



Lindi Jumbo, Tanzania ©Walkabout Resources

Graphite in Africa

Carbon for decarbonisation

CLIVE MITCHELL, INDUSTRIAL MINERALS GEOLOGIST



British
Geological
Survey

Clive Mitchell

Industrial Minerals Geologist

Thirty three years at the British Geological Survey (BGS)
Chartered Geologist (CGeol)

Past work in Afghanistan, Africa, Middle East and Thailand

Resource assessments including andalusite, brick clay, construction aggregate, dimension stone, dolomite, feldspar, graphite, garnet, gypsum, kaolin, limestone, marble, mica, mineral sand, mineral waste, perlite, quarry fines, silica sand and talc

Current research:

- Calcined clays for low-carbon cement
- Battery raw materials (Graphite resources in Africa)



1992 Zambia



2022 Zambia

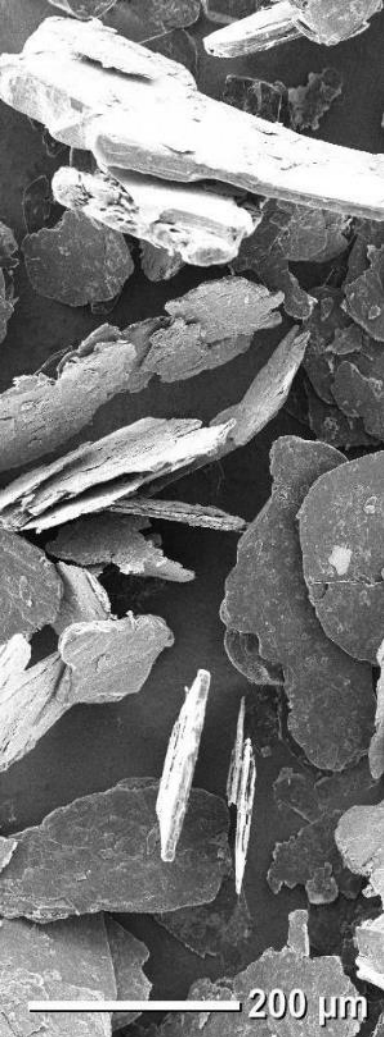
DECARBONISATION TO NET ZERO

Decarbonisation, particularly of energy & transport, by reducing the use of fossil fuels & increasing the use of renewable energy is No.1 ambition of the global economy

The UK has committed to Net Zero by 2050
(a balance between CO₂ emitted and that removed)

Electric Vehicles (EVs) & battery storage technologies are key – this is where Battery Raw Materials such as Lithium, Cobalt and Graphite come into the picture.





Definitions

- Critical Raw Materials (Critical Metals)

Raw materials of growing economic importance & high risk of supply shortage including:

Antimony, beryllium, cobalt, fluorspar, gallium, germanium, graphite, indium, magnesium, niobium, platinum group metals, rare earth elements, tantalum and tungsten

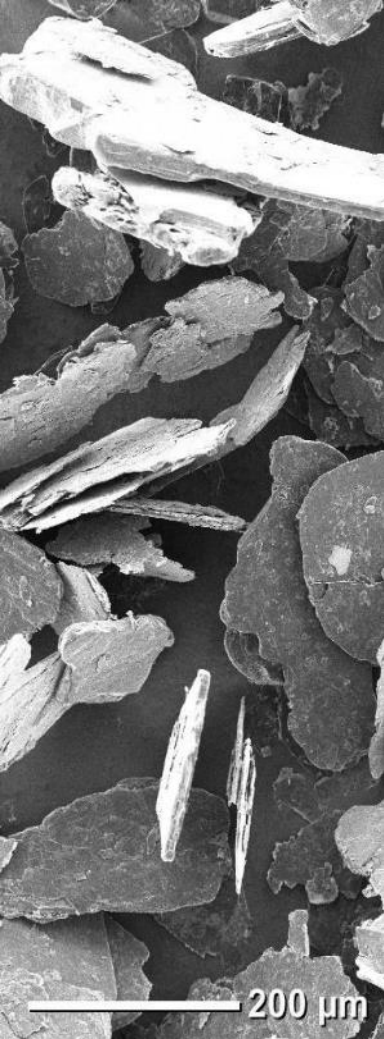
(European Commission: Critical raw materials)

