Geo 302D: Age of Dinosaurs

LAB 3: Fossils and Fossilization

The odds of an organism making it into the fossil record are not very good. Flesh rots away, hair falls out, bones are weathered and crumble, or organisms are eaten and destroyed. There are many biases that wage a war against preservation in the fossil record, and these will be dealt with in lecture. Today's lab is an overview of the basic methods and forms of fossilization. By the end of the lab, you should be able to view hand specimens and determine the type of fossilization into which it falls, and its most likely mode of preservation.

A fossil is any evidence of past life. There are two broad categories of fossils, **body fossils** and **trace fossils**. As the name implies, body fossils preserve some part of the organism itself, or its shape. There are several types of preservation typical of body fossils.

Body Fossils

1. Essentially unaltered or "actual" preservation: As you can probably guess, this is an exceptional form of preservation. Some organisms have mineralized components in their structure that do not need to be altered in order to exist for long periods of time. In other cases, organisms die in unusual environments that prevent the processes of bacterial decay from taking place.

A. Freezing: This occurs only in perennially cold climates. Even a short thaw will allow bacteria to decompose a corpse. Numerous mammoths known from the northern latitudes of Siberia are preserved in this fashion.

B. Trapped in resin: This usually only happens to small organisms, such as insects, although at least three fossil lizards and two frogs were preserved this way. Once buried and hardened by various processes, tree resin becomes **amber** (of "Jurassic Park" fame). The amount of actual tissue remaining in a specimen varies over time and conditions.

C. Asphalt impregnation: Tar seeps are known from a few places around the world; Rancho La Brea in present day Los Angeles is probably the most famous. The oily fluids work into the bones, preventing them from being broken down by micro-organisms.

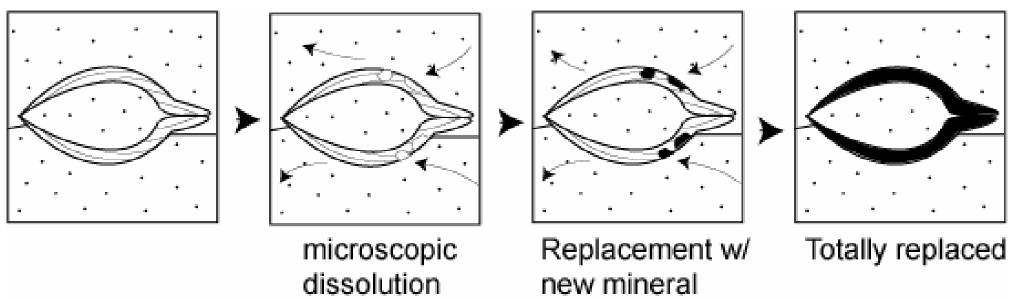
D. Unaltered: Some body parts of organisms are already heavily mineralized and do not easily break down. Calcite skeletons of corals, bryozoans, and oysters are good examples. The phosphatic shells of inarticulate brachiopods and insects, and the chitin skeletons of graptolites and arthropods also preserve well.

2. Desiccation: This occurs when the tissues of an organism get dried out, losing all their water. They become "mummified" through natural processes. Several specimens of large Pleistocene-aged mammals are known from caves in the North American Southwest and in high, dry mountain caves in South America.

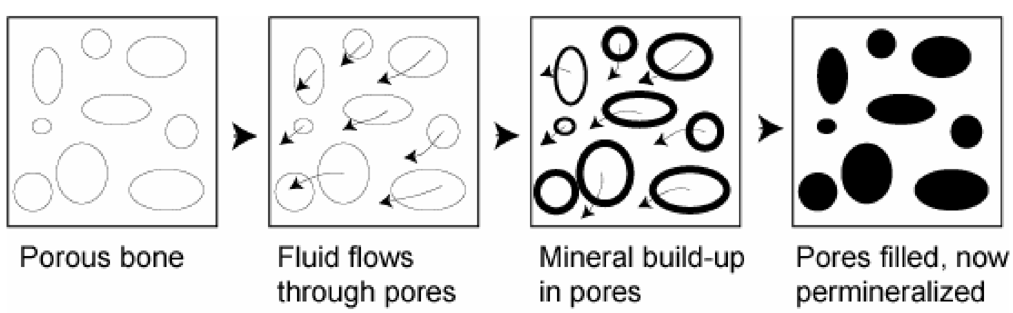
3. Carbonization: As organic remains decompose under water, the volatile elements that make up tissue (oxygen, hydrogen, and nitrogen) are slowly lost in a process called distillation. These elements can also be lost when organisms are buried quickly and placed under pressure. When distillation occurs, carbon concentrations are left behind as a thin film that preserves the shape of the otherwise soft body structure. Plants, graptolites, and fish are sometimes preserved in this manner. On very rare occasions, parts of other vertebrates, such as ichthyosaurs, are also carbonized.

