University of Exeter

GreenFutures

Centre of Excellence for Critical Minerals

Critical Minerals and Technology Metals

Critical Minerals are minerals, metals and commodities of high economic importance and high global supply risk. The criticality of materials is typically assessed using a combination of economic importance, availability of substitutes and supply risk of the raw material.

The specialist technology metals that are essential for the transition to a low carbon economy, e.g. lithium, rare earths, cobalt, tin, tungsten, often fall into the class of critical minerals. They have many applications but often the amounts needed overall are small in comparison to the major metals (iron, aluminium, copper).

This leaves them particularly vulnerable to supply disruption. The UK has recently defined a list of 18 critical minerals, including tin, tungsten and lithium, found in South West England[1].

[1] https://www.bgs.ac.uk/download/uk-criticality-assessment-of-technology-critical-minerals-and-metals/

Introduction

As the world moves towards zero net carbon, the demand for specialist critical minerals is rising exponentially. To keep pace with this demand, more and improved mining, minerals processing, product development and recycling are urgently needed. Research, development and innovation are required to develop new methods for finding technology metal-bearing ores, to improve and develop new technologies, and to understand and mitigate any environmental, social and governance issues that may arise. A highly trained workforce is vital if the industry is to meet these challenges.

Our need for Critical Minerals

Key to our low carbon future will be energy transition and this transition will be metals-intensive, for examples an electric vehicle requires four times more copper than a conventional vehicle. We will therefore need to use more critical minerals and technology metals than ever before. The International Energy Agency estimates that up to 40 times more lithium and 20 times more cobalt will be needed by 2040. Resilience for the Future: The UK's critical minerals, the UK's first ever Critical Minerals Strategy, was published by Government in July 2022. It set out Government's plan to secure the UK's supply chains by:

- accelerating growth of the UK's domestic capabilities;
- collaborating with international partners;
- enhancing international markets to make them more responsive, transparent and responsible.

The Strategy recognised that the UK has 'pockets of mineral wealth', and that it will be important to develop our domestic resources in a way that works for communities and the environment. Presently the UK largely relies on market forces to deliver a secure s upply of minerals to UK industry.

Others countries, including Australia, Canada, Japan, the US and those in the EU, are accelerating efforts to secure their own supplies. The Government's Critical Minerals Strategy aims to ensure that the UK keeps pace.

The Centre for Excellence in Critical Minerals will ensure that our industry has the skills, talent, opportunities for innovation, R&D and national and international partnerships, guaranteeing this resilience and securing the UK's position in this competitive international market.

Securing responsible production and stewardship

The challenges of responsible resource extraction and stewardship are complex. Innovations in exploration, mining and minerals engineering all play a role in improving resource efficiency and best practice.

Environmental challenges from both contemporary and historic mining have yet to be resolved in many regions. Engaging communities is core to ensuring that as we develop our extractive capability, we do so in a way which supports and enhances local communities and the environment. To achieve this new innovations and business models will be needed to link the downstream manufacturing and use/recycling phases to ensure a new integrated circular economy for technology metals.

A new circular economy approach to extraction and production is needed to drive sustainable mining development wherever it occurs globally. Improved materials stewardship will also ensure best value in use, re-use and recycling.

This is not just a multidisciplinary challenge but also an international one.

To tackle this, industry has come together with the University of Exeter's Camborne School of Mines (CSM) (the UK's only mining school), the University of Exeter's Business School and extensive community of researchers in related disciplines, to forge the concept of a new Centre of Excellence. Informed by the new United Nations Resource Management System, the new Centre of Excellence will bring together this multidisciplinary approach with international and national industry, NGOs and international academics to put the UK at the forefront of responsible production and stewardship.

