Lecture Six: Types of fossil preservation

Definition of the fossil: The fossil has defined to be some evidence of the existence of an animal or plant that lived before.

-Body fossils can be broadly classified into one of two groups:

Unaltered remains

Altered remains

1. Unaltered remains

Unaltered fossil remains are comprised of the original materials—and sometimes tissues—produced by an organism when it was alive. These materials have not been altered over geological time. There are two kinds: unaltered mineralized remains and frozen remains.

1-a: Unaltered mineralized remains

The mineralized hard parts of some animals are commonly preserved intact, and unchanged over millions of years. While the soft parts of these organisms usually decayed away very soon after death.

However, bones are mineralized hard parts consisting of calcium phosphate, most fossilized bones are somewhat altered because other minerals have filled their pore spaces. While there are some exceptions, for example the fossil bones from places like the famous La Brea tar pits of Los Angeles California.

1-b: Frozen remains

Fossils with this type of preservation have been found frozen in ancient permafrost in Siberia. Unlike all other types of preservation, frozen remains allow direct study of the actual soft tissues and sometimes organs that made up

Figure 1: Unaltered fossil mollusc shells.

an animal's body. Further, hair commonly covers the bodies of these frozen remains, telling us what colour the animals where they were alive.

Many kinds of frozen extinct animals have been found in the Siberian permafrost, including woolly mammoths and rhinoceros, horses, and bison. These fossils are restricted to the Quaternary period, when large ice sheets covered much of the northern hemisphere.

Figure 2: Frozen woolly mammoth specimen with long hairs appear clearly at the legs.

2. Altered remains

These types of fossils have undergone some sort of change: the hard parts are partially or complexly different from those that the animal produced when it was alive. There are many different types of altered fossil preservation.

2-a: Permineralization and Petrification

Most fossil bones and some fossil plants exhibit permineralization. Bone is a highly porous material because space must be available inside to hold bone marrow and other tissues. After a bone is buried, the pore spaces may be filled with minerals (such as calcite or silica) that precipitate out of ground water, forming a cement. (The original organic material, however, is not removed; thus, that material could be classified as unaltered.) This process effectively changes bone to stone.

Fossil plants are also sometimes preserved as permineralizations because, like bones, they often also have numerous pore spaces that may be filled with minerals following burial.

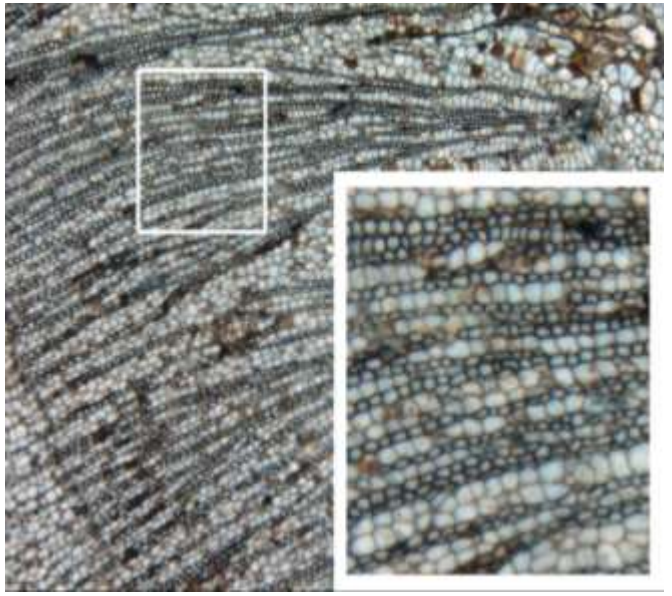

Figure 3: A permineralized plant stem, demonstrates preservation of cellular-level detail.

Petrified wood happened when minerals fill the pore spaces in the wood and the original organic material (i.e., the wood) is replaced with minerals.

2-b: Replacement and Pyritization

Fossil specimens exhibiting replacement do not preserve the original body parts produced by the organism when it was alive. Instead, a different, secondary material replaces the original material shortly following the death of the organism.

Figure 4: A specimen of petrified wood.

The mineral pyrite sometimes replaces calcite, leading to golden coloured fossils that are said to be “pyritized.” The shell of the brachiopod specimen shown in the figure below has been pyritized.

Figure 5: Pyritized brachiopod shell

2-c: Recrystallization

Sometimes the minerals that comprise the hard parts of organisms recrystallize shortly or long after a fossil is buried. Recrystallization involves a change in crystal structure, but not a change in mineral chemistry. For example, the mineral aragonite—which many molluscs use to make their shells—sometimes changes to calcite, a more geologically stable form of the same chemical, $CaCO_3$.

