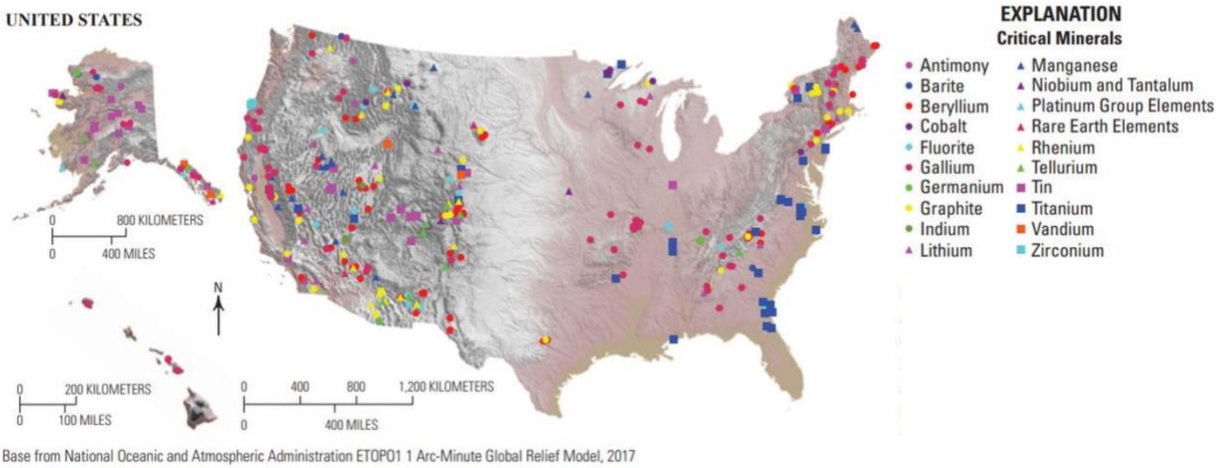
Essential Minerals for the Green Revolution – 9. Critical Minerals for the USA
Why are certain minerals of such importance to the USA?

Earthlearningidea (ELI) has already published a series of activities, discussing the uses and availability of a number of minerals which are essential to modern civilisation. Some of these are "critical minerals", the definition of which varies from country to country. We have already considered critical minerals for the UK and EU https://www.earthlearningidea.com/PDF/435_Essential_minerals_critical.pdf . In this activity we are considering minerals which are regarded as "critical" to the USA.



Critical minerals of the USA (*Source: https://www.usgs.gov/media/images/united-states-critical-minerals-locations*)

The USGS is required to update the list of critical minerals every three years. At the time of writing (May 2025) the list in use dates from 2022. https://www.usgs.gov/news/national-news-release/us-geological-survey-releases-2022-list-critical-minerals The USGS states "The Energy Act of 2020 defines a *critical mineral* as a non-fuel mineral or mineral material essential to the economic or national security of the U.S. and which has a supply chain vulnerable to disruption". Pupils could discuss what factors might disrupt the supply chains to the USA (*political instability or war in source countries*: *countries being unwilling to supply the USA; sources within the USA not being as productive as forecast; natural disasters; failure of a sole US producer of the element*).
Pupils could be split into groups and each group asked to investigate a mineral or group of minerals, using data from the rest of the ELI series, or from the US Geological Survey (USGS), and then to report back to the class (see below).

Appendix 1 on pages 2 and 3 shows the complete USGS list, with some uses of each element and links for further information. (Note that although referred to as "minerals", the list shows the main chemical elements and does not attempt to name the minerals in which they are found).

Activities for small groups of pupils: for each group, ask them to try some of the questions given in the ELI activities below. In particular, pupils should list the main uses of the element and decide why the USA is concerned about its supply lines.

1. Graphite: https://www.earthlearningidea.com/PDF/424_Essential_minerals_graphite.pdf
2. Lithium: https://www.earthlearningidea.com/PDF/416_Essential_minerals_lithium.pdf
3. Rare earths: https://www.earthlearningidea.com/PDF/421_Essential_minerals_rare_earths.pdf
4. The Three Ts: https://www.earthlearningidea.com/PDF/429_Essential_minerals_three_Ts.pdf

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The back up

Title: Essential Minerals for the Green Revolution – 9. Critical Minerals for the USA

Subtitle: Why are certain minerals of such importance to the USA?

Topic: Defining the purpose of a national critical minerals list for the current and future needs of the USA's industries and technology.

Age range of pupils: 14 years and above

Time needed to complete activity: at least 30 minutes for group work, followed by open-ended class discussion.

Pupil learning outcomes: Pupils can:

- define the meaning of the term "critical mineral";
- assess the implications of the uneven distribution of critical mineral resources for the USA;
- explain what factors might upset supply chains of critical minerals to the USA;.
- Name some uses of the main critical minerals.

Context: This activity could form an extension of the Earthlearningidea series on metal ores which are essential for the "new" technologies as well as the growth of existing industries. Pupils' answers to questions posed in the various resources will depend on their choice of topic, so only a few suggestions are given here.