Attracting Talent into Mining

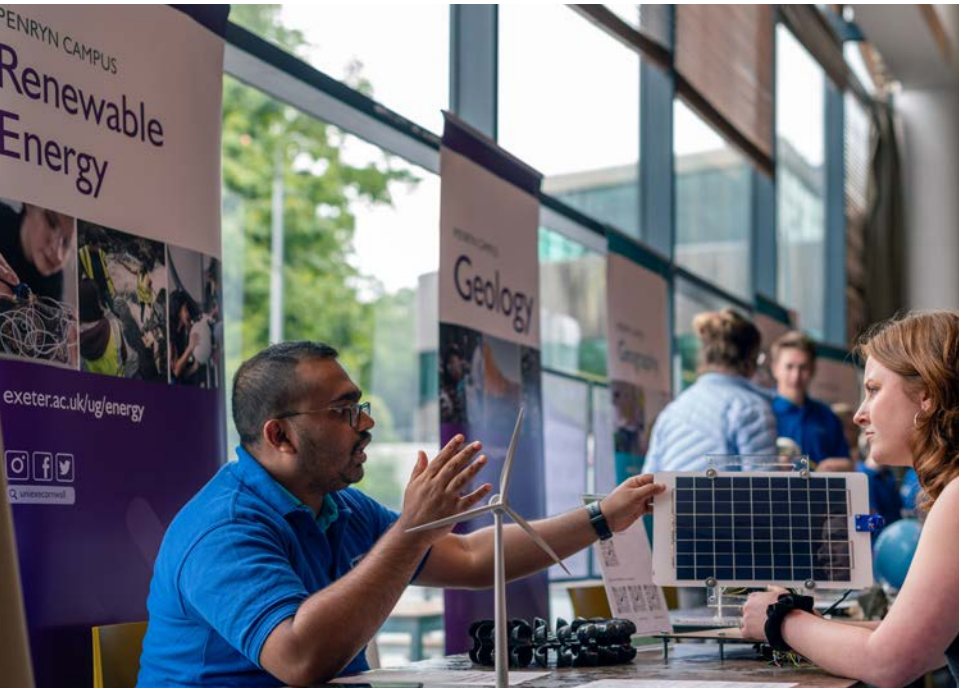
The strategic importance of critical minerals to our future economy, together with technological advances and the need to work in a multidisciplinary environment, mean that it is an exciting time to work in the mining industry, with new employment opportunities throughout the sector.

New skills are needed to support this innovation and a move towards a greener, safer, and more sustainable mining industry of the future. Internationally and nationally, there is a growing need to attract both new talent and to reskill the existing workforce.

Yet just as the demand for skills is increasing, the industry faces a global skills shortage. This is driven both by a lack of awareness of the opportunities available within mining industry, career paths and negative preconceptions about the nature and safety of work in the sector.

The resources industry faces new challenges associated with environmental, social and governance, and circular economy as it embraces new technologies, and as it sustains and improves its existing practices. Industry needs to recruit graduate engineers, geoscientists and a variety of other disciplines with the necessary knowledge and skills to support change.

The University of Exeter's Camborne School of Mines (CSM) is changing how we deliver mining engineering and geoscience education to meet these needs. The Government's Strategy states that it will "Work with Camborne School of Mines to boost its position as a world-leading mining school and launch a degree apprenticeship in mining engineering in 2023". With the UK mining community, CSM has formulated a degree apprenticeship as an industry-led degree for mining employees. A similar international degree has also been designed. New flexible degree courses are needed to weave together all the elements that mining professionals need.



A new Centre for Excellence for Critical Minerals

To deliver on the Government's Critical Mineral strategy, and to ensure that the potential for technology metals extraction, processing and product manufacture is fully exploited in the UK - partners are seeking a £20M investment in a proposed new Centre of Excellence for Critical Minerals, based in Cornwall.

Investment of this order will be required if we are to maintain our competitive position in relation to countries such as Australia and Canada, whose Governments are investing substantially (in the order of 100s of millions of USD)[2] in industry, research and innovation capacity and skills.

Through a private/public sector partnership between industry partners, the University of Exeter, local government, LEPs and international partners, the Centre will enable the UK to take the next step to create, demonstrate and lead globally on responsible resource management and circular economy. This will start right at the front of the value chain with exploration and mining for technology metals and linking to the full metals value chains to ensure good materials stewardship.

This Centre will provide a unique opportunity to:

- develop an industry focused Hub to drive world-leading research, innovation and education for a modern critical metals and minerals industry both domestically and globally;
- build on the strength of the assets in the South West UK and in particular Cornwall and the Isles of Scilly, with the resurgence of exploration for technology metals and substantial associated expertise;
- capitalise on and develop an international lead in the application of the new United Nations Resource Management System, emphasising circular economy research;
- help ensure that the Great South West becomes the Natural Powerhouse for the domestic supply of renewable energy and metals for the green transition.

