

Essential Minerals for the Green Revolution – 8 Critical Minerals

Essential mineral – critical mineral: what is the difference?

The first seven activities in this series have asked which minerals are essential for the “new” technology as the World tries to reduce its carbon footprint in the face of an increase in demand for minerals. (In this context “mineral” mostly means “metal ore”). The major industrialised countries are now looking at the security of the supply chains involved in obtaining these minerals. Do they have enough resources of their own, or do their supplies come from stable overseas countries? If not, then the mineral is declared as “critical” and each country is drawing up its own list for the current situation.

We shall look at the critical minerals list for the UK (and European Union - EU). As an example, the UK imports its lithium from overseas, but regards current sources as reliable, so lithium is not listed as a critical mineral. The critical minerals list for the UK and EU in 2023 contains the following metals (* = features in Earthlearningidea’s Essential Minerals series):

Critical minerals – UK and EU 2023		
antimony	germanium	platinum group metals
beryllium	graphite*	rare earth elements*
cobalt*	indium	tantalum*
fluorspar	magnesium	tungsten*
gallium	niobium*	

Mining for metal ores in the UK

In the 18th and early 19th Centuries, the UK led the world in mining for metal ores, such as lead, copper, zinc and iron, but these mines have now closed. Currently there is only one active mine, working gold ore at Cononish in Scotland, although galena, the ore of lead, is produced as a by-product of fluorspar mining in the Peak District. A tungsten mine operated between 2014 and 2018 – this was the first metal mine to open in 40 years. It plans to re-open again in 2025.

Ecton Mine

For example, copper ores were first worked at Ecton in the Peak District in the Bronze Age (c. 1800 B.C.) but Ecton Mine’s heyday was in the late 18th Century, when the rich copper ores resulted in huge profits for the owner, the Duke of Devonshire. After about 1800 A.D. extraction of ore rapidly declined and the workings below river level have been flooded since the mid-1850s.

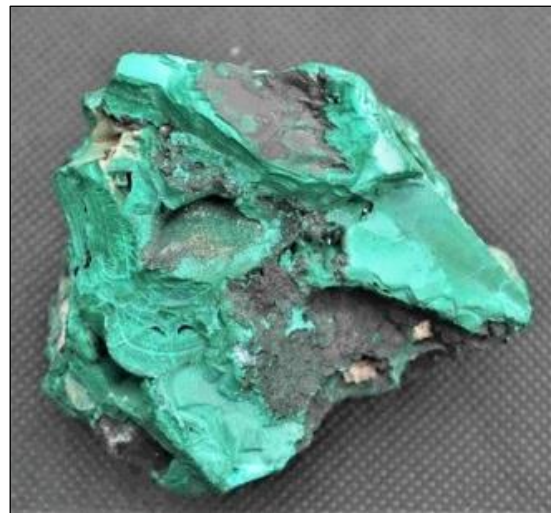


Fig 1: Malachite - one of the ores of copper worked at Ecton Mine (Peter Kennett).

Ask the pupils to look at the details of Ecton Mine below and suggest reasons why the mine closed. Reasons may include factors at the mine itself and further afield.

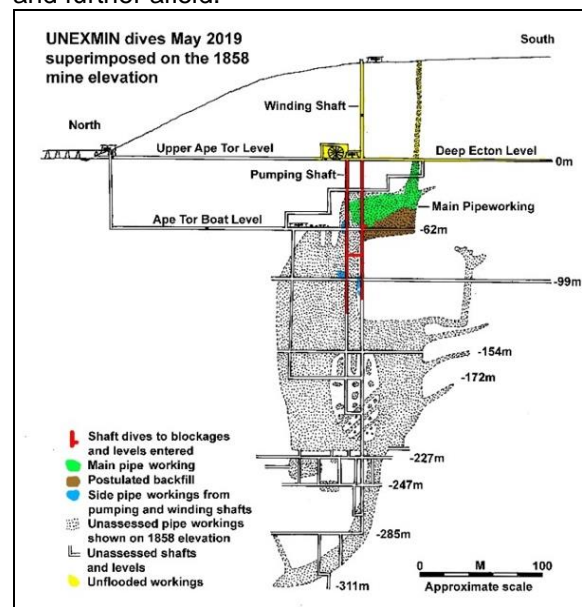


Fig 2: Vertical section through Ecton Copper Mine. The grey stippled area is from a drawing made in 1858. The coloured sections relate to a survey carried out with submersible equipment in 2019 by an international group, UNEXMIN. (John Barnatt for Ecton Mine Educational Trust)

