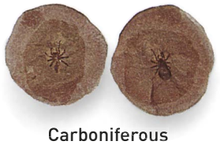


Cretaceous dinosaur tooth



Jurassic ammonite



Carboniferous spider



Pleistocene sea urchin



Cretaceous opalized bivalve



Cretaceous opalized gastropod



Cretaceous bryozoan



Cretaceous worm tube



Jurassic coral (sectioned and polished)



Miocene corals



Pleistocene gastropods



Silurian sea lily



Miocene bat jaws



19th-century microscope for examining thin sections

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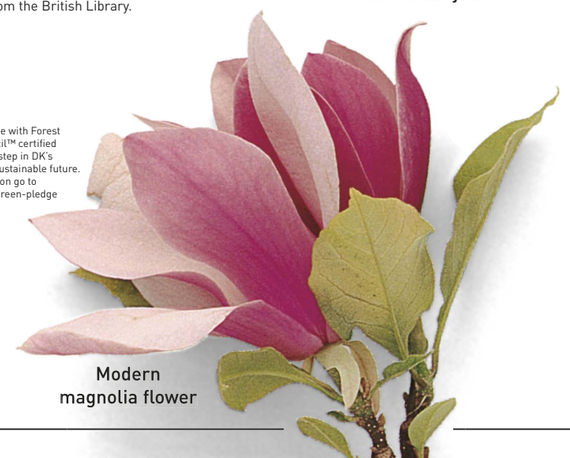
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Slide of thin section of Carboniferous bryozoans





Modern magnolia flower

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Jurassic ammonites

Silurian trilobite (mounted as a brooch)

Fossils – true and false

Fossils are the remains or evidence of animals or plants that have been preserved naturally. They range from the skeletons of huge dinosaurs to tiny plants and animals. Most fossils are formed from the hard parts of animals and plants, such as shells, bones, teeth, or wood. Footprints, eggs, and burrows can be fossilized, too. The study of fossils, called palaeontology, shows us that life began on Earth 3.5 billion years ago. Fossils of extinct species give us a rare glimpse of ancient life.



Fossil collections
People have collected fossils for centuries. This illustration appeared in an Italian book published in 1670.



Only bones
The only remains of animals are often hard bones. This fossilized vertebra is from a plesiosaur, an ancient swimming reptile.



Ancient trail
This image shows the trail of an animal moving across the seabed millions of years ago. Fossilized evidence of animal activities are called trace fossils.

Unnatural burial
This Ancient Greek pot was found in the ground, but it is not a fossil. Fossil, which means "something dug up", once described buried pottery and minerals, but they are no longer considered fossils.



Area where fragments are missing



Easy mistake
These images do not show a fossilized duck head and a human leg! Their shape is pure chance. They are really lumps of rock called flint nodules found in chalk. The shapes of flint nodules can be very peculiar and are often mistaken for fossils.

Flint "duck's head"

Flint "human leg"



Rare delicacy
Detailed fossils of dead plants are rare because plants rot quickly. However, the veins in this leaf have been preserved.



False fossil
This is not a fossil. The tree-like growths, called dehdrites, are manganese in the rock.

Animal or vegetable?
No – mineral! Minerals are not the remains of an animal or plant, and are therefore not fossils.

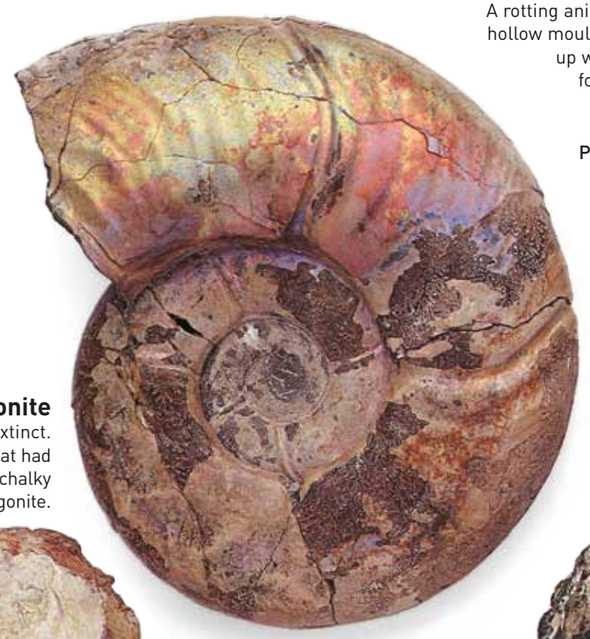


"Bunch of grapes"

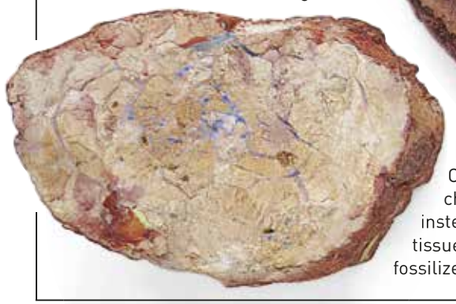
"Squid-like creature"

Fossil fakes
During the 1720s, when the nature of fossils was unclear, these "fossils" were carved and buried in the ground by people trying to fool a scientist named Johann Beringer. He was taken in and published descriptions of his find, but was later humiliated when the hoax was revealed.