Typically, the overall size and shape of a recrystallized fossil does not vary substantially from the original unaltered specimen, but fine details may sometimes be lost.

2-d: Carbonization

Carbonized fossil remains (also called carbonizations) may result when organisms are rapidly buried, especially in low-oxygen conditions. They are most often black in colour, reflecting the fact that they composed mostly of carbon (such as coal, which is also black in colour). Most fossils that exhibit "soft part" preservation are carbonizations. Examples include many plant fossils (also known as compressions), insect fossils in the second figure also shows carbonization.

Figure 6: A carbonized plant leaf.

2-e: Preservation in amber

Amber is a yellow- or orange-coloured semi-precious stone and is frequently used in jewellery. The amber is fossilized, hardened tree resin. Trees ooze out sticky resin when they are injured, helping to seal wounds and protect the plant from infection. Different kinds of fossils—ranging from bugs to lizards—have been found locked inside of amber.

Figure 8: Insect and lizard trapped in amber.

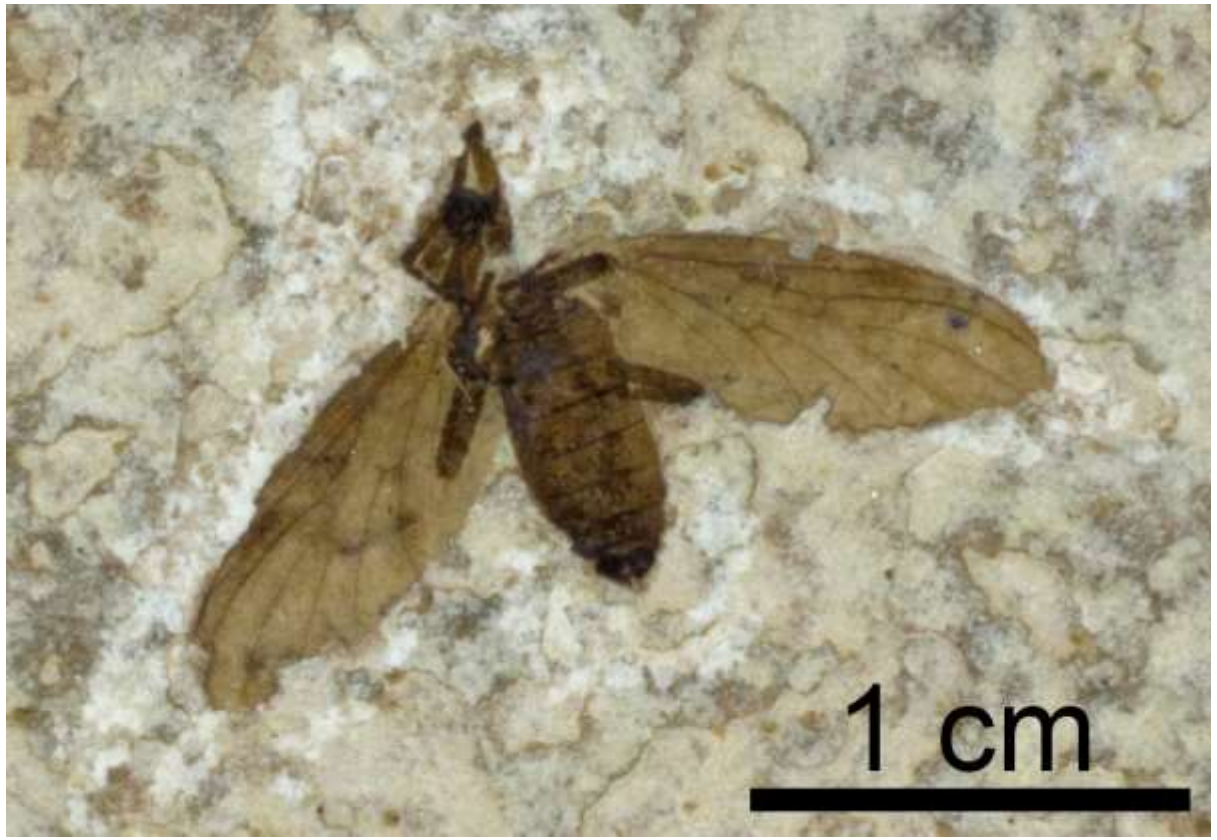

Figure 7: A fossil insect preserved as a carbonization.

