

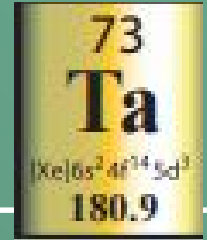


Global Tantalum Supply Chain

Trends and Future Challenges

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What Is Tantalum?



- Metal – dense, ductile, very hard, easily fabricated, and highly conductive
- High dielectric constant and good thermal oxide layer stability
- Bioinert and chemically inert
- Corrosion resistant
- High melting point (3017°C)
- Maintains strength at high temperature
- Ta in concentrate sells for about \$158/kg



What is Tantalum Used For?



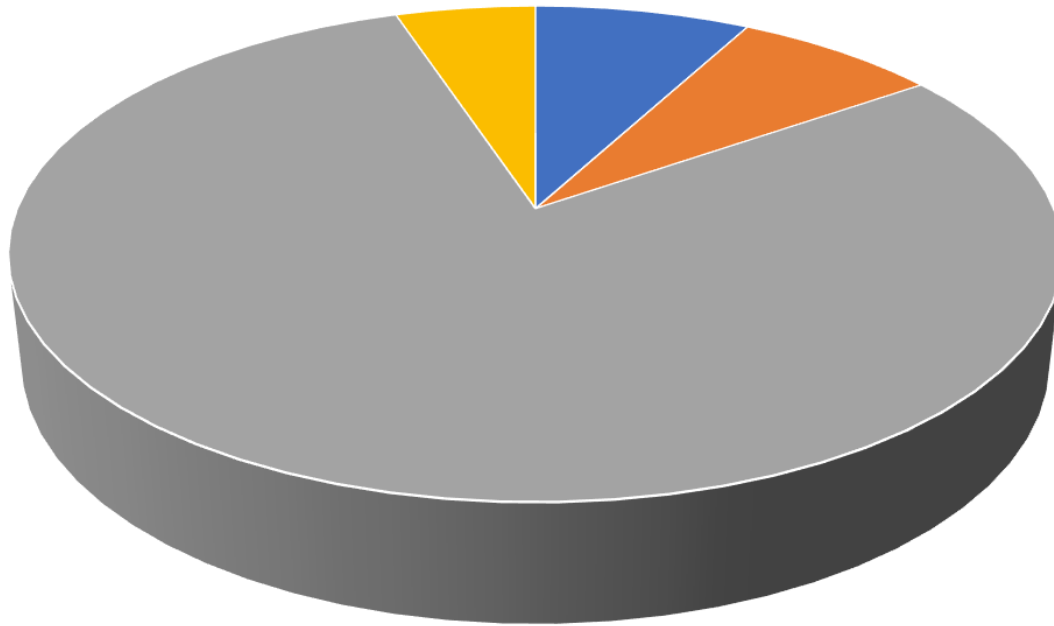
- Capacitors, sputtering targets, and other electronic uses (more than 50% of demand)
 - Various alloys, superalloys, and other specialty materials (~20%)
 - Chemicals (~20%)
 - Cutting tools (~10%)
 - Camera lenses, tooth implants, surgical tools, armor-penetrating shells, vacuum furnace parts
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Where do we get tantalum?

- Imported tantalum ores and concentrates
- Imported tantalum chemicals, metals, and alloys
- Foreign and domestic tantalum scrap
- Global consumption: 2,000 to 3,000 metric t/yr
- US consumes 500 to 650 metric t/yr
- US strategic stockpile: 15 t tantalum materials

Where is Tantalum Mined?

