



19th-century microscope for examining thin sections



Cretaceous dinosaur tooth



Jurassic ammonite



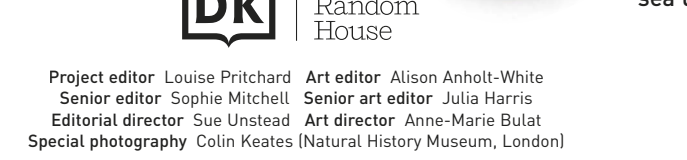
Cretaceous bryozoan



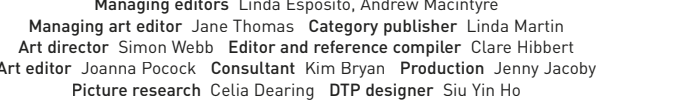
Jurassic coral (sectioned and polished)



Carboniferous spider



Pleistocene sea urchin



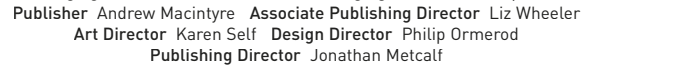
Cretaceous opalized bivalve



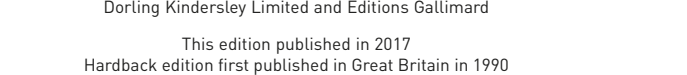
Cretaceous opalized gastropod



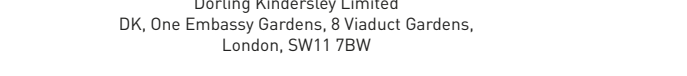
Cretaceous worm tube



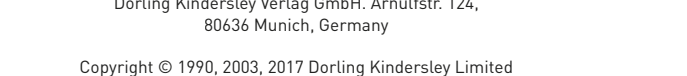
Miocene corals



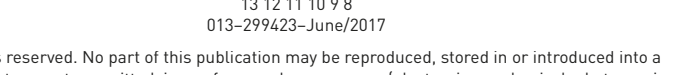
Pleistocene gastropods



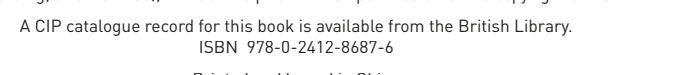
Silurian sea lily



Miocene bat jaws



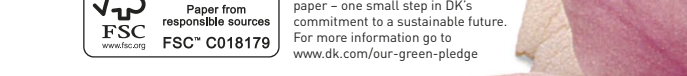
Modern magnolia flower



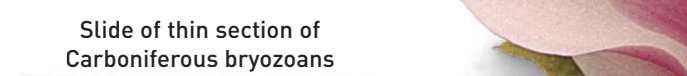
Slide of thin section of Carboniferous bryozoans



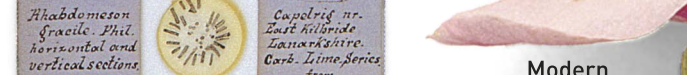
Silurian trilobite (mounted as a brooch)



Jurassic ammonites



Cretaceous dinosaur tooth



Cretaceous bryozoan



Jurassic coral (sectioned and polished)



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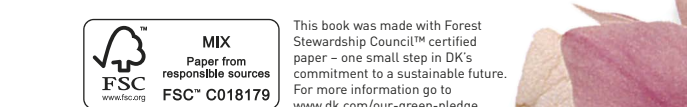
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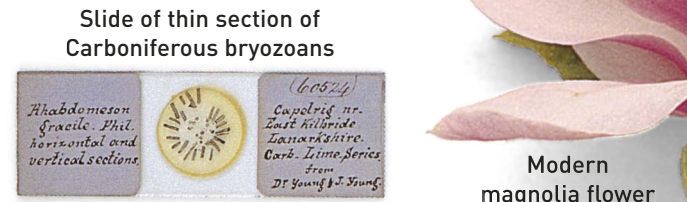
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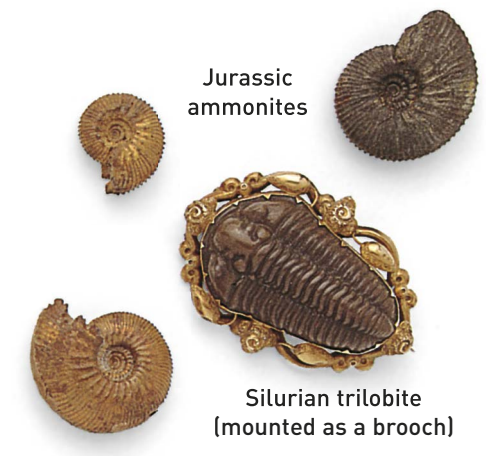
Slide of thin section of Carboniferous bryozoans



Slide of thin section of Carboniferous bryozoans

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Fossils – true and false



Fossil collections

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



Rare delicacy

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

Pearly ammonite

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

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.