- Battery Raw Materials (Energy Transition Raw Materials)

Minerals and metals used as the key constituents of a battery including:

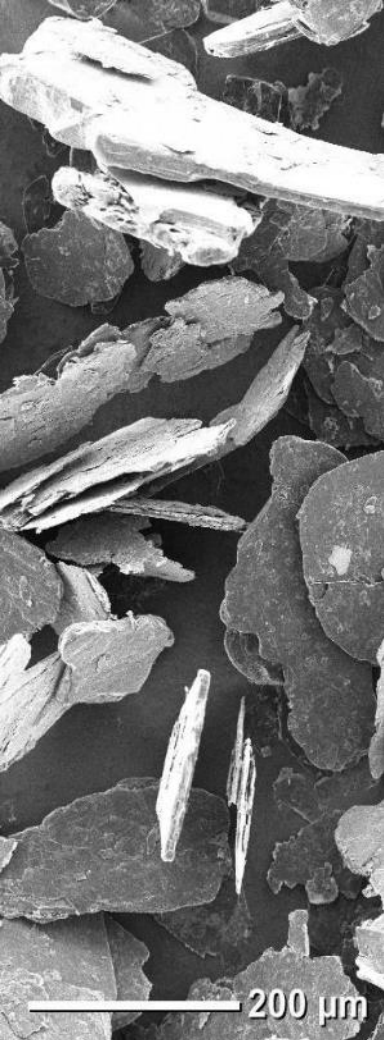
Aluminium, cobalt, graphite, lithium, manganese, nickel, phosphate, sulphur and vanadium

(Benchmark Minerals)



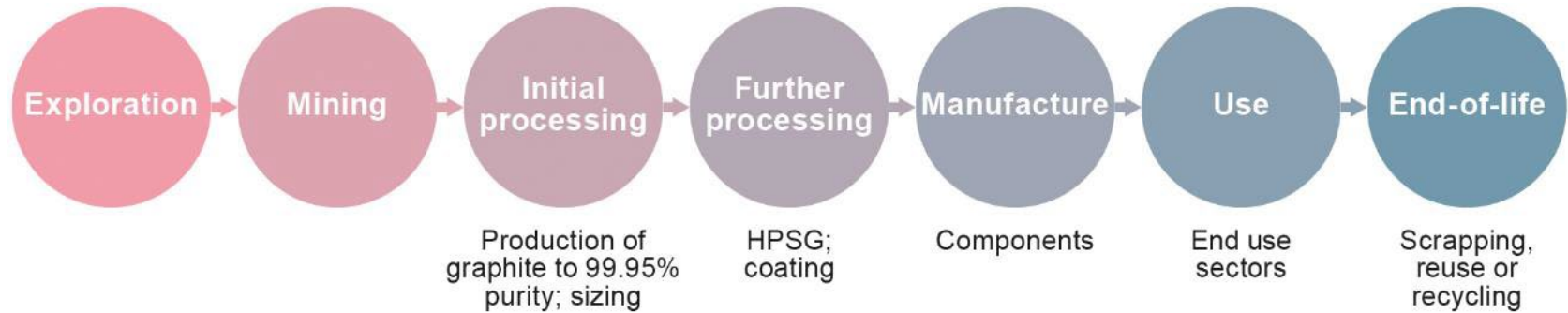
Graphite: Raw material for a low carbon future

- Graphite is the primary anode material in Lithium-ion batteries. China dominates world supply of graphite and is the only producer of High Purity Spherical Graphite (HPSG) used in the manufacture of battery anodes.
- Demand for battery raw materials is predicted to grow by at least 30 times by 2040. The race is therefore on for new sources of graphite and to develop the processing capacity to produce HPSG.
- Africa, in particular eastern Africa, has large resources of graphite and is experiencing a surge in exploration and development activity.