World Tantalum Mine Production
2017

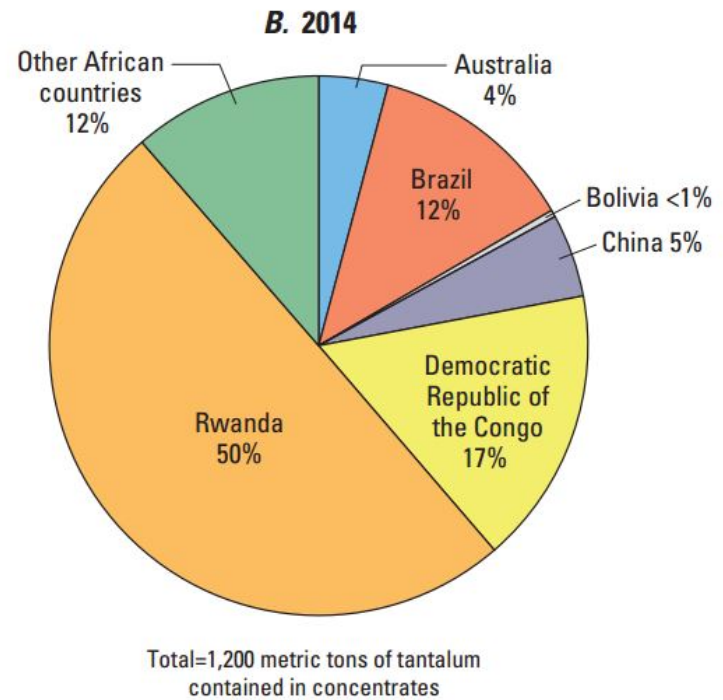
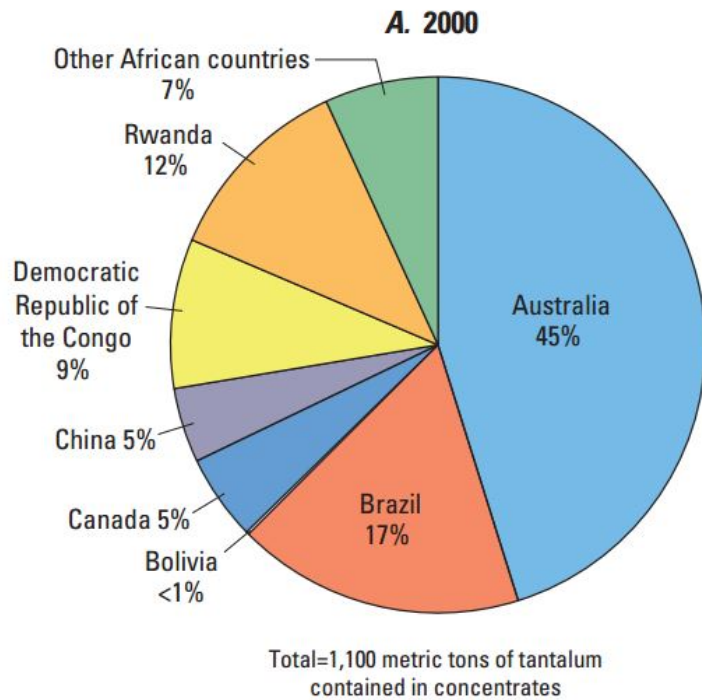


■ Brazil ■ China ■ Africa ■ Other

80%
from
Africa



Tantalum – Production Trends



Tin Smelter Byproduct

1980s – About half of tantalum produced as a byproduct of tin smelting (10% today)

Other half from mines in:

Brazil	30%
Southeast Asia	25%
Canada	20%
Australia	15%
Africa	13%



Tantalum – Conventional Mining

International and local mining companies

Easily monitored and regulated

Conform to global standards for mining, labor, and environmental practices

When mines are exhausted and closed, sites are reclaimed to global standards

Mechanized mining – advanced mineral processing



Tantalum - Unconventional Mining

- Also known as artisanal mining
- Unregulated and unaccountable
- Now a major source of tantalum



African Tantalum

- Artisanal and small-scale mining is a significant part of local economies
- Some production is diverted to help finance unlawful combatants (conflict minerals)



