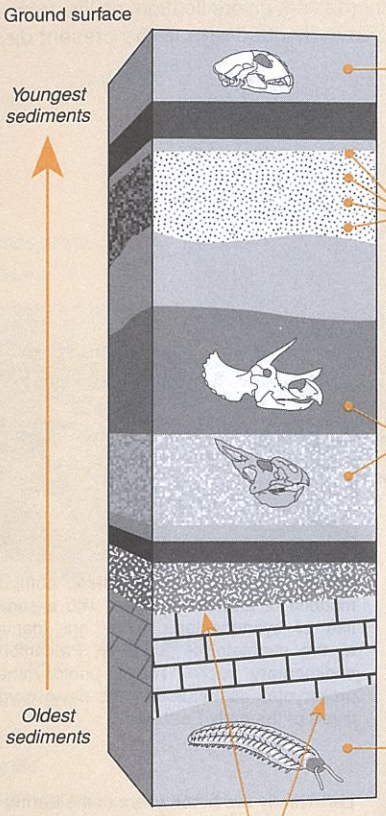
Sedimentary Rock Profile

This diagram represents a cutting through layers of sedimentary rock in which fossils are exposed. Fossils are the remains or impressions of plants or animals that become trapped in the sediments after death. Layers of sedimentary rock are arranged in the order that they were deposited, with the most recent layers near the surface (unless they have been disturbed).



Recent fossils are found in more recent sediments
The more recent the layer of rock, the more resemblance there is between the fossils found in it and living forms.

Numerous extinct species
The number of extinct species is enormously greater than the number living today.

Fossil types differ in each sedimentary rock layer
Fossils found in a given layer of sedimentary rock generally differ in significant respects from those in other layers.

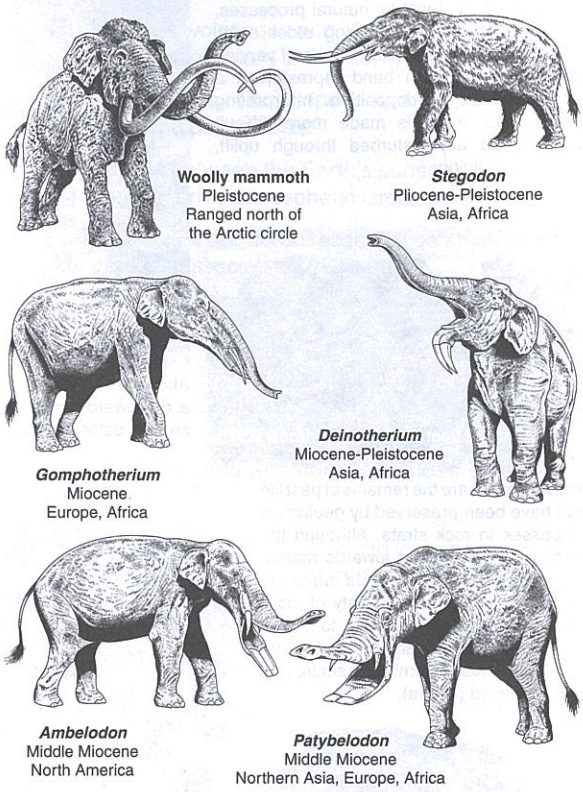
Only primitive fossils are found in older sediments
Phyla are represented by more generalized forms in the older layers, and not by specialized forms (such as those alive today).

New fossil types mark changes in environment
In the rocks marking the end of one geological period, it is common to find new fossils that become dominant in the next. Each geological time period had an environment very different from those before and after. The boundaries of these coincided with considerable environmental change and the creation of new niches. These produced new selection pressures and resulted in diversification of surviving genera.

A Case Study in the Fossil Record

The history of modern day species can be traced
The evolution of many modern species can be well reconstructed. For instance, the evolutionary history of modern elephants is well documented for the last 40 million years. and the modern horse has a well understood fossil record spanning 50 million years.

Fossil species are similar to but different from today's species
Most fossil animals and plants belong to the same major taxonomic groups as organisms living today. However, they do differ from the living species in many features.



African and Indian elephants have descended from a diverse group of **proboscideans** (named for their long trunks). The first pig-sized, trunkless members of this group lived in Africa 40 million years ago. From Africa, their descendants invaded all continents except Antarctica and Australia. As the group evolved in response to predation, they became larger. Examples of extinct members of this group are illustrated above.

3. Explain how radiometric dating has made the construction and interpretation of the stratigraphic record more reliable:

_____

_____

4. Describe an animal or plant taxon (e.g. class, family, or genus) that has:

   (a) A good fossil record of evolutionary development: _____

   (b) Shown little evolutionary change despite a long fossil history (stasis): _____

5. Discuss the use of fossils as indicators of environmental change: _____

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The Earth's History

Geologists gather information from many sources to reconstruct the Earth's history. Analysis of extra-terrestrial material, such as meteorites, can provide information about the early history of the Earth, while the Earth's rocks, minerals, and fossils provide information about the crust and the nature of the Earth's deeper layers. The history of the Earth (bottom figure) spans the last 4600 million years and scientists have made sense of this enormous time span by dividing it into hierarchical scheme of time periods. The boundaries of these time periods are based on the worldwide correlation of distinctive fossils and rock types (a process made more reliable with the advent of radiometric dating). This **stratigraphic record** documents the nature of the ancient Earth and the increasing diversification of life from its origins in the seas approximately 3800 mya to the present day.