Reasons for the closure of Ecton Copper Mine are common to many other such mines. Most pupils will state that it is because the ore body ran out. The section of the mine shows that the ore body was indeed narrowing with depth, but no surveys were carried out to see if it expanded again lower down. More commonly mines were closed because they became uneconomic due to: increased costs for pumping out water as the depth increased; unexpected geological difficulties such as faulting or the stability of the workings;

costs of fuel for pumping and winding engines; high labour costs; the development of more economic mines in other countries; a fall in demand for the product as technology changed; environmental factors in the surrounding landscape. (Ecton is now in the protected Peak District National Park, but this was only created in 1951 and no such considerations applied in the 18th and 19th Centuries).

Similar reasons may be found for the closure of other mines in the UK, e.g. for the ores of lead, tungsten, tin and zinc.

In order to safeguard the UK's future sources of critical minerals, the British Geological Survey commissioned a report in 2023, entitled "Potential for Critical Raw Material Prospectivity in the UK" (see "Useful links"). The Report examines each of the critical minerals in turn and has produced maps of regions where the geology is potentially suitable for such minerals to occur. The maps do **not** show where economic deposits of ores have been found, but merely where prospecting could realistically be carried out, based on the geology which is normally associated with each mineral. As an example, the map for areas where prospecting for tin, tungsten, tantalum, beryllium and lithium might be carried out is shown below.

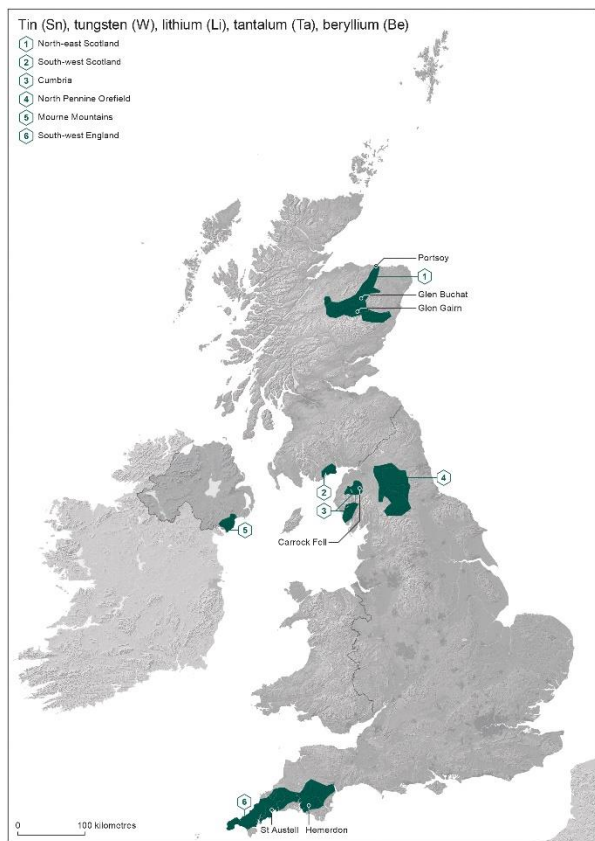


Fig 3: Areas of the UK that may be prospective for tin, tungsten, lithium, tantalum and beryllium (Permit Number CP23/044, BGS © UKRI 2023 see below)

In fact, several companies are actively exploring for some of these metals, notably tin and lithium in Cornwall. One of these companies, Cornish Metals, has drilled many boreholes around the former South Crofty Mine. These have confirmed the size of the known reserves of tin ores and

have discovered a major new deposit (known as a lode in Cornwall). Prospects for lithium extraction are also under way. South Crofty was abandoned in 1998, when the world price for tin dropped to less than \$5,000 per tonne, but the price is now (2023) around \$28,000 per tonne. Cornish Metals has just installed equipment to pump out the flooded workings of the mine, and to treat the mine water, and the company is hoping to start mining in a year or so.