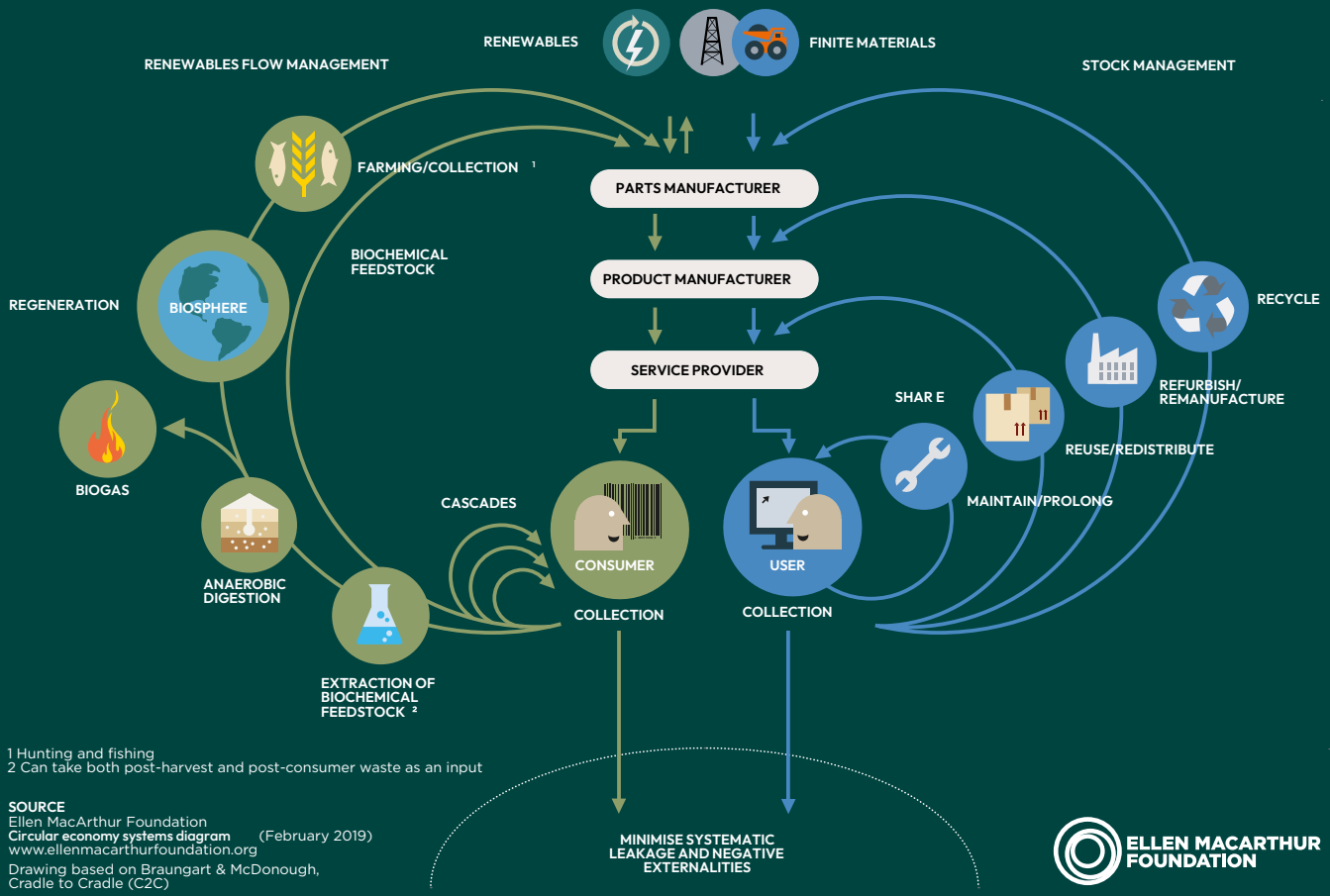
This Centre will enable the UK to take an integrated and whole value chain approach to resource management. In doing so it will raise the profile of the region and UK by continuing to produce internationally recognised research and innovation for a modern technology metals industry both domestically and globally.

This unique facility will support skills and talent development, R&D activity, equipment and a state of the art facility at the University of Exeter's Penryn Campus that will equip new laboratories and a collaboration environment which will bring together industry, NGOs, researchers and educators, policy makers and students.