Rock **strata** are built up through the deposition of material by natural processes, with younger layers overlying older ones. Strata appear as distinctive bands of varying thickness, with each band representing a specific mode of deposition. Interpreting stratigraphic layers is made more difficult when strata are disturbed through uplift, tilting, and folding.

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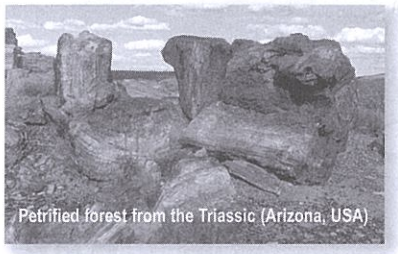
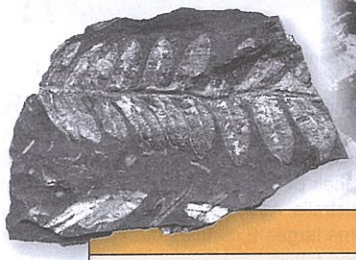
Above: The Rainbow Basin syncline in California. A syncline is a downward-curving fold. Folds typically form when the Earth's crust is deformed during mountain building episodes.



Petrified forest from the Triassic (Arizona, USA)

Above: Fossils are the remains of past life that have been preserved by geological processes in rock strata. Although the fossil record is biased towards marine organisms with hard parts such as shells, there is a huge variety of fossil types, from large skeletons to pollen grains and other plant parts (below), fossil footprints, entombed insects, and petrified wood (above).



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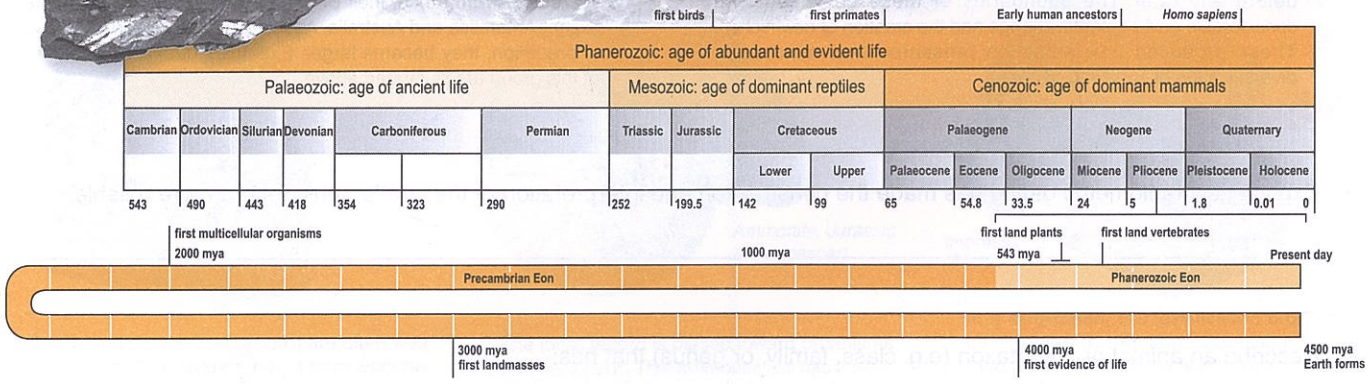
Above: Modern stromatolites comprise mounds of layered sediment with a surface film of cyanobacteria. They are identical to the stromatolites found in Precambrian sedimentary rocks. These photosynthetic prokaryotes contributed to the rising oxygen levels of the early Earth.

Left: Nearly two billion years of the Earth's history have been exposed in the Grand Canyon as the Colorado River and its tributaries cut through layer after layer of rock while the Colorado Plateau was uplifted. Rocks in the Grand Canyon were laid down over a period of almost 1500 million years and the oldest are 1700 million years old.



1. Describe the nature of the stratigraphic record: _____

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2. (a) Outline how the record of the Earth's history is compiled: _____

_____

(b) Explain why the interpretation of strata on this basis is sometimes difficult: _____

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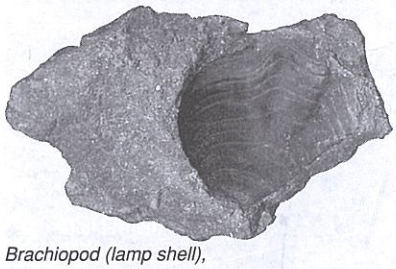
Periodicals: *How old is...*
Related activities: *The Earth's Crust, Fossil Formation*
Weblinks: *Getting into the Fossil Record*