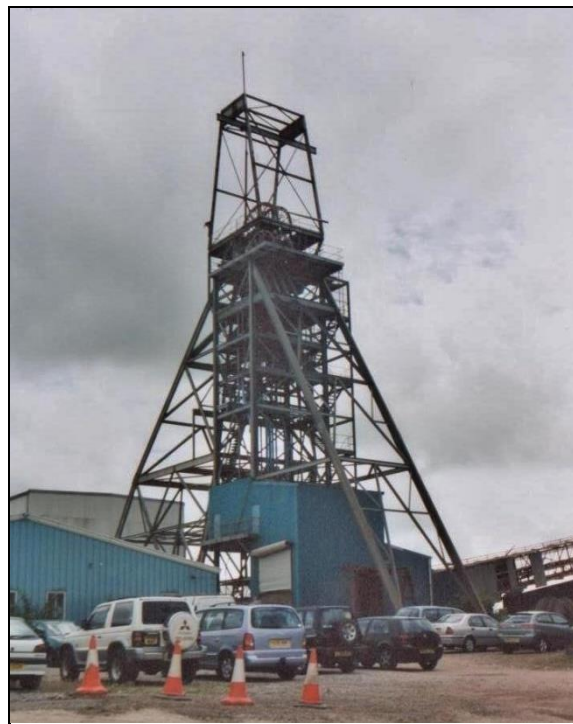


Fig 4: South Crofty Mine, Cornwall (By A.H.W.May.(User:Ahwmay)- Public Domain, https://commons.wikimedia.org/w/index.php?curid=8838_1806)



Fig 5: A protest against prospecting for lithium in Cornwall: <https://novaramedia.com/2022/06/14>

Ask pupils to watch the promotional YouTube presentation from Cornish Metals, made in 2021 and then to suggest reasons for and against re-opening South Crofty Mine.

Answers might include:

For: Demand for tin has risen with greatly increased uses for it in the electronics industry; mining would secure supplies of tin from within the UK; Cornwall has historic expertise in mining and

has local educational facilities for training the workforce; Cornwall is a depressed region of the UK and would welcome the jobs which a re-opened mine would provide; borehole data are very extensive and indicate large deposits of the minerals; the Cornish deposits contain some of the highest grade tin ores in the world; the world price of tin is high at present; other ores including those of copper occur alongside the tin ores.

Against: Mining is dependent on many factors outside the control of the operators, as already outlined for Ecton; parts of Cornwall are of great beauty and the county is an important tourist destination; most mining produces large volumes of waste – “tailings” (although in this case, this

would be disposed of in former workings below ground): water pumped from the mine carries dissolved salts and will need treatment before it is piped into local watercourses. Local groups may organise protests against perceived damage to the environment, or inadequate use of local labour as new ventures are developed, e.g. April 2022 when another company started drilling at the disused Wheal Vor mine for tin prospects.

It is important to repeat that the 13 maps in the BGS Report do not imply that any of the critical minerals are physically present in economic quantities. “They simply represent areas where the geological criteria have been met and thus there is potential for deposits to occur”.

The back up

Title: Essential Minerals for the Green Revolution – 8 Critical Minerals

Subtitle: Essential mineral – critical mineral: what is the difference?

Topic: Defining the purpose of a national critical minerals list for the future needs of the UK’s technology.