[2] https://www.cfref-apogee.gc.ca/program-programme/competitions-concours-eng.aspx

Visualising the circular economy

The circular economy system diagram, known as the butterfly diagram, illustrates the continuous flow of materials in a circular economy. There are two main cycles – the technical cycle and the biological cycle. Secure and responsible supply of critical minerals needs a whole value chain circular economy approach, right from the very first stages of exploration and minin.



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input

SOURCE
Ellen MacArthur Foundation
Circular economy systems diagram (February 2019)
www.ellenmacarthurfoundation.org
Drawing based on Braungart & McDonough, Cradle to Cradle (C2C)

State of the Art Centre for Excellence Building

Equipped with state-of-the art technical facilities, this will provide a nexus for academia, industry, NGO, and governmental collaboration, with space for research, teaching and learning, and outreach.

Equipment Hub

The equipment hub will be a nexus for academia, industry, NGO, and governmental collaboration. It will house state-of-the-art geoscience equipment, aiming to facilitate technology development and demonstration via industry collaborations. Enabling SMEs to have access to leading technologies.

Skills: Support for Talent creation and retention

Establishing the South West as an international leader in mining engineering, mineral processing, geoscience, environmental and social science and business for Net Zero. Enabling graduates to thrive in an evolving industry. These graduates will be leaders in Environmental, Social and Governance (ESG) and systems thinking, for a sustainable, Net Zero, and equitable future. We will seek to develop new international courses, including courses based on the degree apprenticeship model, address CPD and executive education in the industry.

RD&I

Driven by industry challenges, the Centre will sponsor a programme of research development and innovation, bringing together industry and academia. Building on the strong foundation of the Camborne School of Mines and collaborative partnership projects across the university and internationally and engaging industry and other stakeholders, this will increase and widen the research capacity for critical minerals.

What the Centre will deliver:

Regionally:

- Support regional development in line with Cornwall's 2050 Plan and Cornwall and the Isles of Scilly Local Enterprise Partnership I ndustrial Strategy, creating jobs, start-ups and growth.
- Support businesses, including SMEs to make transition to net zero and circular economy practice.
- Provide training and skills support to industry locally, nationally and globally.
- Position Cornwall and the Great South West as a world leading hub for education and research in responsible mining and materials stewardship for a sustainable/ net-zero future.
- Raise the profile of the region by building international links and business opportunities.

UK PLC:

- Enable Government to implement all three themes of the UK Critical Minerals Strategy - a ccelerating domestic production and circular economy, collaborating overseas and enhancing leadership in responsible production and stewardship.
- Build a national talent pool delivering skills relevant to a modern, digitised, responsible technology metal industry that will support sectors in transition to Net Zero and Circular Economy.
- Development of prototype United Nations Resource Management System. Developed for the South West and then deployed to other areas of the UK.
- Improve private public sector access to data, evidence and expertise to support decision making for technology metal projects.
- Improve the resilience and circularity of supply chains.
- Attract green investment to the UK.

Globally:

- Provide global leadership in responsible resourcing for the green transition - knowledge assets can be licensed and commercially exploited globally.
- Develop internationally recognized United Nations Resource Management System knowledge asset that can position the UK and South West of England as a global leader in responsible resource management practices.
- Keep UK expertise at the forefront of sustainable development through the application of Circular Economy principles to resource management.
- Collaborate with international strategic partners to address global supply chains and address the global labour market for talent

Why Cornwall?