Graphite and where to find it

- Graphite, crystalline forms of Carbon (C), as well as Diamond
- It occurs in three main forms:
 - Amorphous graphite, typically metamorphosed coal
 - Vein, pure sheets of coarsely crystalline graphite
 - Flake, formed by the metamorphism of carbon in sediments, this is the main variety worked commercially
- Flake graphite is found in high-grade metamorphic rocks (schist, gneiss & marble) in Precambrian basement terranes
- Graphite is resistant to weathering and is often found in the residual soils & saprolite over hard-rock graphite deposits.

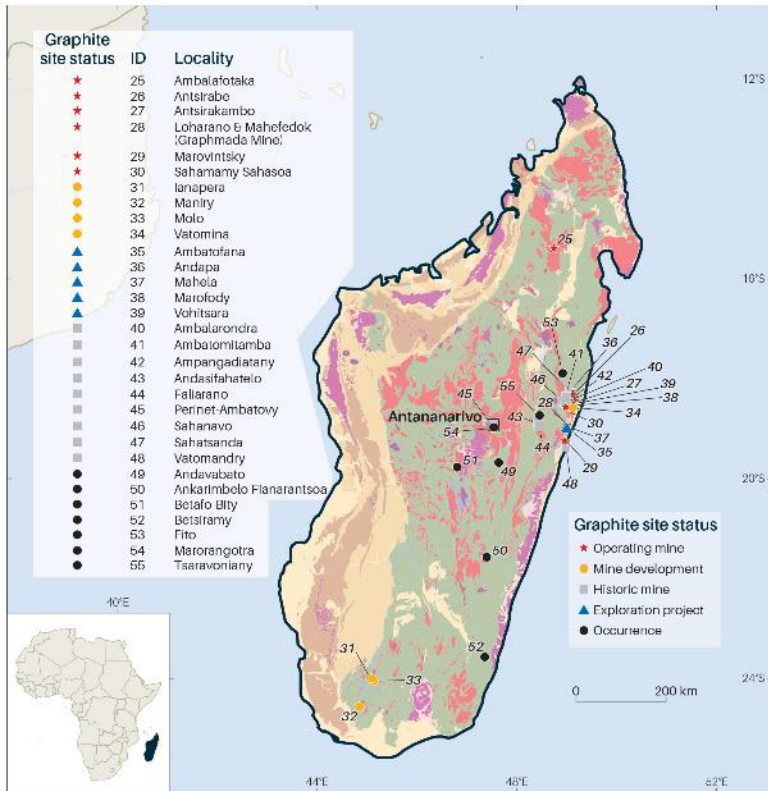


The stages in the graphite supply chain

1. **Exploration:** discovery and exploration of the mineral deposit
2. **Mining:** mining and processing to produce graphite concentrates (including crushing, screening, grinding, froth flotation, dewatering and drying)
3. **Processing:** to make specialised products such as High Purity Spherical Graphite (HPSG).
4. **Manufacturing:** of anode material for lithium-ion batteries.
5. **Use:** production and use of the consumer product.
6. **End-of-life:** scrapping, reuse or recycling of graphite to graphene.

Graphite in Madagascar

- Flake graphite occurs in the Neoproterozoic metasedimentary 'basement' (schist, gneiss, granitic & basic igneous rocks) that forms a broad N-S oriented belt
- Graphite production 22,000 tonnes (2021)
- Etablissements Gallois works the **Antsirakabo** and **Marovintsy** deposits
- Bass Metals manages **Graphmada** operation
- Tirupati Graphite operates **Sahamamy Sahaso** mine
- **9 graphite projects**: Ambatofana, Andapa & Mahela (Bass Metals), Ianapera & Maniry (Blackearth Minerals), Molo (Next Source Materials), Vatomina (Tirupati Graphite) and Vohitsara & Marofody (DNI Metals)





