium and are often mined for lithium as a primary product. Tantalite is the tantalum-rich end of the isomorphic tantalite-columbite series, where tantalum and niobium can substitute for each other. The typical ratios between the two metals (Ta:Nb) range from 3:1 to 1:3, so the mineral is often called tantalite-columbite or columbite-tantalite (frequently abbreviated as "coltan" in Africa). The deposits usually have sizes of less than 100 Mt with grades below 0.05% Ta_2O_5. Examples include the Kathleen Valley, Greenbushes, and Wodgina mines in Australia, Tanco in Canada, and Pitinga in Brazil.

The Great Lakes region of Africa is an important area for columbite-tantalite mineralisation in pegmatites. These deposits are primarily found in eastern DRC, Rwanda, Uganda, and to a lesser extent, Burundi. Such deposits extend for about 1,300 km from north to south and are significant sites of artisanal mining.

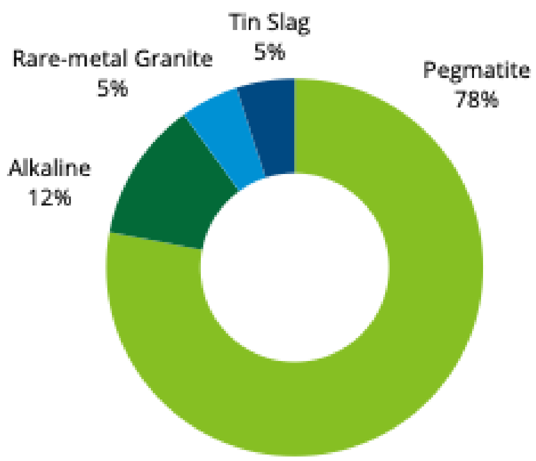
Carbonatite-hosted Deposits

Carbonatites are igneous rocks that contain over 50% carbonate minerals. They form in areas of continental rifting from magmas believed to originate in the Earth's mantle, with minimal influence from continental rocks. Carbonatites are most often found as dykes, sills, and intrusive plugs within alkaline igneous provinces. They are typically enriched with various elements, including rare earths, barium, strontium, fluorine, phosphorus, niobium, zirconium, uranium, and thorium. They exhibit a wide range in both grade and tonnage. Approximately 90% of the world's niobium supply comes from Brazil, where niobium deposits are found in alkaline ultramafic-carbonatite complexes. Examples of carbonatite deposits include Niobec and Oka in Canada, as well as Araxá, Catalão I and II, and Morro dos Seis Lagos in Brazil. These deposits contain niobium and REE but lack reported economic concentrations of tantalum.

Alkaline Granite and Syenite Deposits

Alkaline rocks are most frequently found in intra-plate settings that underwent continental rifting, but they can also form in post-continental collision environments. High levels of iron, fluorine, zirconium, rubidium, uranium, thorium, and REE characterise intrusive alkaline granites and syenites. Such deposits contain niobium and smaller amounts of tantalum and are typically large (<1,000 Mt) with grades of 0.1 to 1.0% niobium oxide (Nb_2O_5) and less than 0.05% Ta_2O_5. Examples include Motzfeldt and Ilímaussaq in Greenland, Lovozero in Russia, and Thor Lake and Strange Lake in Canada.

Figure 17. Tantalum Primary Ore Types



Source: BGR –Tantalum Sustainability Information 2021

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