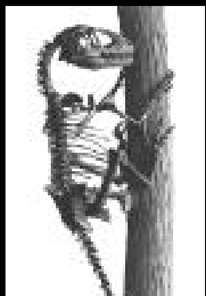
FOSSILS

NOTE 51



Fossils are traces or remains of organisms that have been preserved in rocks. They once were part of plants and animals. They interacted continuously with their environment and each other, and their lives were an essential prelude to the development of organisms living today.

Fossils furnish information about the kinds of animals and plants that existed, when they appeared and vanished, where and how they lived, and the type of environments they preferred. Fossils help us learn how species evolved, how some descended from others, and how groups of organisms are related.

Although fossils are abundant in some places and absent in others, they are most often found in marine sedimentary rocks such as limestone, sandstone, and shale. Some fossils are found in rocks of nonmarine origin such as sand dunes, volcanic ash, lake sediments and ice. The characteristics of the enclosing rock reflect the environment in which organisms lived and were buried. Fossils are common only when the conditions for burial were favorable for the preservations of organisms' remains. Bones, teeth, shells, wood, burrows, worm trails, and impressions (for example leaf imprints) are a few remains that are commonly preserved as fossils.

Photo by Max Flanery, CGS.

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HOW ORGANISMS BECOME FOSSILS

To be part of the fossil record, all or part of an organism or some trace of its activity must be preserved in the rock. Not all plants and animals have an equal chance of being preserved and almost no organisms are preserved in their entirety. Also, all geological environments are not equally favorable for preservation. Hard parts of plants and animals, such as skeletons and shells, are most likely to be preserved as fossils. Their preservation requires rapid burial in a substance that protects them from scavengers and other predators such as bacteria, and from physical and chemical changes in the environment, such as weathering.

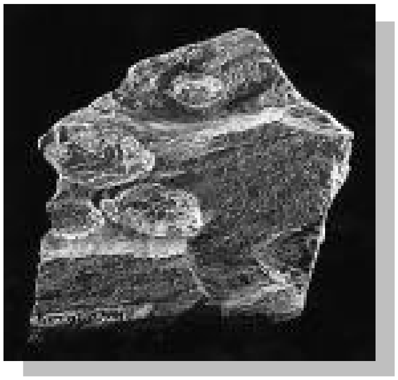
Direct and ***indirect*** evidence are categories used for preservation classification.

Direct Evidence

***Soft Parts*:** Preservation of the entire organism is rare. Remains of mammoths and rhinoceroses preserved in the frozen tundra of Siberia and organisms trapped in resin or oil seeps are examples of preservation without alteration.

***Hard Parts*:** Remains of unaltered hard parts such as shells, teeth, and bones are more frequently fossilized than the soft parts. Many shells and skeletons are preserved in the rocks with no recognizable organic matter. The hard parts of most invertebrates are composed of calcium carbonate in the form of calcite (corals, mollusks) or aragonite (brachiopods, echinoderms, forams, sponges, bryozoans), calcium phosphate (brachiopods, arthropods, vertebrates, conodonts), silica in the hydrated opaline form (sponges, radiolarians), complex organic compounds (complex molecules of carbon, hydrogen, oxygen, and other elements such as those found in chitin in arthropods, graptolites, and some other invertebrates), or a combination of these.

***Carbonization*:** When solution and other types of chemical action underwater transform the composition of plant and animal tissues to a thin film of carbon, the organic remains are carbonized. During the carbonization, the volatile substances of the original organism–including hydrogen, nitrogen and oxygen–are driven



MUD PECTEN OR GLASS SCALLOP

Delectopecten vancouvernsis fernandoensis

AGE: late Miocene, 7-8.5 million years ago

off leaving a thin film of carbonaceous material to show the outline of the original organism. Graptolites, arthropods, fish and plants are commonly preserved this way.

***Permineralization or petrifaction*:** Shells, bones, and plant material that are porous and buried in the earth are sometimes affected by underground solutions. When the solutions come in contact with air-filled pores of the organisms, the solutions evaporate leaving a residue of dissolved mineral matter—commonly calcium carbonate or silica—in these spaces.

***Recrystallization*:** Solution and precipitation can change the internal physical structure of some shells so the original microstructure is blurred or lost and the shell is converted into a mosaic of interlocking crystals. Recrystallization commonly maintains the original composition but sometimes changes one mineral to another of similar chemical composition. For example, many Mesozoic and Cenozoic shells originally made of aragonite have recrystallized into a stable form of calcium carbonate—calcite.

***Replacement*:** Replacement involves the complete or almost complete removal of the original hard structure by solutions and the deposition of new mineral substances. The most common replacing minerals are calcium carbonate, silica and pyrite.