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.



Only bones

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

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.



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.



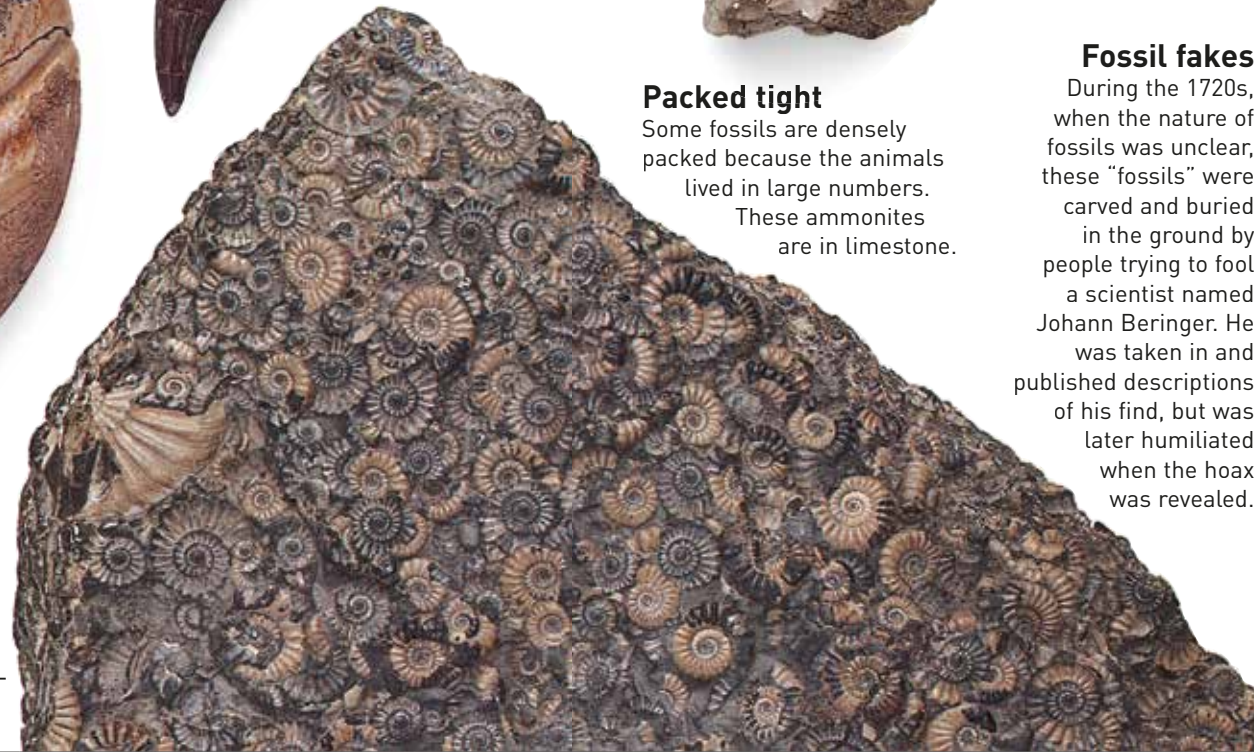
False fossil

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



Packed tight

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



Animal or vegetable?

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

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.



Flint “duck’s head”

Flint “human leg”

“Bunch of grapes”

“Squid-like creature”



Beringer’s “Lying Stones”

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.

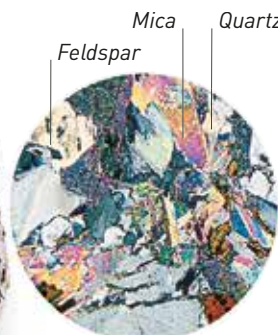


Amethyst

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.