Cornwall has a 4000 year history of technology metals mining

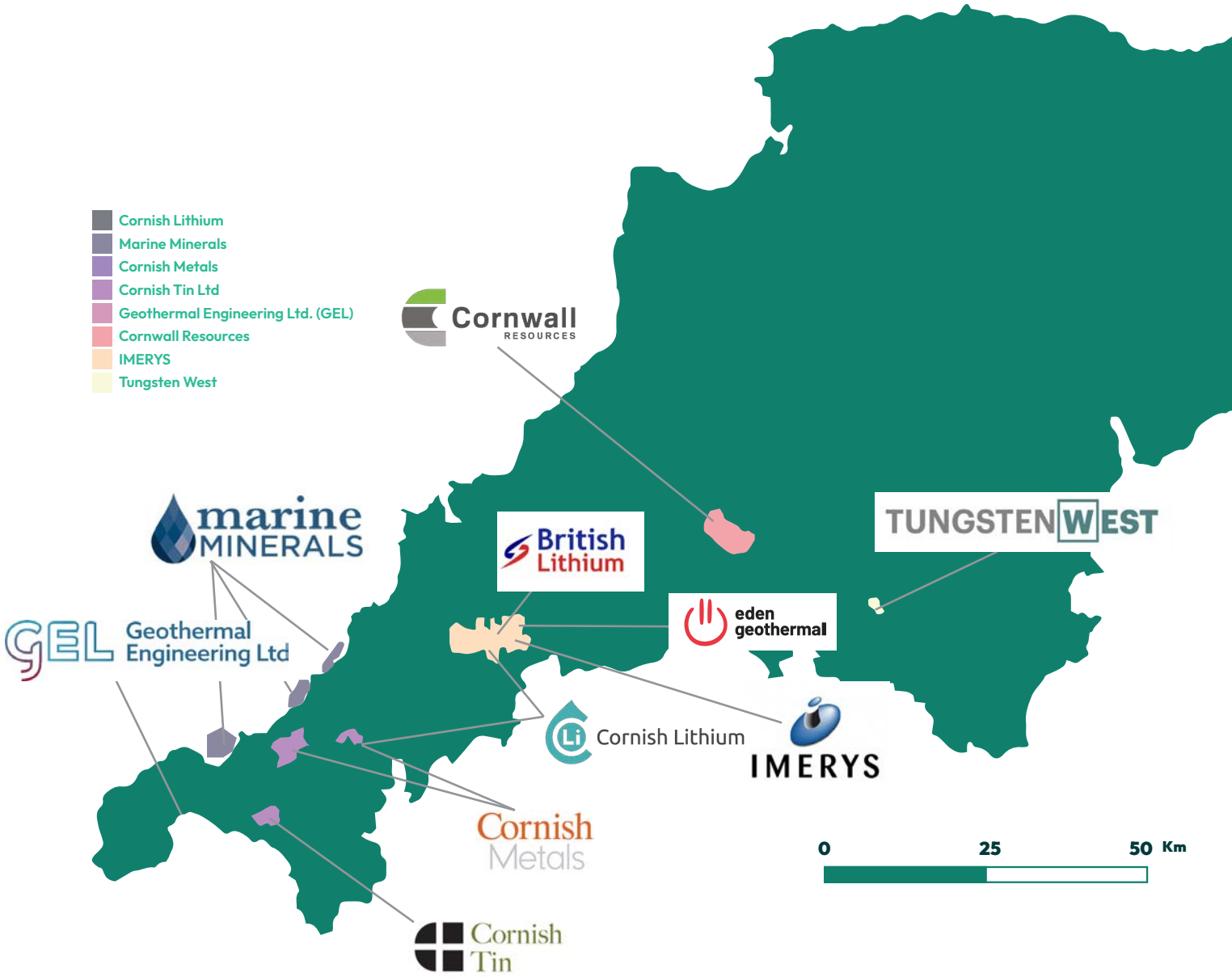
Cornwall's Mining Alliance lists over 70 companies operating in the mining sector, providing international consultancy, equipment and expert services worldwide. Together these companies provide expertise in mining, mineral processing, legal, accountancy, geophysics, IT support, construction, engineering, geology, mineralogy and environmental and social impact of mining.

Critical Minerals are identified as a unique regional opportunity by the Cornwall and Isles of Scilly Local Enterprise Partnership. The Department for International Trade (DIT) identifies mining as a High Potential Opportunity, a high-earnings export opportunity and allocates particular resources to Cornwall.

Cornwall is home to the Camborne School of Mines (CSM), the UKs only mining school whose graduates deliver mining expertise globally, including in senior positions in the world's largest minerals producers. CSM has a global reputation and global convening power.

Researchers at CSM have extensive experience and international reputations in conducting high-quality research on technology metals and critical minerals. Recent multi-million pound projects include the UKRI Interdisciplinary Circular Economy Centre for Technology Metals (Met4Tech; https://met4tech.org/about/), Lithium for Future Technology (LiFT; http://lithiumfuture.org/) and GREENPEG (https://www.greenpeg.eu/).

Extraction companies in Cornwall and West Devon



Multiple **significant investments** in Cornish critical minerals initiatives:

- **Cornish Metals: £25M** from Vison Blue Resources + **£15.5M** UK institutional investors, Canadian investors, and private investors.

