UK Critical Minerals Intelligence Centre

CRITICAL MINERALS

KS3 lesson 2 teacher's notes: life cycle of a mineral

British Geological Survey

Department for Business & Trade

Minerals in everyday life

Curriculum Links:

Wales	England
Science & Technology • Being curious and searching for answers is essential to understanding and predicting phenomena • Matter and the way it behaves defines our universe and shapes our lives Humanities • Our natural world is diverse and dynamic, influenced by processes and human actions • Human societies are complex and diverse, and shaped by human actions and beliefs	Science • Working scientifically Chemistry • Materials • Earth and atmosphere Geography • Locational knowledge • Place knowledge • Human and physical geography • Geographical skills and fieldwork

Lesson 2 overview

- Recap from Lesson 1: pupils discuss what minerals they discovered at home or on the journey to and from school, and how minerals affect our daily lives
- Use of minerals and critical minerals in electric vehicles
- Key mineral components in an electric vehicle battery
- Supply of minerals in mobile phones
- The life cycle of a mobile phone
- Careers in geoscience

Introduction

[See Powerpoint slide 2]

Review homework from previous lesson.

[SUGGESTION]

You could use the Mineralogy4Kids website to access information on common minerals you may find in your home that pupils may have highlighted as part of their homework.

Suggested discussion areas you might be interested in covering:

- The environmental effect of the statement 'if it can't be grown, it must be mined'
- The effect this statement could have on climate change
- Ethics: should we mine? Should we sacrifice potential farmland for mining? How can cash-crop growth be managed in the future?

Some additional information surrounding the above discussion points.

Humanitarian concerns

- People in developing countries often work very long hours for very low wages; for example in India, many people live on less than £1 per day
- Low standards of living because of a lack of money to invest in and improve education, healthcare and infrastructure
- Working conditions may be very poor
- Lack of employment law means that people can be treated badly, for example no rest or food breaks
- Cash crops such as coffee and cotton are grown for export, removing vital land available for local people to grow food to survive

Environmental concerns

- Lack of strict laws and policies in developing countries mean that factories can pollute the environment without any consequences such as large fines or prosecution
- Cash-crop plantations are unnatural and rows upon rows of the same tree spoil the look of the landscape
- Soil erosion and land degradation are common where cash crops exhaust the land of vital nutrients
- The use of fertilisers and pesticides to grow more crops pollutes rivers and water sources
- Mining can cause erosion, collapsed ground and loss of biodiversity
- Chemicals resulting from mining processes can cause contamination of soil, groundwater and surface water

Definition

- 'Cash crops' are agricultural crops that are planted for the purpose of selling on the market or for export to make profit
- 'Subsistence crops' are planted for the purpose of self-supply of the farmer (like livestock feeding or food for the family)

Activity 1: the life cycle of a mobile phone

[See Powerpoint slides 4 and 5]

Part 1

There are a range of components needed to make a mobile phone.

Pupils work in pairs or small groups, using an atlas or working online to find the many countries involved in the supply chain for mobile phones. Pupils plot the countries on a world map. Research what resources come from which countries and then plot the cumulative distance all the different parts of a mobile phone have travelled to end up in the UK.

Use the scale 1 cm = 1000 miles .

Please note: this is not 100% accurate but will give the pupils an idea of the global impact of the mobile phone supply chain.

Countries that provide mobile phone parts for Nokia:

- Austria
- Brazil
- China
- Czechia
- Denmark
- Estonia
- Finland
- France
- Germany
- Hungary
- Ireland
- Israel
- Japan
- Malaysia
- Mexico
- Morocco
- Netherlands
- Philippines
- Portugal
- Singapore
- Slovakia
- South Korea
- Spain
- Sweden
- Switzerland
- Taiwan
- Thailand
- UK
- USA

Consider the implications that this pattern of distribution may cause.

Look at the map and note the wide range of components and distribution, and wider implications this may have:

Pupils should consider the following:

- Transportation: economical costs and environmental costs
- Conflicts in countries where components are mined
- Conditions for miners in some of the less developed nations

Part 2

[Play video ‘Life cycle of minerals’ from start to end]

[See Powerpoint slide 6]

Suggestions for answers to questions in video.

