How do Fossils Form?

What is Fossilization?

Fossilization is the process by which a fossil preserves in the fossil record. This typically occurs in several ways: recrystallization, carbonization, replacement, permineralization, and moldic preservation. The type of preservation is controlled by environmental factors and what the composition of the organism's body is.

What do we mean by 'preservation'?

Preservation is defined as, "to keep in an unaltered condition."

As paleontologists, the more well preserved the specimen is, the more details we can examine. This means we may be able to see the fine details on a brachiopod shell or even the remnants of feathers on a dinosaur. This information gives paleontologists information on evolution, ecology, functional morphology, growth, and distribution.

What are hard vs. soft parts?

Hard parts are things that are 'mineralized', like our bones and teeth, which contain apatite (a phosphate mineral that is very resistant to decay). Other examples are shells, which are made out of calcium minerals, calcite and aragonite. Soft parts are not mineralized, and therefore decay very quickly after death (e.g. hair, skin, and organs). We rarely find soft parts in the fossil record.

Taphonomy

Taphonomy is the branch of paleontology that deals with how we understand the preservation potential of the fossil record. Taphonomists look for clues to determine how an organism might have died, how far the organism might have been transported after death, and what chemical changes the organism might have gone through from death to the time it was discovered by paleontologists.

Different Processes of Fossilization

Recrystallization

Recrystallization is the process by which the original material of the organism retains the same chemical composition, but the bonds within the chemical structure change. These are termed 'polymorphs'. An example would be calcite ($CaCO_3$) to aragonite ($CaCO_3$). They have the same chemical formula but the arrangements of bonds is different. Because calcite is more stable than aragonite, it is rare that something calcitic will recrystallize to aragonite.
(Photos from left to right: an aragonitic clam recrystallized to calcite, and an aragonitic ammonite recrystallized to calcite)

Carbonization

Carbonization occurs under extreme temperature and pressure. The organic material is compressed and all volatiles are released from the material, leaving only carbon. These fossils typically occur as imprints or molds and are a dark gray to black in color.
(Photos from left to right: *Fagus sylvatica, Didier Descouens,* fossilized fish from the Eocene-age Green River Formation)


Replacement

Replacement is the process by which the original shell material of the organism is altered completely. Unlike recrystallization, the chemical composition of the fossil is not the same as when it was living. Common minerals that replace the original body material are silica (SiO_2) or pyrite (FeS_2).
(Photos from left to right: An unaltered aragonite cephalopod shell, cephalopod shell that has undergone replacement to pyrite)

Moldic

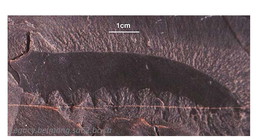
Moldic preservation occurs in two forms: imprints and casts. Imprints are the impressions left behind of a portion of an animal. A cast can be internal or external and typically has to do with how the organism was buried. What remains is usually a carbonate mud.
(Photos from left to right: an imprint of a trilobite body, an external mold of a trilobite)

Permineralization

Permineralization, commonly referred to as petrification, is when a fluid (often silica) rapidly infills pores of the fossil. This mechanism leaves no organic material but retains high detail such as the cell walls of wood.
(Photos from left to right: a permineralized dinosaur vertebra, permineralized (petrified) wood)

Special Preservation

In very special circumstances, there are situations that can preserve fossils extremely well. One way is within amber (fossilized tree sap). Another special case of preservation is within Lagerstätten (German for 'storage place'): places that are defined as areas that contain exceptionally well preserved fossils, like the famous Burgess Shale or the Solnhofen. These areas have unusual chemistry that allow for the fossils to be so well preserved.
(Photos from left to right: insect in amber, an arthropod (relatives of spiders) in the Burgess Shale, and famous *Archaeopteryx* from the Solnhofen Limestone)



Created by:
Jennifer Bauer jbauer5@vols.utk.edu and Sarah Sheffield ssheffi2@vols.utk.edu
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