Chapter 2. The processes of fossilisation

1. Fossilisation refers to the transformation of a living being into a fossil

Fossilisation is a very long process. Generally, when an organism dies, its body isquickly decomposed. However, sometimes the remains of an organism are placed in conditions that favour their preservation. We then say that the remains are fossilised.

The fossilisation of a living being takes place in several stages. First, a living organism dies and is deposited on the surface of the lithosphere, either in the open air or at the bottom of an ocean. The soft tissues that make up the organism then decompose within a short period of time.

On the other hand, the hard parts (bones, fins, scales, teeth, etc.) are quickly covered with sediments, which prevents them from dispersing. As the sediments accumulate, they harden and turn into sedimentary rock, where the remains of the living being are fossilised. The fossil can thus be preserved without deteriorating.

Fossils are most often found in sedimentary rock. However, fossils can also be preserved in ice or in plant resin such as amber. It should be noted that only a small percentage of animals and plants are preserved as fossils. The vast majority decompose without leaving any traces.

Some fossils are exceptionally rare and sometimes deserve to be shared with the scientific community and the general public. This is the case when new specimens are found. In such cases, there may be a desire to display the fossils. However, given the rarity of the fossil, it is sometimes wise to reproduce the fossil and keep the original in a safe place.

- The following figure shows you different scenarios that can occur during fossilisation :

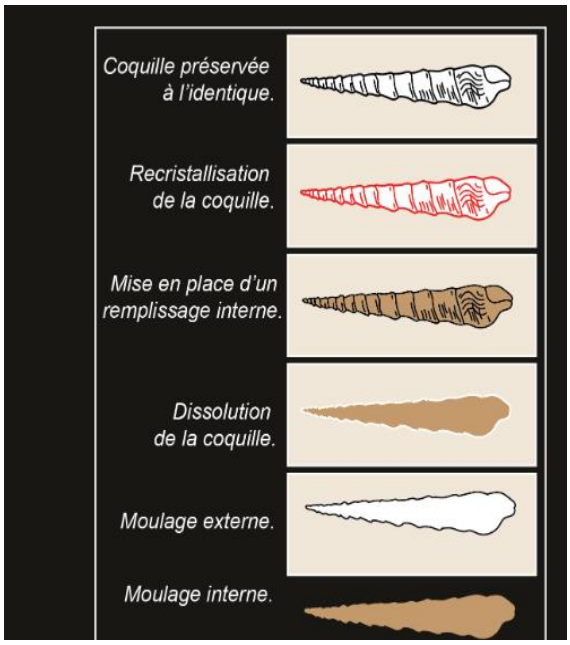

Figure 1. Some scenarios that occur during fossilisation. Example of a gastropod shell.