Fossil Formation

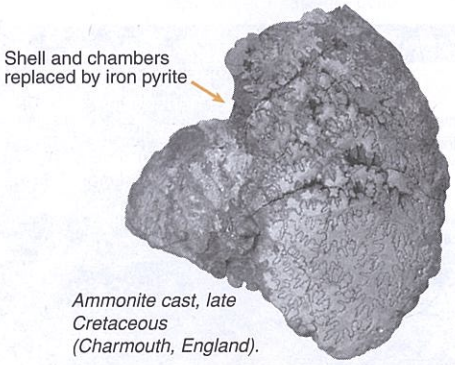
Fossils are the remains of organisms that have escaped decay and have become preserved in rock strata. A fossil may be the preserved remains of the organism itself, a mould or cast, or the marks made by it during its lifetime (trace fossils). Fossilization requires the normal processes of decay to be permanently arrested. This can occur if the remains are buried rapidly and isolated from air, water, or decomposing microbes. Fossils provide a record of the appearance and extinction of organisms. Once this record is calibrated against a time scale, it is possible to build up an evolutionary history of life on Earth.

Some Fossil Types and Modes of Preservation



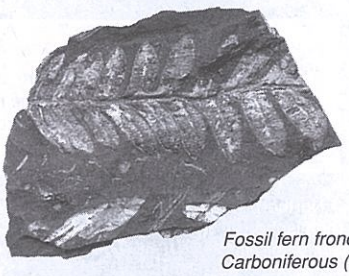
Brachiopod (lamp shell), Jurassic (New Zealand)

Mould: An organism-shaped impression left after the original remains were dissolved or otherwise destroyed.



Ammonite cast, late Cretaceous (Charmouth, England).

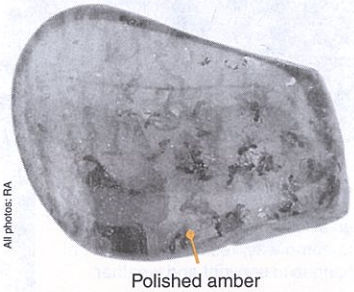
Cast: The original materials of the organism have been replaced by new unrelated ones, in this case, iron pyrite.



Fossil fern frond Carboniferous (USA).

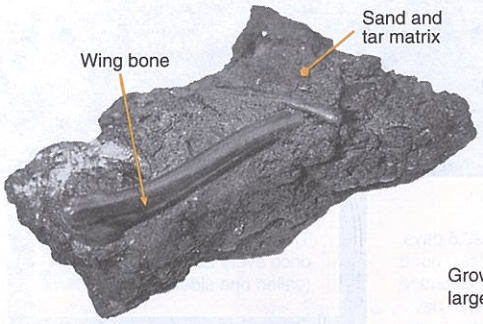
This **compression fossil** of a fern frond shows traces of carbon and wax from the original plant. Compression fossils are preserved in sedimentary rock that has been compressed.

Ants in amber about 25 mya (Madagascar).



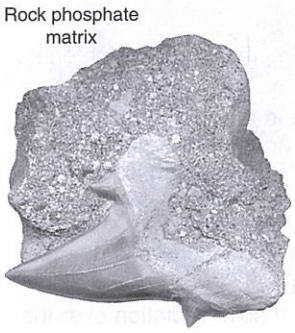
All photos: RA

Fossilized resin (or amber) produced by some ancient conifers trapped organisms, such as these ants, before it hardened.

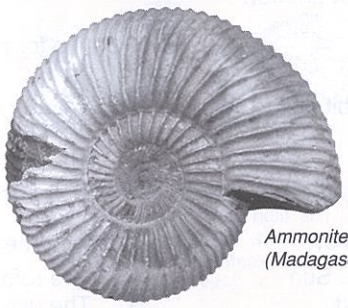


Fossilized bones of a bird that lived about 5 mya and became stuck in the **tar pits** at la Brea, Los Angeles, USA.

Permineralization: In some fossils, the organic material is replaced by minerals, as in this **petrified wood** from Madagascar.

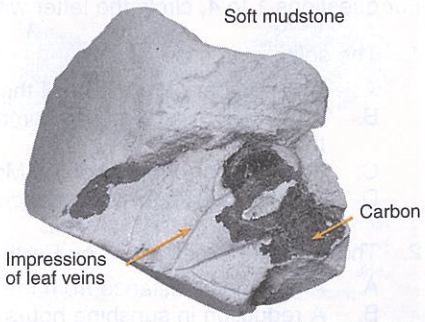


Teeth and bones (being hard) are often well preserved. This shark tooth is from Eocene phosphate beds in Morocco.



Ammonite, Jurassic (Madagascar).

The fossil record is biased toward organisms with hard parts. This ammonite still has a layer of the original shell covering the stone interior.



In a **sub-fossil**, the fossilization process is incomplete. In this leaf impression in soft mudstone, some of the leaf remains are still intact (a few thousand years old, New Zealand).

1. Describe the natural process that must be arrested in order for fossilization to take place: _____

2. Explain why the fossil record is biased towards marine organisms with hard parts: _____

_____

_____

3. Fossils tell us much about the organisms that lived in the past. Suggest what other information they might provide:

_____

_____

Periodicals: *The quick and the dead*

Related activities: *The Earth's History*
Weblinks: *Getting into the Fossil Record*

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