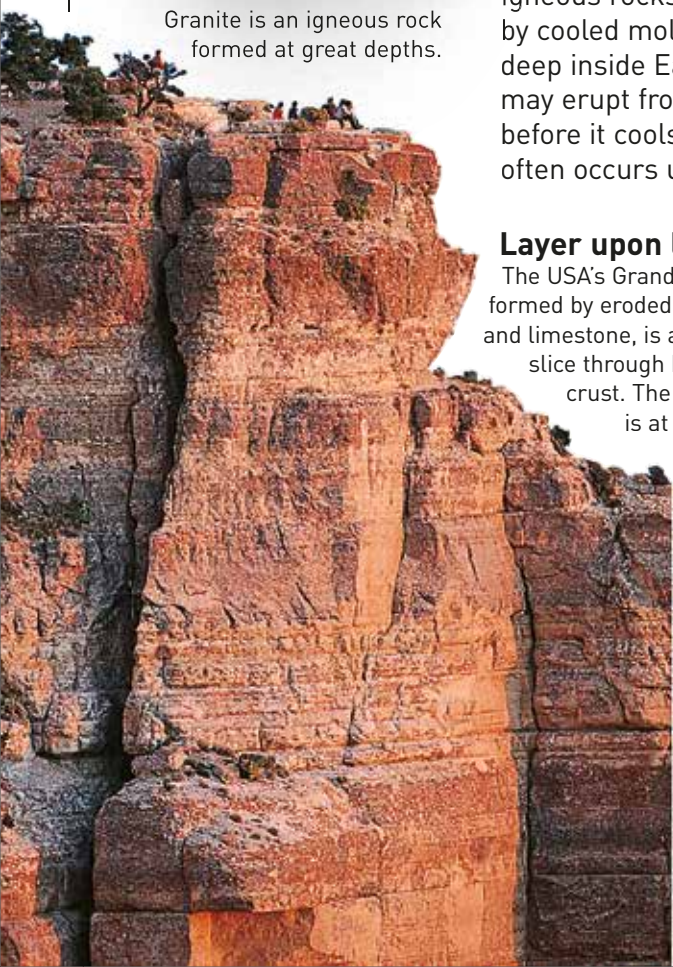
Black mica
Glassy quartz
White feldspar

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.



Thin section of granite

Band rich in mica



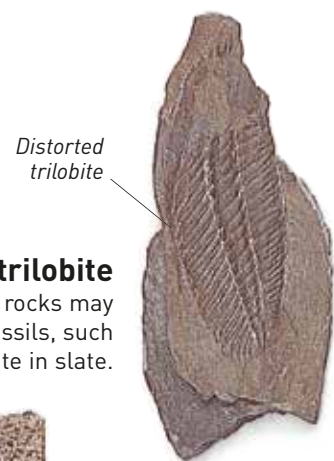
Schist

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



Folded rock

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



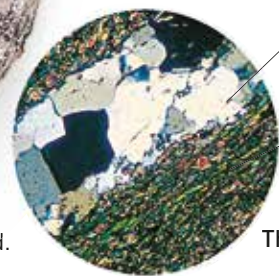
Distorted trilobite

Twisted trilobite

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

Hot rocks

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



Band of quartz

Band of silicate minerals

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.

Pebble
Natural cement

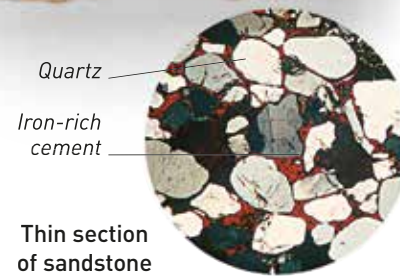
Looses and grains

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.



Quartz
Iron-rich cement

Thin section of sandstone



Clam shell

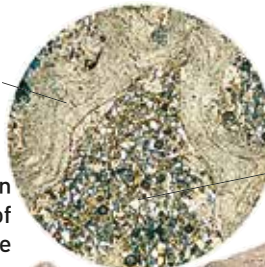
From rock to rock

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



Shell fragment

Thin section of limestone



Fossil container

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

Finely broken shells

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).



Fossil brachiopod

Chalk cliffs

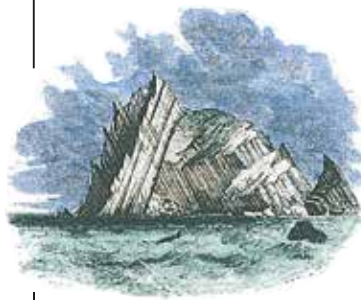
Chalk is a white limestone composed of the skeletons of tiny marine plants.



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
Mesozoic	Palaeocene (Epoch)	65
	Cretaceous	142
	Jurassic	206
	Triassic	248
	Permian	290
	Carboniferous	354
Palaeozoic	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

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.

Land shapes

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



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.

Soft parts have rotted away

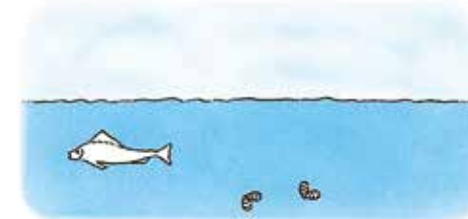


3 Hard parts remain

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.



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



Living mussel

Byssal threads

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.



Separated shell

Tough ligament holding shells together

Fossil mussel shell

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.