Indirect Evidence

***Preservations as molds and casts*:** The most common indirect methods of preservation are molds and cast. After an organism has been trapped in sediment that has hardened around the fossil, later solutions may remove the fossil leaving a cavity in the rock known as a mold. If the shape of the outer side of the original organism is shown, the cavity constitutes an external mold. If the cavity reveals the form and markings of the inner surfaces of the organism, it's an internal mold or steinkern. Many times an external form is later filled with mineral matter and forms a cast. It's sometimes difficult to distinguish between an internal mold and a cast. On the surface of a cast, the external part of the original animal is represented while on the surface of an internal mold the internal surface of the shell is represented.

***Tracks and Trails*:** Track and trails made by the feet, tails, and other portions of animals are abundantly preserved in mudstones at certain places. (They were originally made in mud and then solidified in mudstone.) Impressions made by jellyfish and other delicate organisms are also found in some fine-grained sediments.

***Burrows and Borings*:** Burrows and tubes made by worms and other animals such as clams are sometimes preserved as molds and casts. Round holes in clam and other shells indicate that predator snails once sought the soft part of the animal as food.

***Coprolites*:** Coprolites are fossilized animal excrement. They are important because they may show the structure of the animal's gut as well as indicate its diet.

SEASTAR (STARFISH)

Zoroasteridae

AGE: late Miocene, 7-8.5 million years ago

The branch of geology dedicated to the study of fossils and the history of life is called paleontology (paleo=ancient; logy=study). Paleontology is separated into fossil animals with backbones (vertebrate paleontology); fossil plants (paleobotany); fossil spores and pollen (palynology); and microscopic forms (micropaleontology). A person who studies fossils is a paleontologist.

Some paleontologists are concerned only with the classification and description of fossil remains (morphological paleontology); others study fossils for use in dating rocks (stratigraphical paleontology); some trace the ancestors of particular organisms (evolutionary paleontology); and others study relationships between ancient organisms and their environments (paleoecology). It’s through paleontology that geological evidence of past life and the biological evidence of present day organisms are integrated.

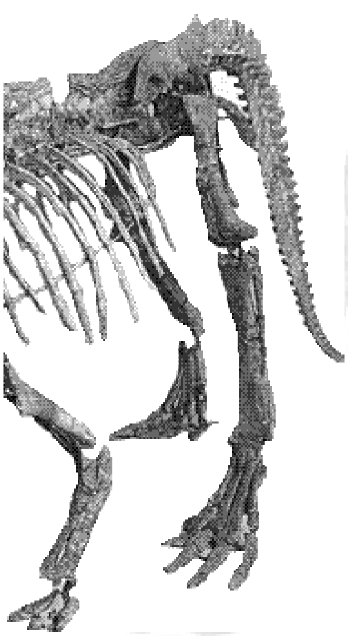
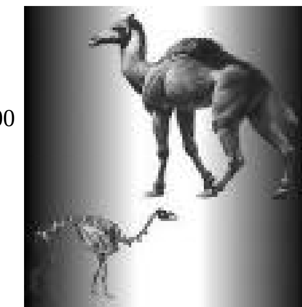


Photo by Max Flanery, CGS.

EXTINCT CAMEL

Camelops hesternus

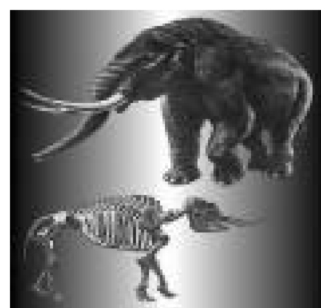
AGE: late Pleistocene, 10,000-280,000 years ago



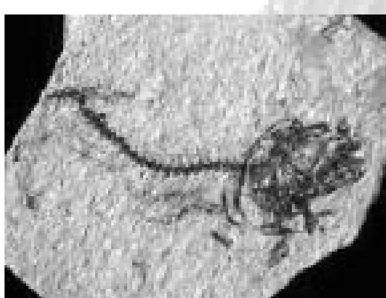
AMERICAN MASTODON

Mammut americanum

AGE: late Pleistocene, 10,000-280,000 years ago



Although they had tusks and a trunk, mastodons are only distantly related to modern elephants. Mastodons originated in Africa and migrated to North America about 15 million years ago. They survived until the end of the last Ice Age about 10,000 years ago.



DEEP-SEA SMELT

Bathylagus

AGE: late Miocene, 7-8.5 millon years ago

PALYNOLOGY

THE STUDY OF POLLEN

While a relatively unknown science, palynology is one of the best ways to understand ancient environments and their climates. Through modeling, this information helps us to understand future weather and environmental patterns.

As standard practice, pollen is separated from ancient fossil sediment and from the earth in the immediate vicinity of fossil finds. The specimens are then sent to a lab for analysis.

Graphics by Dinah D. Maldonado, California Geological Survey.

For more information about fossils:
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