Graphite schist, Razafy deposit, Madagascar ©Blackearth Minerals

Drill core, Epanko graphite deposit,
Tanzania ©EcoGraf



Gallois mine site, unprocessed graphite ore and flake graphite products, Madagascar ©Etablissements Gallois



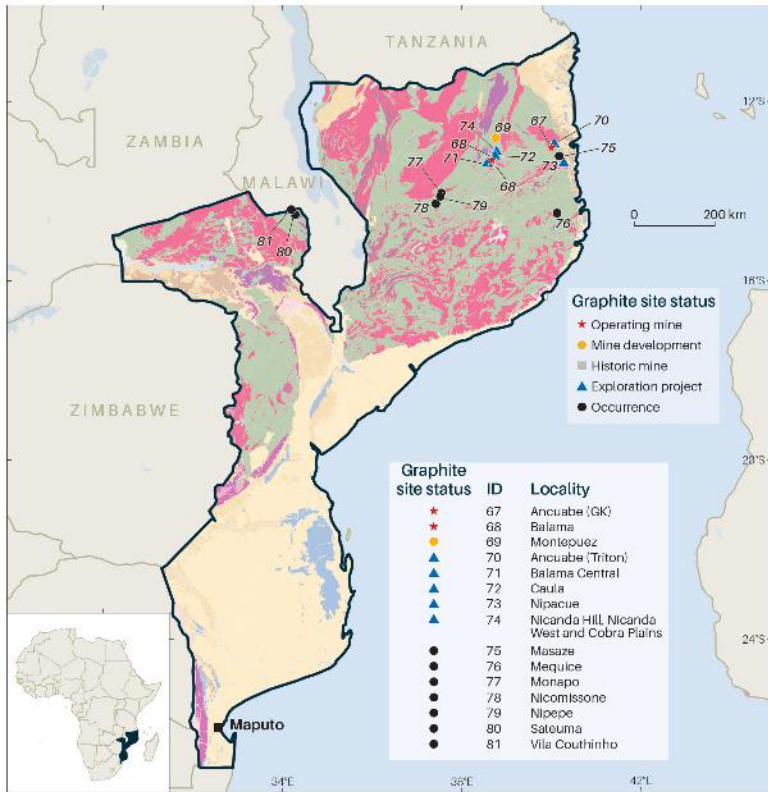
Graphite froth flotation, Graphmada, Madagascar
© Bass Metals