2-f: Molds and casts

Molds and casts are two very common types of fossil preservation and are closely related.

a. Molds

Molds come in two forms:

External molds

Internal molds

1. External molds

They are impressions. For example, after pushing a any shell into Play-Doh, then removing it the impression left behind is an external mold. The image below shows a sample with both unaltered fossil snail shells and external molds of the same species of snail (either the unaltered shells fell out at some point or were dissolved away); in this case, the external molds are impressions that were left in the sediment when it was soft and before it lithified (turned to stone).

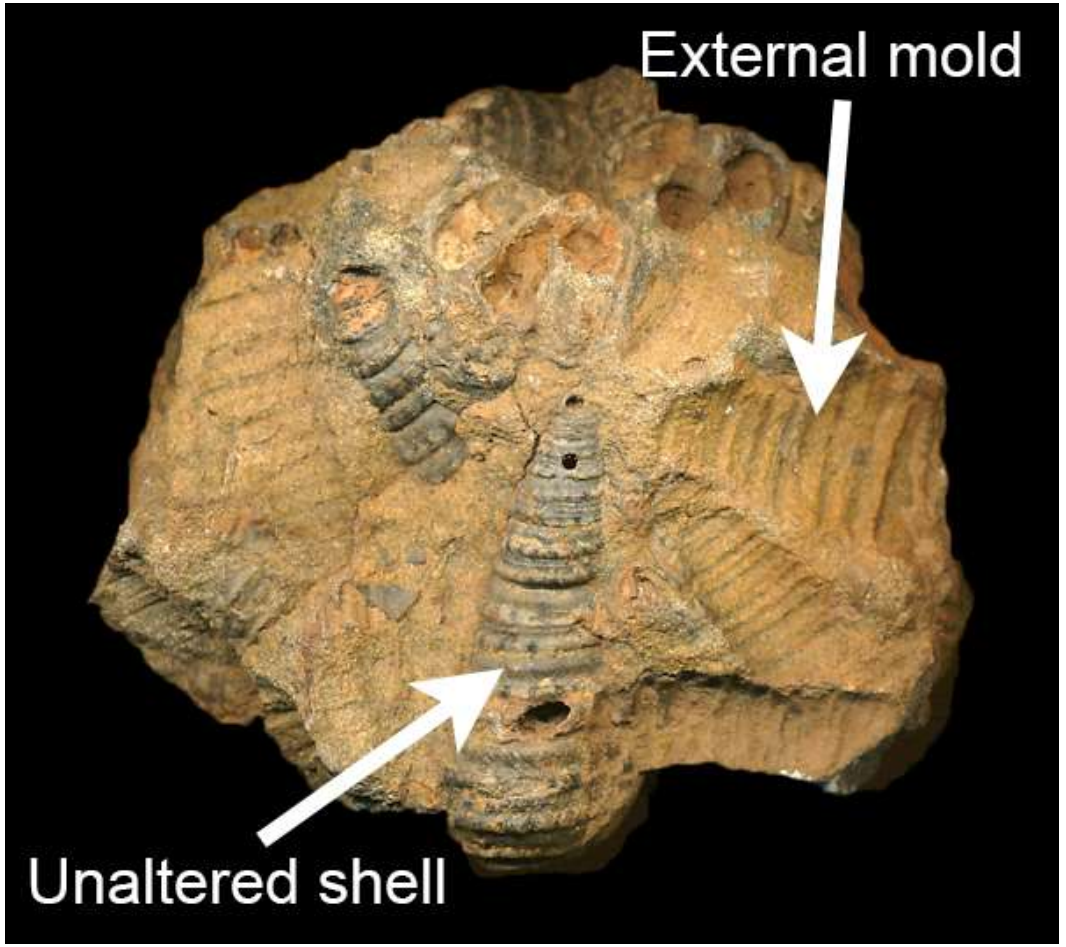

Figure 9: Specimen showing unaltered snail shell remains, as well as external molds.

2. Internal molds

Internal molds (also known as steinkerns). When a mollusc shell that has been buried in soft sediment. After the animal decays, sediment fills the inside of its spiral shell. Eventually this sediment hardens. When the unaltered shell dissolves away. All that may have been left is the lithified coil of sediment that filled the inside of the mollusc's shell. This tells us what the inside of the mollusc's shell looked like, but not much about the external morphology of the shell. Internal and external molds are often found in association.

Figure 10: Fossil specimen of a gastropod preserved as an internal mold.

a. Casts

Casts form when an external mold (or the void between an external and internal mold) is filled by sediment that later lithifies, reproducing the form of the original organic structure.

Figure 11: A cast of a trilobite fossil looks like an original shell.