Beringer's "Lying Stones"



Pearly ammonite
Ammonites are now extinct. They were animals that had hard shells made of a chalky mineral called aragonite.



Precious wood
One type of fossilization occurs when chemical changes make a mineral grow instead of the original animal or plant tissues, or material. The tissues of this fossilized wood have been replaced by opal.



Trilobite cast and mould

Taking shape
Fossils can have two parts. A rotting animal leaves a hollow mould, which can fill up with sediment to form a hard cast.



Plesiosaur tooth

Tough tooth
Teeth are often fossilized as they are hard.



Packed tight
Some fossils are densely packed because the animals lived in large numbers. These ammonites are in limestone.



Amethyst
This is the purple mineral quartz, with hexagonal (six-sided) crystals.

The making of rocks

The rocks beneath us have been forming for 4 billion years. Earth's crust is made up of elements, particularly oxygen, silicon, iron, aluminium, calcium, sodium, carbon, magnesium, and potassium. These combine to form minerals. Rocks are made of minerals. They can be metamorphic, sedimentary, or igneous.



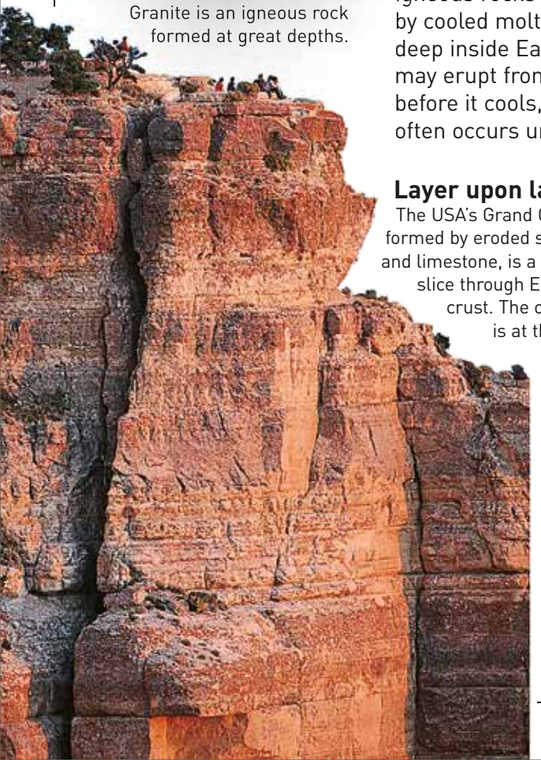
Folded rock
Movements in Earth's crust can make rocks crack, forming faults, or buckle, forming folds.



Granite
Granite is an igneous rock formed at great depths.

Molten rocks

Igneous rocks are formed by cooled molten magma deep inside Earth. Magma may erupt from volcanoes before it cools, but cooling often occurs underground.



Layer upon layer
The USA's Grand Canyon, formed by eroded sandstone and limestone, is a natural slice through Earth's crust. The oldest layer is at the bottom.



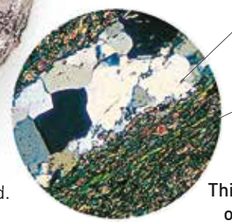
Twisted trilobite
Metamorphic rocks may contain distorted fossils, such as this trilobite in slate.

Thin section of granite



Hot rocks

Heat and pressure create metamorphic rocks. Marble is metamorphosed limestone, while slate is metamorphosed shale.



Schist
Parallel bands of minerals feature on metamorphic rocks. Schist forms from shale or mud.

Thin section of schist



Rock bands
In this sedimentary rock, each set of one light layer (fine sediment) and one dark layer (coarse sediment) is a year's accumulation of silt and mud, called a varve, at the bottom of a glacier-fed lake.



Conglomerate
This sedimentary rock consists of pebbles bound by a natural mineral cement.

Chalk cliffs
Chalk is a white limestone composed of the skeletons of tiny marine plants.