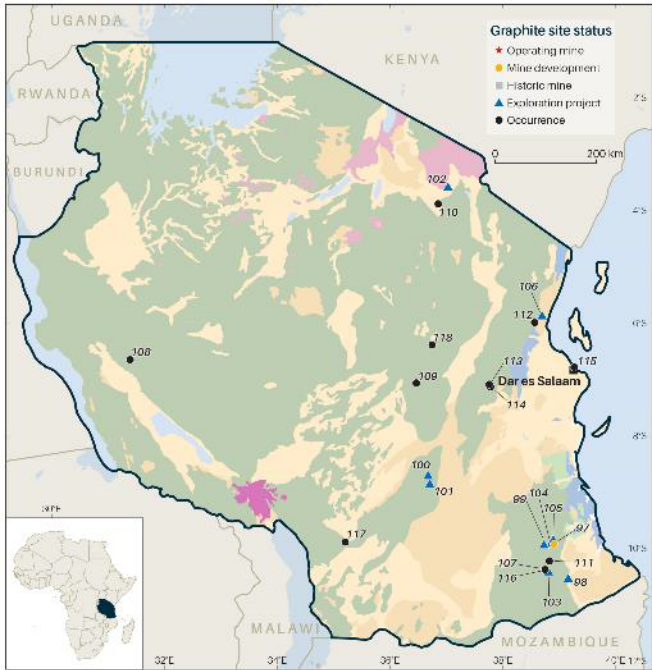


Flake graphite, Madagascar
©Etablissements Gallois

Graphite in Mozambique

- Flake graphite occurs in the Proterozoic metasedimentary rocks (gneiss and schist) of the Mozambique Belt in the north
- Graphite production 30,000 tonnes (2021)
- Syrah Resources works the **Balama** graphite deposit province with flake graphite production capacity of 350,000 tpa
- Graphit Kropfmühl (part of AMG Graphite) operates **Ancuabe** graphite mine
- **8 graphite projects**: Ancuabe (Triton), Balama Central (Battery Minerals), Caula (New Energy), Cobra Plains (Triton), Montepuez (Battery Minerals), Nicanda Hill & Nicanda West (Triton) and Nipacue (Graphit Kropfmühl)





Graphite in Tanzania

- Flake graphite occurs in the Proterozoic metasedimentary rocks (gneiss and schist) mostly in the east of the country
- Graphite production 150 tonnes (2021)
- **10 graphite projects:** Bunyu (Volt Resources), Chilalo (Marvel Gold), Epanko, Tanga & Merelani-Arusha (EcoGraf Resources), Lindi Jumbo (Walkabout Resources), Mahenge Liandu (Armada Capital), Nachingwea (Syrah Resources), Nachu (Magnis Energy technologies) and Pula (Pula Graphite)

British Geological Survey

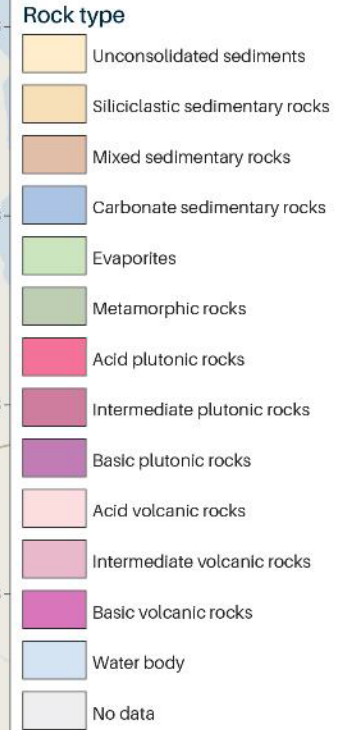
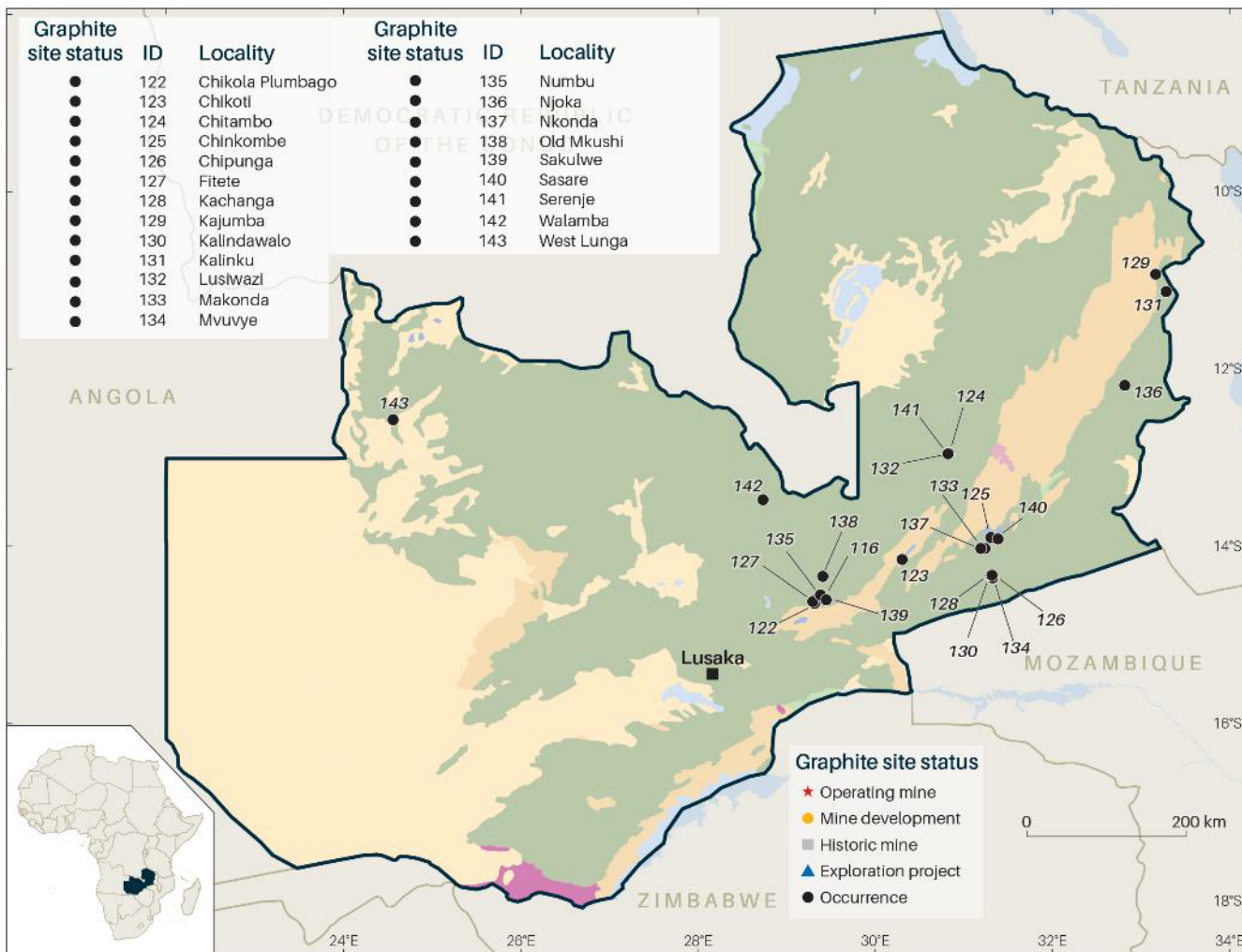
TANZANIA