What is Being Done

- **OECD Due Diligence Guidance for Responsible Supply Chains**
 - **ICGLR Certification Scheme**
 - **Public-Private Alliance for Responsible Minerals Trade (PPA)**
 - **USAID Responsible Mineral Trade Program**
 - **Section 1502 Dodd-Frank Act – Annual reporting of measures taken to exercise due diligence for sourcing conflict minerals**
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Why it Matters to Manufacturers

- **Secure supply chain**

 - War zones are not reliable sources of minerals*
 - Artisanal mining is not reliable or sustainable*

- **Legal disclosure requirements**

 - Section 1502 Dodd-Frank Act*

- **Corporate citizenship**

 - Corporate image and goodwill*
 - Potential liability from failure to conduct due diligence*
 - Alignment between sourcing and corporate values*

Alternative Tantalum Sources

- Learn to do with less or without (technological substitution)
- Increase recycling
- Recover from existing stockpiles of mineral processing wastes
- Increase output at existing mines
- Develop new mine sources

Steps to New Mine Production

- Find a tantalum-bearing mineral deposit
 - Explore the deposit to determine its size, quality, and amenability to extraction
 - Develop a method of recovering and refining the tantalum into a marketable form
 - Determine economic feasibility
 - Find financing
 - Get a few dozen government approvals
 - Build and commission the mine
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Tantalum Mineral Deposits

- No such thing – tantalum is a byproduct of mining tin, lithium, or niobium
- Thousands of deposits known – hundreds of places to look for more
- Which one do you want and can you get to it?
- Rio Tinto – internal audit – for every new mine they developed they examined 2,000 prospects

Exploring a Mineral Deposit

- Newly discovered deposits are drilled to determine the extent and limits of mineralization
- Portions of a deposit of economic interest are grid drilled
- Resources are estimated from samples collected by drilling
- Bulk samples collected to develop mineral processing methods

Process Development

- Need large representative samples for metallurgical testing
- Bench-scale testing in an independent lab
- Pilot plant testing
- Full-scale plant testing
- Operational adjustments

Feasibility and Financing

- Detailed economic feasibility study performed by independent contractor
- Rare metals are a specialty market – major mining companies and banks rarely involved
- Market project to potential investors
- Equity financing – public or private
- Typical tantalum project promoted by a small public company you never heard of

Government Approval

- Environmental Impact Statement
 - Approvals for water sourcing and disposal
 - Approvals for air emissions
 - Approvals for storage of solid mine wastes
 - Approvals for buildings and physical plant
 - Approvals for explosives and chemical storage
 - Generally obtained concurrent with mine design
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Construction and Commissioning

- Complete engineering design using specialty contractor
- Pre-order long lead-time machinery
- Select and hire contractor to develop mine and build mineral processing and support facilities
- Complete construction and ramp-up to commercial production

How Long Does All This Take?

- Find a deposit – a few years to decades
 - Explore a deposit – depends on size, one to five years
 - Develop Process Methods – a few months to a few years
 - Feasibility Study – about a year
 - Find financing – depends on market timing
 - Government approval – can take years
 - Construction – 18 months on average
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The Take Away

- In the short-term (next few years) only mine projects already well along in the pipeline are relevant
- In the medium-term (10 years) current advanced exploration projects are relevant
- In the long-term (decades) everything is speculative
- This is why African production has surged so quickly – you can skip all these steps

Tantalum Pipeline Today

- Bald Hill Li-Ta mine in Australia started production last month – no Ta production yet, could reach 180 tpy
- There are plans to resume Ta production at the Greenbushes lithium mine in Australia (370 tpy)
- There are a handful of projects with planned or potential Ta byproduct production at the feasibility-financing stage

More Information

- U.S. Geological Survey – National Minerals Information Center – www.usgs.gov/minerals/
- Public-Private Alliance for Responsible Minerals Trade - www.resolv.org
- OECD – Due Diligence Guidance www.oecd.org/corporate/mne/mining.htm
- Many electronics firms have dedicated web pages to the conflict minerals issue