MINING

www.geolsoc.org.uk/factsheets

The Geological Society
serving science & profession

Image left: Bingham Canyon open-pit copper mine, USA
Image centre: Copper ore (azurite and malachite)
Image right: Underground mine tunnel
Image below: Drilling for rock core

Mining is the underground extraction of minerals from economically valuable deposits (such as metal-bearing ore-bodies, coal and gemstones). The surface extraction of a wide range of minerals is termed quarrying. Large surface operations are referred to as open-pit mines.

Mining is carried out on the surface and underground:

Open-Pit mining is used for less complex, usually larger, mineral deposits which occur near the Earth's surface (typically less than 1km deep). This involves excavation of the mineral and the overlying material (known as 'overburden'). It is generally cheaper than underground mining.

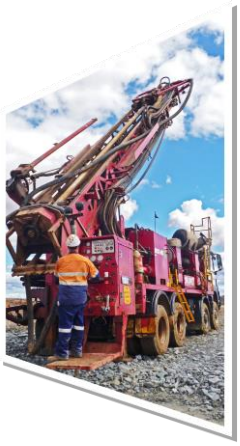
Underground mining is used for more complex, sometimes smaller, deeper mineral deposits. These methods produce much less waste rock, but are usually much more expensive than open-pit mining.

How much metal do we mine every year?

Iron	Copper	Nickel	Silver	Gold	Platinum
2.9 billion tonnes	18 million tonnes	1.9 million tonnes	25,000 tonnes	3,000 tonnes	180 tonnes

→ Increasing value and scarcity →

The weight of ore mined before the metal can be extracted is even higher than the figures above, and the concentration of metal in ore (the 'grade') also varies. Although we extract about one million times more iron than gold, the grade of gold ore is so much lower than that of iron that similar volumes of rock are extracted for both metals.



Exploring for mineral deposits

Mining and exploration companies undertake investigations to look for potentially economic mineral deposits. Nowadays most undiscovered deposits do not outcrop at the surface so geologists use techniques that provide information about rocks underground to estimate the quantity and concentration of a metal or mineral present in a deposit.

Exploration techniques include:

- Using Geophysics to look for variations in gravity or the Earth's magnetic field.
- Testing soil chemistry.
- Drilling and analysing rock core.

DID YOU KNOW?

The deepest open-pit mine in the world is **Bingham Canyon Copper Mine,** Utah, USA. It is nearly a kilometre deep!

The deepest underground mine is the **Mponeng Gold Mine,** South Africa. Its deepest level is almost 4 kilometres below the surface. At this depth, the rock is so hot (around 60°C) that the mine uses 6,000 tonnes of ice a day for refrigeration.

MINING

www.geolsoc.org.uk/factsheets

The Geological Society
serving science & profession

How do we extract and process minerals?

Mining and processing minerals (separating useful products from waste) needs some really big toys!

Mining techniques





Drills are used to analyse rocks and load explosives.
Explosives are the most common way to excavate rock.
Excavators move the excavated rock to trucks. Large excavators used in open-pit mines can hold 70 tonnes of rock. Underground mines use smaller versions known as 'scoops' or 'dumpers'. Enormous 'bucket-wheel excavators' are used in some open-pit coal mines.
Trucks take rock from the excavator to the processing plant, and can be huge - the largest can carry 450 tonnes, or the mass of a fully loaded Boeing 747. Some mines use driverless trucks controlled by computer.

Processing techniques

Crushers & mills break up the rock and expose minerals for processing.
Froth Flotation separates ore minerals, which float, and waste, which sinks. This forms a metal 'concentrate' which can be 'smelted' (heated with various compounds) to produce metal.

Explosives image © Vicky@Canada / Flickr

Critical Metals

Many metals like iron and aluminium are relatively abundant. However, nowadays we use a huge variety of rarer elements; for example, about 60 different elements go into a smartphone. Most are used in small quantities and many are deemed 'critical' (at risk of supply shortages) by the European Union.

Critical element		Produced in	Reasons for criticality	Some uses	
Rare Earth Elements		China (90%)	• Single producing nation • No substitutes • Difficult processing	Magnets in electronics, laser technology	
Rhenium		Chile, USA	• Only produced as a by-product of molybdenum mining	Turbofan jet engines	
Lithium		Australia, Chile	• Rarity • Few producing nations	Battery technology for electronics	

Images: Rhenium © Alchemist-hp / Wikimedia, **Lithium** © Tomihahndorf / Wikimedia

Responsible mining and environmental issues

As well as ensuring the safety of the people who work there, mines have important environmental responsibilities. Processing can involve toxic substances (such as cyanide, used to extract gold) so careful management is essential. This continues for many years after mine closure, as weathering of waste ores can release acidic water containing arsenic or lead. Abandoned tunnel collapses can also cause subsidence on the surface, and tips of waste rock have to be carefully constructed and maintained.
Innovative techniques are used to address these issues, and many former mines are important ecological sites with rare plant communities, as well as being great places to study geology!

Mining in the UK

The UK's mining heritage stretches back to the Bronze Age. Devon and Cornwall were once among the most productive areas for tin and copper in the world, and Scotland, Wales and Northern Ireland all have histories of metal mining. Coal mining was formerly a huge industry across central and northern England and Wales.

The industry declined during the later 20th Century, and in 1998 the closure of the South Crofty Tin and Copper Mine in Cornwall left the UK without an active metals mine for the first time in centuries. The last underground coal mine in the UK, the Kellingley Colliery, also closed in 2015.

However, in 2008 the Cavanacaw Gold Mine opened near Omagh in Northern Ireland, and in 2015, the Drakelands Tungsten and Tin mine entered production near Plymouth in Devon.

The UK also continues to quarry industrial and construction minerals such as sand and clay.

Drakelands Mine, Hemerdon, Devon