Age range of pupils: 12 years and above

Time needed to complete activity: at least 30 minutes, depending on viewing time for video etc

Pupil learning outcomes: Pupils can:

- define the meaning of the term “critical mineral”;
- list the main factors which determine whether mining for metal ores is viable or not;
- explain that the identification of a “prospective area” highlights the most likely geology for critical minerals to occur but not that they will necessarily be found or exploited there;
- outline the main benefits and drawbacks for the local people of a mine being developed.

Context: This activity could form a summary of the Earthlearningidea series on metal ores which are essential for the “new” technologies as well as the growth of existing industries.

Following up the activity:

- Some of the critical minerals from the UK list (shown with a *) also feature in Earthlearningidea activities. Choose one of these and use the activity to explain why it is a critical mineral for the UK and not merely an essential mineral.
- Download maps of some of the other critical minerals from the BGS Report and investigate the potential for their discovery.
- Follow the progress through their publicity videos of Cornish Metals and other firms which are actively prospecting for minerals in the UK.
- Choose a region of the UK shown in the BGS maps, other than Devon and Cornwall, and

discuss the implications for that region if a critical mineral were to be discovered there.

Underlying principles:

- “Critical raw materials (CRMs) are those mineral commodities that are both economically important and at risk of supply disruption” (BGS Report).
- The critical minerals list includes minerals which are essential to maintain existing industries as well as growth industries involved in cleaner energy and carbon reduction.
- The situation is very volatile and the list may change if disruption is caused to the supply chain because of increased demand from other countries, or suppliers ceasing to export the minerals.
- Factors affecting the viability of any mine for metal ores are given above and are not repeated here.

Thinking skill development:

Establishing the concept of a critical mineral involves construction. Cognitive conflict may arise in the distinction between an essential mineral for industry and a critical mineral for the country as a whole. Discussion between pupils involves metacognition. Application to the country at large is a bridging skill.

Resource list: Access to the information in this activity (and to some of the activities in the “Essential minerals” series for follow up).

Useful links: [Critical raw materials | Commodities & statistics | MineralsUK \(bgs.ac.uk\)](#)
[BGS Report, single column layout \(ukcmic.org\)](#)
Cornish Metals:
https://www.youtube.com/watch?v=QMjiAng_atQ
Protest groups:
<https://www.cornwalllive.com/news/cornwall-news/residents-call-drilling-stop-wheal-7004693>

Source: Written by Peter Kennett of the Earthlearning idea team with advice from Ben Lepley of SLR Consulting Ltd and Dr. John Barnatt.

Permission from the British Geological Survey to reproduce Figure 3 is gratefully acknowledged. (Permit Number CP23/044, BGS © UKRI 2023. All Rights Reserved. From Fig 15 Areas of the UK that may be prospective for Sn, W, Li, Ta and Be. Contains Ordnance Survey data © Crown Copyright and database right 2023. Contains NEXTMap Britain elevation data from Intermap

Technologies. Sourced:
[UK Critical Minerals Intelligence Centre \(ukcmic.org\)](https://www.ukcmic.org)

Note: This activity was as accurate as possible in autumn 2023. Rapid developments are taking place in the technology of low and renewable energy and in prospecting for critical minerals.

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Essential Minerals for the Green Revolution

Earthlearningidea has compiled a series of activities on the minerals which are essential if modern technology is to be able to reduce the World's carbon footprint. Some are regarded as "critical" minerals and many of them are relatively "new" in terms of needing to be exploited.

This table will be updated as fresh activities are added.

All titles begin with: Essential Minerals for the Green Revolution...

Mineral	Title
Lithium	1 Lithium: an element which is pulling more than its weight in the world
Copper	2 Copper: an element for which the demand is increasing rapidly
Rare Earths	3 Rare Earth Elements: vital components in modern technology
Graphite	4 Graphite: from a pencil to the electric car!
Cobalt	5 Cobalt: mined by children
Tin, Tungsten, Tantalum	6 "The Three Ts": Tin, Tungsten and Tantalum
Gold	7 Gold: an essential mineral - or is it?
Critical minerals	8 Critical Minerals: Essential mineral - critical mineral: what is the difference?