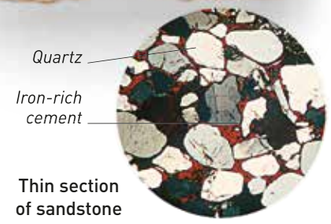
Looses and grains



Sandstone

Deposited rocks

Rocks are continually being eroded, creating grains carried by river, sea, or wind. They are deposited, together with the remains of animals and plants, as mud, sand, or coarser material. When this sediment is buried deeper, it becomes compacted and cemented to form sedimentary rock.



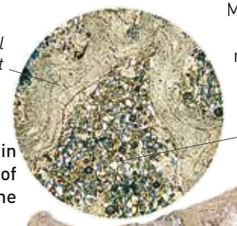
Thin section of sandstone



Fossil container
Many sedimentary rocks contain lumps called concretions or nodules. These formed around fossil shells like this clam.



From rock to rock
As cliffs of sedimentary rocks are eroded, small pieces are deposited on the beach to later form new sedimentary rock.



Thin section of limestone

Fossiliferous rock
Limestone is a sedimentary rock composed of calcite and other carbonate minerals. The calcite is derived from the shells and skeletons of marine animals and plants.This Silurian limestone contains fossil brachiopods (see pp.24–25).



Era	Period	Million years ago
Cenozoic	Holocene (Epoch)	0.01
	Pleistocene (Epoch)	2
	Pliocene (Epoch)	5
	Miocene (Epoch)	24
	Oligocene (Epoch)	34
	Eocene (Epoch)	55
	Palaeocene (Epoch)	65
Mesozoic	Cretaceous	142
	Jurassic	206
	Triassic	248
Palaeozoic	Permian	290
	Carboniferous	354
	Devonian	417
	Silurian	443
	Ordovician	495
	Cambrian	545
	Precambrian (about seven times longer than all the other periods put together)	4,600 (origin of Earth)

Stratigraphical column
A series of eras and periods describe the age of rocks and fossils.

Turning to stone



Land shapes
Over millions of years rocks are eroded, bringing ancient fossils to the surface.

The process of changing from a living organism to a fossil takes millions of years. As soon as animals and plants die, they begin to rot. Hard parts, such as the shells, bones, and teeth of animals, or the wood of plants, last longer than soft tissue, but they are often scattered by animals, wind, or water. For fossilization to take place, an animal or plant must be buried quickly by sediment. Only a tiny fraction will ever be found.

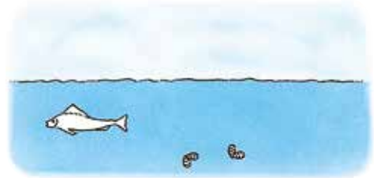


2 Decaying mussel
When a mussel dies, two chalky shells open out into a "butterfly" position. The soft parts of the mussel inside the shells begin to rot, or are eaten by animals.



1 Living mussel
Mussels live in the sea, attached to rocks by byssal threads. Dense masses form mussel beds. If a mussel becomes detached it may die.

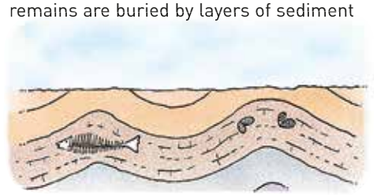
From preservation to discovery
These four drawings show how animals can be preserved and their remains discovered millions of years later. It is a slow process, and the climate and shape of the land will change as much as the animal and plant life.



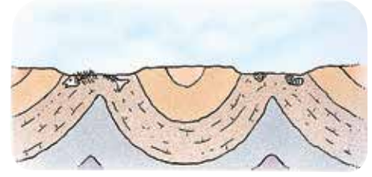
1. Dead animals sink to the seabed and the remains are buried by layers of sediment



2. Lower layers of sediment turn to rock, and the remains harden to form fossils



3. The rock is folded and eroded



4. The fossils are exposed on the surface

Soft parts have rotted away



3 Hard parts remain
When the soft parts of the mussel have rotted away, the hard parts – that is – the shells, remain.

4 Towards fossilization
The shells of dead mussels are carried along and dropped together by water currents, where they are mixed with pebbles and sand to form "mussel beaches". Some mussels have two shells held together by tough tissue called ligament, but in others, this has broken and the shells have separated. The sea can break shells into small pieces. These may become buried and eventually fossilized.





5 Fossilized mussels
Small mussels can become embedded in rock. Here a natural mineral-cement binds the sediment grains and fossil shells together.

Blue fossils
The shells of living mussels are blue. Some colour remains in these fossil mussels, which are 2 million years old.





Lost colour
The colour in shells is usually lost during fossilization. The brown in these fossils is from the rock where they were fossilized.