Following up the activity:
Ask small groups of pupils to investigate the main uses of several elements in these 5 different applications (renewable energy: medical implants: mobile devices, satellites; fireworks) as outlined in "What are Critical Minerals? | U.S. Geological Survey see "How do critical minerals affect me?"

The critical minerals list for the USA in Appendix 1 could be compared with that for the UK and EU in https://www.earthlearningidea.com/PDF/435_Essential_minerals_critical.pdf (Note that in the UK lists of the rare earths are grouped together, whereas the USGS names each element separately). Why are elements like copper regarded as critical for the UK and EU but not for the USA? (*The USA has large reserves of copper minerals; copper is readily recycled.)*

- **Underlying principles:** a critical mineral is "a non-fuel mineral or mineral material essential to the economic or national security (of the USA.) and which has a supply chain vulnerable to disruption"**.**
- 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.
- Of particular concern is the supply of rare earth minerals. In 2024, the USA produced 45,000 tonnes of rare earth minerals from just one mine, compared to China's output of 270,000 tonnes. (See Link below)

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: See links given throughout the text above.
Top 10 Countries by Rare Earth Metal Production | INN

Source: Written by Peter Kennett of the Earthlearning idea team

Appendix 1 from https://www.usgs.gov/news/national-news-release/us-geological-survey-releases-2022-list-critical-minerals

"The 2022 list of critical minerals includes the following — click a mineral's name to find relevant statistics and publications": (*ELI Note: although referred to as "minerals", the list shows the main chemical elements and does not attempt to name the minerals in which they are found. American spellings have been converted to English ones. * = rare earth element*)

- Aluminium, used in almost all sectors of the economy
- Antimony, used in lead-acid batteries and flame retardants
- Arsenic, used in semi-conductors
- Barite, used in hydrocarbon production.
- Beryllium, used as an alloying agent in aerospace and defence industries
- Bismuth, used in medical and atomic research
- *Cerium, used in catalytic converters, ceramics, glass, metallurgy, and polishing compounds
- Caesium, used in research and development
- Chromium, used primarily in stainless steel and other alloys
- Cobalt, used in rechargeable batteries and superalloys
- * Dysprosium, used in permanent magnets, data storage devices, and lasers
- *Erbium, used in fibre optics, optical amplifiers, lasers, and glass colourants

- * Europium, used in phosphors and nuclear control rods
- Fluorspar, used in the manufacture of aluminium, cement, steel, gasoline, and fluorine chemicals
- *Gadolinium, used in medical imaging, permanent magnets, and steel-making
- Gallium, used for integrated circuits and optical devices like LEDs
- Germanium, used for fibre optics and night vision applications
- Graphite , used for lubricants, batteries, and fuel cells
- Hafnium, used for nuclear control rods, alloys, and high-temperature ceramics
- *Holmium, used in permanent magnets, nuclear control rods, and lasers
- Indium, used in liquid crystal display screens
- Iridium, used as coating of anodes for electrochemical processes and as a chemical catalyst
- *Lanthanum, used to produce catalysts, ceramics, glass, polishing compounds, metallurgy, and batteries
- Lithium, used for rechargeable batteries
- *Lutetium, used in scintillators for medical imaging, electronics, and some cancer therapies
- Magnesium, used as an alloy and for reducing metals
- Manganese, used in steel-making and batteries
- *Neodymium, used in permanent magnets, rubber catalysts, and in medical and industrial lasers
- Nickel, used to make stainless steel, superalloys, and rechargeable batteries
- Niobium, used mostly in steel and superalloys
- Palladium, used in catalytic converters and as a catalyst agent
- Platinum, used in catalytic converters
- *Praseodymium, used in permanent magnets, batteries, aerospace alloys, ceramics, and colourants
- Rhodium, used in catalytic converters, electrical components, and as a catalyst
- Rubidium, used for research and development in electronics
- Ruthenium, used as catalysts, as well as electrical contacts and chip resistors in computers
- *Samarium, used in permanent magnets, as an absorber in nuclear reactors, and in cancer treatments
- Scandium, used for alloys, ceramics, and fuel cells *(ELI note – found in association with rare earths)*
- Tantalum, used in electronic components, mostly capacitors and in superalloys
- Tellurium, used in solar cells, thermoelectric devices, and as alloying additive
- *Terbium, used in permanent magnets, fibre optics, lasers, and solid-state devices
- *Thulium, used in various metal alloys and in lasers
- Tin, used as protective coatings and alloys for steel
- Titanium, used as a white pigment or metal alloys
- Tungsten, primarily used to make wear-resistant metals
- Vanadium, primarily used as alloying agent for iron and steel
- *Ytterbium, used for catalysts, scintillometers, lasers, and metallurgy
- Yttrium, used for ceramic, catalysts, lasers, metallurgy, and phosphors *(ELI note– found in association with rare earths)*
- Zinc, primarily used in metallurgy to produce galvanized steel
- Zirconium, used in the high-temperature ceramics and corrosion-resistant alloys".