- **Cornish Lithium: £18M** from TechMet Ltd. **+ £10.7M** since 2020 from public sources.

University of Exeter's Camborne School of Mines (CSM)

Camborne School of Mines (CSM) is the UKs only multidisciplinary mining department in the UK. It was founded in 1888 and is now located at the University of Exeter's Penryn Campus.

It is Europe's leading institution of higher education in mineral and mining engineering (11th in QS World ranking 2022)[3], with an international reputation, links with global mining companies and an international alumnus.

CSM provides world class education and research in geology, mineral and geothermal resources, mining and mineral processing, environmental and social science, leading on technology metals circular economy, and sustainable resource management.

Current capabilities

Mining and Mineral Processing

- Mining engineering
- Mineral recovery
- Geotechnical and safety engineering
- Geometallurgy
- Geomicrobiology
- Bio-processing

Digital Technologies and Smart Mining

- Digital innovation for mining
- Visualisation and Immersive technology
- Data science and modelling – including: Institute of Data Science and Artificial Intelligence
- Robotics

Energy, Environment and Society

- Geothermal energy
- Mine waste impact and valorisation
- Circular economy - joint with Business School
- Life Cycle Assessment - links to Renewables Engineering
- Social, humanities and archaeology interdisciplinary links
- Climate change impact and extreme weather research

Geoscience

- Ore deposit geology
- Exploration geology
- Applied Mineralogy
- Geological carbon capture and storage

CSM has more than 25 full time staff and 40 PhD students and is a leader in technology metals.

Employers from the mining sector have worked with the Camborne School of Mines to develop a new mining engineering degree apprenticeship programme, which has been approved by the Institute for Apprenticeships and Technical Education and is planned to start in 2023. This apprenticeship will contribute to the skills needed for critical minerals mining in the UK.

CSM has students and staff from all over the world, including Botswana, Canada, South Africa, India, Zambia. CSM will continue to develop and innovate in its education offering to provide the multidisciplinary skills required for the mining industry across the world.

[3] https://www.topuniversities.com/university-rankings/university-subject-rankings/2022/mineral-mining-engineering

Camborne School of Mines currently partners with:

Anglo American

Rio Tinto

Centamin

Glencore

Imerys

Debswana

Cornish Lithium

Cornwall Resources

Cornish Metals

Cornish Tin

Tungsten West

British Lithium

British Geological Survey

Babcock

CSM leads the UKRI Interdisciplinary Circular Economy Centre for Technology Metals (Met4Tech) and the University of Exeter Business School leads the Circular Economy Hub of the UKRI National Interdisciplinary Circular Economy Research programme. The University of Exeter is the first University Partner for the Ellen MacArthur Foundation[4] which supports circular economy approaches.

CSM leads the Deep Digital Cornwall project – a research and innovation project working with 40 regional SMEs delivered jointly by CSM, the Institute for Data Science and Artificial Intelligence and industry partners Cornish Lithium and Cornwall Resources.

[4] https://ellenmacarthurfoundation.org/

CSM recently announced a £3.5 million donation for a Mark Cutifani Anglo American Chair in Mining Innovation

Collaborations with leading research organisations globally

CSM has a Strategic Partnership with the University of Queensland. Their Resources Technology and Critical Minerals Trailblazer - "...is the first under the [Australian] Federal Government's $242.7 million Trailblazer program. The project has attracted 33 industry partners* committing a further $90 million, in addition to the $50 million funding provided by the Federal Government, towards the aim of sourcing the critical minerals needed to support emerging technologies including electric vehicles, renewable energy products, low-emission power sources and consumer devices."

Our experts advise key national and international committees, including the Expert Committee for the UK Critical Minerals Strategy, the British Geological Survey Science Advisory Committee, Extractives Industry Transparency Initiative, Mining Association of the UK, UK Minerals Education Forum, and the Geological Society decarbonisation working group.

The following organisations have indicated their support for this initiative:

University of Exeter

gsl

Great South West

Cornish Lithium

CIOS LEP

CORNWALL & ISLES OF SCILLY LOCAL ENTERPRISE PARTNERSHIP

heart of the south west local enterprise partnership

Cornwall RESOURCES

CORNWALL COUNCIL

TUNGSTEN WEST

University *of* Exeter

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