4. Alteration by mineralizing solutions: Rock is surprisingly porous, and often contains a large amount of fluid. These fluids move through rock, and as they go they tend to either dissolve minerals from their surroundings or deposit the dissolved minerals they already carry with them. There are several forms of alteration.

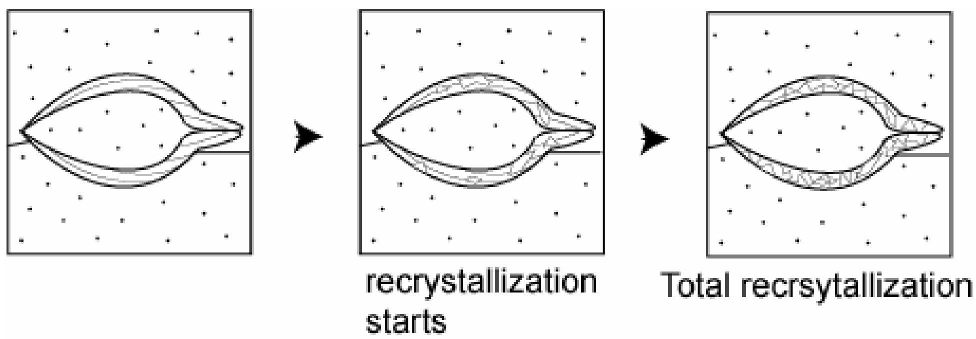
A. Replacement. The original skeletal material is replaced molecule by molecule by another mineral. As the skeleton is slowly dissolved and carried away, the space left behind is filled by a totally different mineral. Fine detail is usually preserved, unlike the condition of recrystallized fossils. Common replacement minerals are silica, calcite, pyrite (called "pyritization" in this case), limonite, and glauconite.



B. Permineralization. There is no destruction of the original material. Instead, mineralized water flows through the porous remains and precipitates mineral deposits within the pores. Eventually they are filled with minerals. This process occurs mainly in wood and vertebrate bone, both of which are very porous.

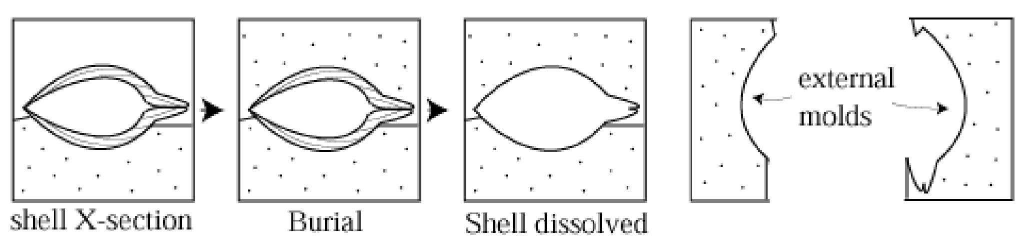


C. Recrystallization. The original skeletal material alters in place into another more stable mineral. This occurs mainly with alteration from aragonite (a form of calcium carbonate) to calcite (another form of calcium carbonate). It usually results in the destruction of fine details, because the alteration process yields larger crystals of the new mineral than the original substance. Recrystallization is common in corals, certain molluscs, and other invertebrate groups.

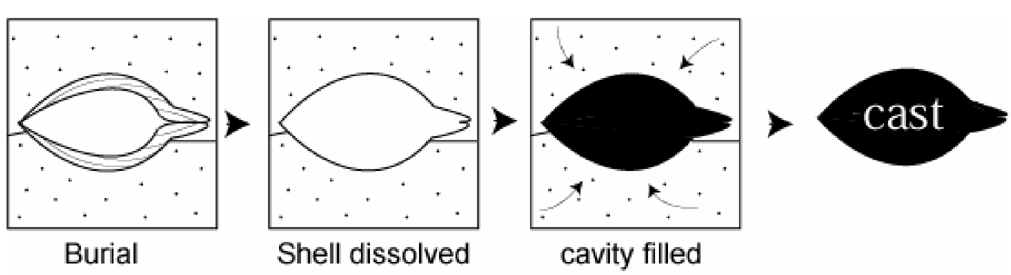


D. Concretions. Fossils may be preserved in spherical or ellipsoidal nodules of hardened material. The decomposing organism provides a localized chemical environment that favors the precipitation of mineral around it. Often the degree of preservation within a nodule is exquisite, but the concretion is usually very hard material.