Stage 1: extraction of raw materials

A typical mobile phone is made up of 40% metal, 40% plastic and fibreglass and 20% ceramics and trace materials. In fact, mobile phones can contain between 500 to 1000 components altogether. You may have heard of some of the metals and trace materials used, for example:

- copper
- gold
- lead
- nickel
- zinc
- tin
- silver

Other materials such as plastics are made from oil. Oil takes millions of years to form from small, dead, organic lifeforms called plankton, which fall and accumulate on the floor of the ocean.

Fibreglass is formed from sand and limestone. Sandstone is made of sand grains that may have been deposited in the sea, by rivers, or in deserts, and later cemented together by minerals precipitated from groundwater. Limestone is a sedimentary rock most commonly formed in warm shallow seas and composed mainly of calcium carbonate ($CaCO_3$).

Stage 2: processing

The rechargeable battery in a phone may contain:

- nickel
- cadmium
- cobalt
- zinc
- copper
- lead
- lithium

Cobalt and lithium are critical minerals and nickel is on the watchlist. These have to be separated from their ores to concentrate the metal.

Some issues that affect the materials’ extraction and processing stages include conflict where some of these materials are mined, for example wars or political unrest. Also, some of the conditions that the miners work in are poor and there is little protection for the miners or indeed the surrounding environment. We also need to consider the amount of energy required to operate the machinery in the mining process and then transport the materials to ports and airports.

Stage 3: manufacturing

This is the process of converting the raw materials into a finished product. The raw materials are often made into components for a mobile phone in many different countries, for example, the mobile phone maker Nokia gets its components from at least 29 countries, as you learnt earlier.

Again, just like with the previous processes, energy is required to operate the factories and transport the components to where they are eventually assembled in a mobile phone.

Stage 4: packaging and transportation

Packaging for mobile phones can be made from paper or cardboard, which both come from trees, or from plastics (from oil) and other materials. Yet again, energy is needed in the factories that pack the phones and for transporting the finished articles to the shops.

Stage 5: useful life of the phone

Did you know that in the USA, a mobile phone is only used for 18 months on average before the user replaces it with another one? You can extend the life of your phone by taking care of it: protect it from damage by storing it in a case, avoid dropping it, keep it out of extreme heat and cold and keep it away from water and other liquids.

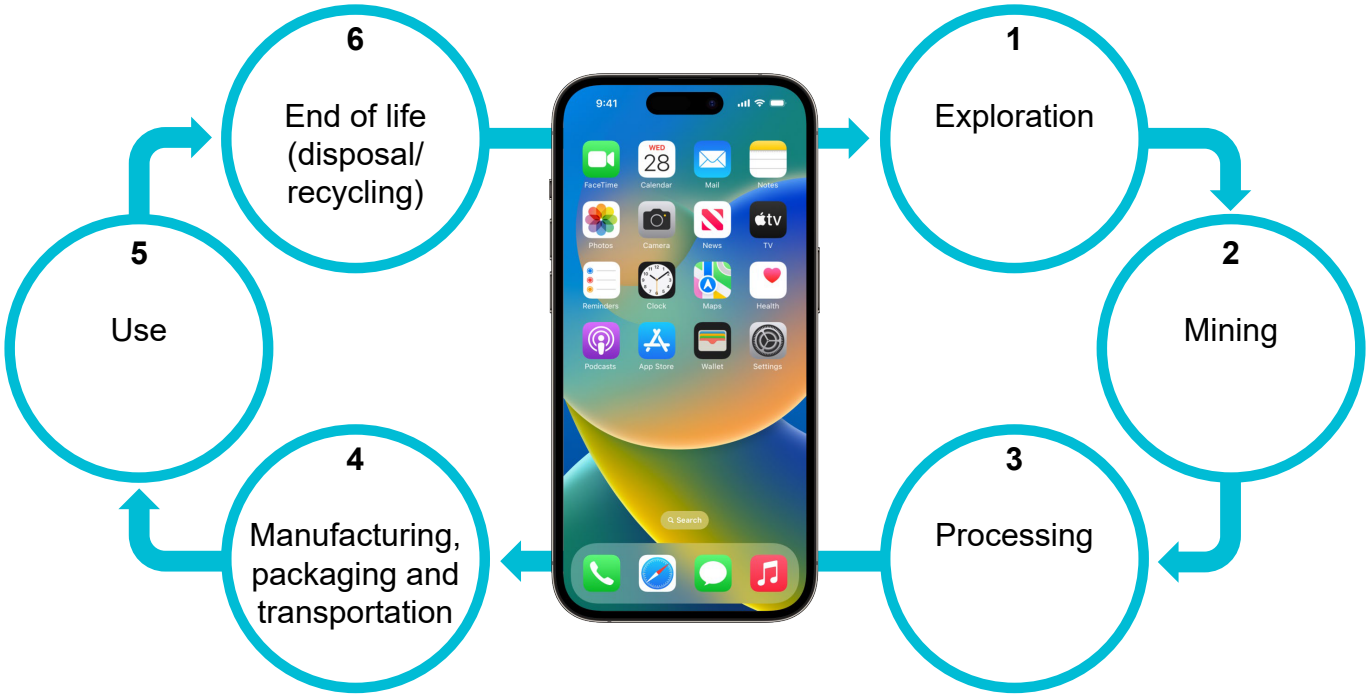
The issue of energy is again important as we need energy to charge the batteries in our phones. Sometimes we can overcharge a phone by leaving it longer than necessary and this wastes energy. Another point to consider is that different companies, for example Samsung and Apple, are constantly competing and roll out new, updated models on a regular basis. The phones may have different connectors so theyare not interchangeable, which may cause people to change their phone more often than necessary.