Coordinates system: CGRS WGS 1984
Datum: WGS 1984
Units: Meters
Reference: GDA 2011 Geographical Map of the World
Original scale: 1:50 000 000
EPSG:31474



Lindi Jumbo graphite deposit, Tanzania © Walkabout Resources

Graphite in Zambia



Coordinate system: GCS WGS 1984
 Datum: WGS 1984
 Units: Degree
 Basemap: GLIM Lithological Map of the World
 Original scale: 1:35 000 000
 ©CCGM-CGMW 2015



CLAVEN MUTSILA, MWILA NYAMBI

Exciting time for mining

Woolley welcomes new investments into Zambia mining industry

BESTISH High Commissioner to Zambia Nicholas Woolley says Zambia is busy to increase export production by more than 50 per cent in the next five years.

Zambia, which is Africa's second largest producer of copper, currently produces 300,000 tonnes of copper. But the target is to reach three million within the next decade.

"The announcements we have seen show a number of investments that just work are coming," Mr Woolley said in remarks. For example, the announcement by FOM that it is ready to invest an additional US\$1.35 billion worth of capital into the expansion of Kansanshi and Sentinel mines represents an exciting level of interest in the mining sector."

country because there are a number of attractive mining zones."

There is renewed confidence in Zambia's investment climate with FOM, the nation's largest copper producer, announcing a US\$1.35 billion package of new projects.

In Zambia since FOM's Sentinel project was approved in 2012, Mr Woolley said.

Mr Woolley said the project will be involved in the long-awaited expansion of Kansanshi's operations in Sentinel, known as the "T2 project", and that US\$1.35 billion will go towards the US\$2.5 billion Kansanshi Enterprise nickel project in Kitalembika.

Mr Woolley said the project offers at least 100 jobs in terms of the support chain as well as employment.

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FEATURES/COLUMNS

Significance of Zambia-DRC cooperation agreements

By NKUSUWILA NACHALWE-MBAO

I. Background

THE invasion of Ukraine by Russia has threatened the energy security of many countries around the world.