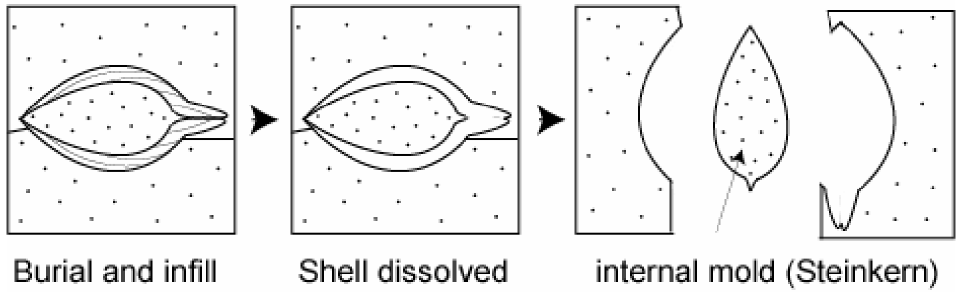
E. Molds and Casts. Sometimes, after burial and lithification of the surrounding sediment, the skeleton of an organism is completely dissolved away, leaving an empty cavity in the rock. This is a natural external **mold**.



If sediments or minerals later fill the mold, a three-dimensional copy of the external surface of the object is created. This is a **cast**.



Sometimes, a skeleton such as that of a clam or snail, may be filled with minerals or sediments. THEN the skeleton is dissolved, leaving a copy of the internal surfaces of the shell. This is an **internal mold**, also called by its German name, a **steinkern**.



Trace Fossils

The other major category of fossil is **trace fossils**. Trace fossils are indirect evidence of an organism, or evidence of the activity of past life.

1. Tracks and trails: These are obvious traces of past activity. They can provide valuable insight into the behavior or locomotor techniques of organisms.

2. Burrows: Burrows are usually the traces of feeding behavior in soft, aquatic sediments. Many marine bottom dwellers make their living by burrowing through the soft ooze of the sea floor, ingesting sediment, and passing the digested material behind them. This alters the chemistry of the material enough that the burrow will stand out in a rock unit. Sometimes we find burrows left by vertebrates (like gophers and other small, burrowing mammals) in terrestrial sediments, though this is much rarer.

3. Borings. Do not confuse borings with burrows. A boring is a hole drilled into a relatively hard surface, such as a rock, hard bottom sediment, or skeletons of other organisms. Several types of gastropods (snails) specialize in boring into other shelled invertebrates. Some sponges chemically bore holes into objects.

4. Coprolites. Everybody's favorite trace fossil. Coprolites are fossilized feces. These can yield info as to shape and features of the soft tissue of the digestive tract, and diet of extinct organisms.

5. Gastroliths: Highly polished, rounded stones sometimes found in association with archosaur skeletons. These are "gizzard stones" that aided in the physical breakdown of swallowed food items. They have been found with some sauropodomorph dinosaurs. Today gastroliths are used by crocodilians and birds.

Exercises

1). What mode of preservation do you see in here?

2). A). Look at these three objects. Rank them in likelihood of making it into the fossil record.

Most likely 1.

2.

Least likely 3.

B). Why did you put them in this order?

3). What specific type of fossil is this specimen?

4). What mode of preservation is represented in this specimen?

5). A). What is the <u>most likely</u> mode of preservation of this specimen?

B). What evidence is there for your answer?

6). Look at the tiny holes in the surface of this shell.

A). What kind of fossil are these holes?

B). What is the name given to these holes (i.e., identify the specific type of fossil)?

7). What is this?

Give two modes of preservation you are likely to see in this fossil.

1.

2.

8). What specific type of fossil is this specimen?

9). Careful!!! Very Fragile!!! Assume this specimen was found in sediments that were later determined to be 12,000 years old.

A). Would you consider this object to be a fossil?

B). Why or why not?

C). Has this specimen undergone any major mode of preservation/fossilization yet?

D). What should be the most likely mode of preservation for this specimen (either already happened or will likely happen one day)?