Stage 6: end of life of the phone

If a phone goes to landfill, the toxic components can remain in the ground for hundreds of years and could possibly leak out into water supplies. Between 1999 and 2003, 2.5 million phones were collected to be recycled or reused, accounting for less than 1% of the millions of mobile phones returned or discarded each year. You should always recycle, donate or trade in your old phone. Don’t throw it away! Phones that are thrown away waste energy and result in the loss of valuable resources.

Did you know?

Years ago, the technology needed for a mobile phone would have filled the entire floor of an office building. Now, everything needed for a mobile phone weigh on average less than 220 grams.



Labels:

1. Exploration
2. Mining
3. Processing
4. Manufacturing, packaging and transportation
5. Use
6. End of life (disposal/recycling/restoration of mined area)

Activity 2: careers in the geosciences

[See Powerpoint slides 10, 11 and 12]

Geoscience is the study of the planet and how various geological process have influenced how the planet looks or works. Geoscientists try to understand these processes and relate them to our human built environment.

Pupils match up the photographs to the job descriptions. Check answers (Powerpoint slides are useful for this) before completing the table in their workbooks.

Answers for workbook

Job title	Job description
Jewellery designer	Many jewellery designers are self-employed or work freelance because this provides opportunities to work on a part-time basis.
Waste disposal expert	We need waste disposal sites to dispose of rubbish that cannot be reused or recycled. Geoscientists working in waste disposal identify suitable landfill sites (areas where rubbish can either be deposited directly on the ground (land raising) or dumped to fill unwanted holes in the ground (landfilling)).
Landscape architect	Landscape architecture is designing environments of varying scales that encompass elements of art, environment, architecture, engineering and sociology. Outdoor environments consider the local geology.
Petroleum geologist	Working as a petroleum geologist provides great opportunities to travel. The average annual salary for petroleum geologists is very rewarding.
Hydrogeologist	Hydrogeologists are concerned with deep groundwater. Their work involves studying the quality of groundwater and how contaminants move through the ground.
Volcanologist	Volcanologists study volcanoes, particularly with a view to predicting how people may be affected by volcanic activity. A volcanologist's job takes them to exciting places like Hawaii, Java and the Andes.
Geophysicist/ seismologist	Geophysicists and field seismologists use complex equipment to collect data on earthquakes and seismic waves. Here a scientist is using a seismograph to monitor data.
Civil engineer	Civil engineering is about creating, improving and protecting our built environment. Civil engineers provide facilities such as tunnels, bridges, harbours, railways, hospitals, roads and buildings.
Quarry or mining geologist	The roads, footpaths, bridges and buildings (houses, schools, hospitals and shops) that make up our built environment are made from raw materials extracted from the earth by quarrying and mining industries. A mining geologist is a professional who applies this science to mining. It is the primary responsibility of this geologist to ensure that minerals, rocks and gems are extracted from mines, pits and quarries in a manner that allows maximum profit and involves minimal problems.
Forensic geoscientist	Forensic geoscientists work with the police, environmental agencies and humanitarian organisations to help bring some types of crimes to successful conclusions. Forensic geoscientists may be laboratory-based, providing physical evidence, or field-based, using their skills in exploration to search the ground to locate items related to a crime.