Sub-Saharan Africa is no exception, buckling under the pressure of high fuel prices on the world market and decreasing the vulnerability interest in its dependency on oil producing countries.

Oil prices are wreaking havoc to commerce, forcing West African countries like Nigeria to suspend domestic flights because of high jet fuel prices.

Unprecedented fuel shortages in East Africa threaten to grind Kenya's economy to a halt.

A poignant reminder of how easily geopolitical conflicts distort the global economy and trading to interconnectedness.

With such a gloomy energy crisis outlook, it makes one wonder whether there is any respite on the horizon.



-COMMERCE Minister Chipoka Mulenga and his DRC counterpart Julien Kahongya sign the Memorandum of Understanding at Mulungushi International Conference Centre. Picture by KACHA MIYOBA-ZANIS



-PRESIDENT Hakainde Hichilema (right) talks to DRC President Felix Tshisekedi at Mulungushi International Conference Centre in Lusaka. Picture by KACHA MIYOBA



African graphite production capacity

Country	Current production capacity (tonnes, 2022)	Potential future production capacity (tonnes per year)
Guinea	0	100,00
Madagascar	78,000	241,000
Mozambique	359,000	739,000
Namibia	0	170,000
Tanzania	150	649,000
Total	437,150	1,899,000

NB China produced 820,000 tonnes of graphite in 2021





Graphite resources, and their potential to support battery supply chains, in Africa

Clive Mitchell and Eimear Deady



Lithium resources, and their potential to support battery supply chains, in Africa

Kathryn Goodenough, Eimear Deady and Richard Shaw

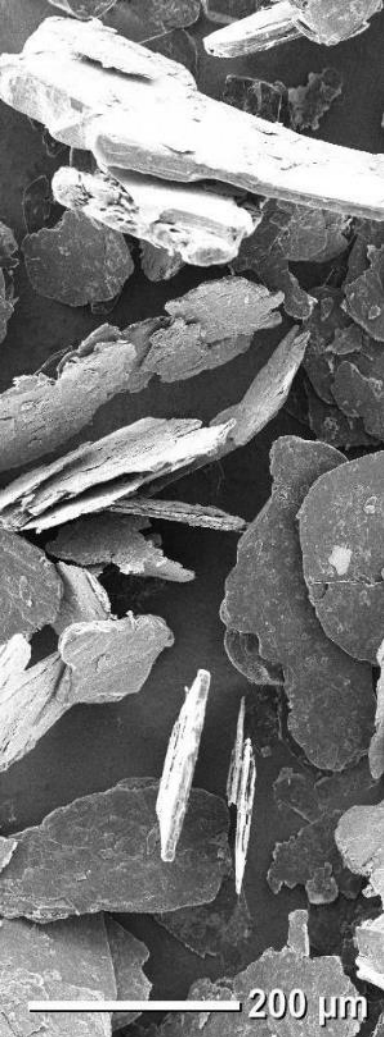


Raw materials for a low carbon future

Download from:

<https://www2.bgs.ac.uk/mineralsuk/statistics/rawMaterialsForALowCarbonFuture.html>





The future is graphite!

- Demand for battery raw materials is forecast to outstrip supply by 2030
- Current exploration and development activity is focused on East Africa particularly Madagascar, Mozambique & Tanzania
- Poorly explored basement terranes in Africa are likely to become the new hunting ground for sources of Battery Raw Materials, for example the Arabian-Nubian Shield (ANS) Precambrian basement NE Africa), and the Mozambique belt in countries such as Zambia
- In addition to exploration, investment in Africa is needed to create the sophisticated industrial processing capacity for the production of High Purity Spherical Graphite, battery anodes and the batteries themselves to reduce the supply chain reliance on China

Thanks for listening!



Clive Mitchell, Industrial Minerals Geologist, British Geological Survey

Email: cjmi@bgs.ac.uk

Twitter: [@CliveBGS](https://twitter.com/CliveBGS)



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