Job title	Job description
Disaster and hazard risk expert	Disaster hazards include landslides, flooding, earthquakes, volcanic eruptions, coastal erosion, storm surges and tsunamis. Disaster hazard risk reduction includes modifying natural events, determining the risks posed by the events and assessing their possible outcomes.
Palaeontologist	Palaeontology is the branch of earth science that studies the fossils of plants and animals to learn about the history of life on Earth and record patterns of how life has changed, providing a reference point for current events. If the study of ancient life excites you, palaeontology may be the field for you.
Mining engineer	Mining engineers deal with the safe, economic, and environmentally responsible recovery of mineral resources from the Earth. No two days as a mining engineer are ever the same. Work may involve: advanced computer aided design mine planning technical work setting off blasts with the shot-firing crew
Astronaut	This is James Reilly. He studied and gained a doctorate in geosciences. A career as an astronaut provides opportunities to travel to places that are *literally* out of this world!
Geological surveying and mapping	Geological surveying and mapping involve looking at how rocks are: • folded and fractured • altered by geological processes • dated Geological maps and databases are basic tools underpinning the use of Earth's resources. The work is both indoors (in laboratories and offices) and outdoors (on land or at sea).
Museum worker or curator	An earth science museum worker cares for rock, mineral, gemstone and fossil collections by applying scientific methods to preserve and restore artefacts. Work involves interpretation of specimens to inform and educate the public.
Flood management expert	About 5 million people live in flood-risk areas in England and Wales alone. Flood management involves protecting people and the environment. It can be a challenging and rewarding career. Work may involve: • investigating the causes of flooding • assessing the risks associated with flooding • examining the effect of climate change on flooding patterns modelling water resource systems
Geo-conservationist	Geological conservationists work to preserve the natural geological and geomorphological features in our landscapes and liaise closely with other conservationists to protect the diverse range of habitats and natural resources produced in the different geological environments. Spectacular scenery attracts visitors and helps to sustain local tourist industries. You can expect to work in some interesting areas of the world.
British Geological Survey	The British Geological Survey is a world-leading geological survey and global geoscience organisation, focused on public-good science for government and research to understand earth and environmental processes. We help society to use its natural resources responsibly, manage environmental change and be resilient to environmental hazards.

Job title	Job description
Science communicator	Sir David Attenborough studied geology and zoology at university and obtained a degree in natural sciences. He has worked in the media as a film maker, concentrating on natural history including many geological topics, in a wide range of places around the world.
Industrial mineralogist	Industrial minerals are vital to a modern economy. They underpin the manufacturing industry, construction and agriculture and they have important environmental applications. A industrial geologist studies the properties of rocks, gems and other minerals, including their chemical and physical properties and crystalline structures. They are vital in the exploration for critical minerals used in modern technologies.
Climatologist	Climatology is the study of the Earth's weather patterns and the systems that cause them. Climatologists today are directing their efforts towards understanding, explaining and attempting to do something about global warming since it became clear that human actions are damaging the environment and changing the climate.
Environmental lawyer	This area of work focuses on the legal rules that regulate pollution and otherwise protect the environment. Work deals with public international law in regulating environmentally harmful activities.
Environmental impact assessor	In environmental impact assessment, you apply an understanding of different aspects of the environment based on firm scientific foundations. Work is varied. Examples of the types of project you could work on include: • recycling schemes • effects of road building proposals on wild life habitats • impacts of dams on migratory fish in rivers
Nuclear geologist	Geologists are employed in the nuclear sector in a variety of roles, from resources (uranium mining) to engineering and hazard consultancy. Another growing sector is geological storage of radioactive waste.
Teacher	Science subjects are core subjects in secondary schools. Teaching is a rewarding profession, offering a variety of career prospects and development opportunities.

Homework/extension

Research a geoscience-related job. This is a good, short video on the subject.

Ask the pupils to consider the following in their research:

- what would be the expected salary?
- where in the world may the job take you?
- what qualifications would you need?
- what sort of a person would you need to be?