2. The phases of fossilisation

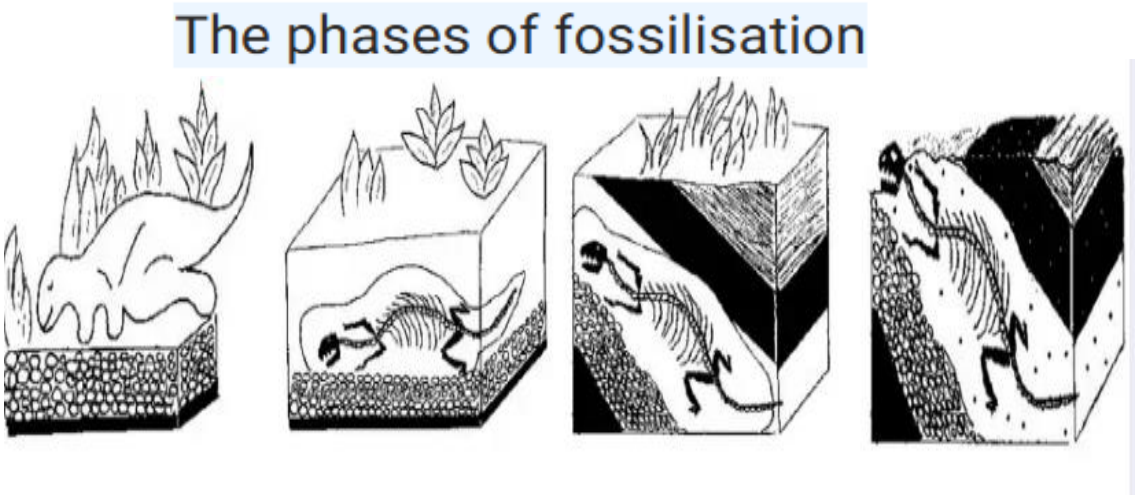

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Figure 2. The phases of fossilisation

1 : Death of the organism

2 : The disappearance of soft parts

3 : The covering of the organism by sediments

4 : The transformation into sedimentary rock.

Fossilisation requires the following conditions :

- The presence of a solid part of the living being (bone, shell, root, tooth)
- The burial of the living organism immediately after death to prevent physical, chemical, and biological factors that facilitate decomposition
- A large amount of sediment where the organism dies.
- The death of a large number of living organisms at the same time.

3. Substances serving in fossilisation

- Carbonates

In terms of importance, carbonates are predominant. Aragonite is restructured into calcite, $CaCO_3$.

-Silica

Silica, SiO_2, is the second most important fossilising agent. The three main mineral forms are opal, which epigenes into chalcedony, chalcedony itself, and quartz, which is a recrystallisation mineral.

- Silicates

Glauconite, a hydrated silicate of iron, aluminium and potassium (clay mineral) with a greenish tint, can epigenitise the shells of brachiopods, bryozoans and corals.

- Iron hydroxides

Limonite or brown haematite, $FeO\text{-}HO\text{-}nH_2O$, which is brown in colour, produces brown or yellow fossils when mixed with clays.

- Sulphates

Gypsum, $CaSO_4$, $2H_2O$, is quite often a fossilising substance (e.g. lamellibranchs with fibrous white gypsum).

- Sulphides

Pyrite (FeS_2) epigenitises almost all animal and plant fossil groups. The best known are cephalopods, crinoids, and corallians.

- Phosphates

Tricalcium phosphate, $Ca_3(PO_4)_2$, in particular apatite $Ca_5(Mg,Fe)(PO_4)_3(OH)$, is more abundant in bones and teeth. This substance is found in fossil bones, in the fruits of conifers, and in sponges from the Lias.

- Simple bodies

Exceptional in fossils. There are Permian fossils from Germany containing native copper and silver, and fossil moulds made of pure silver in Chile.

Figure 3. Conifers

4. Fossil morphology

The different types of fossils found in nature are living fossils, mummies, incrustations, mineralisation, organic imprints, and trackways.

- **Living fossils**

A living fossil is a species that exists today but has ancient origins, dating back to geological times.

It It is therefore a creature that has not evolved. Examples:

- Brachiopods of the genus Lingula, whose form has not evolved since the Cambrian period.
- Coelacanths, fish that have existed since the Devonian period to the present day.

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- **Mummies**

These are organisms that have been preserved in their entirety, including soft tissue (organs, etc.). Examples :

- Mammoths and rhinoceroses from the Lichkov Islands (Siberia),
- Herbivorous dinosaurs from Dakota. In 1999, a specimen named Dakota, aged between 67

and 65 million years old, in an ideal state of preservation since it was mummified before petrifying, was found in the Hell Creek Formation in eastern Montana and western Dakota. It was completely excavated and studied in 2006. The skin was so well preserved that traces were found on certain parts of the animal's body suggesting that it had stripes and bands like a zebra.

- Insects from Oligocene Baltic amber, fossilised resin in which insects and arachnids were trapped.
- Microfossils embalmed in flint silica.

- **Incrustations**

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These are contemporary and occur in tufa and travertine, giving shape to the plants.

Mineralisation

This involves changes to the structure and composition of the hard parts of the organism. The most common cases are :

- Transformation of opal (amorphous, transparent, and containing 5 to 10% water) into chalcedony (fibrous, with different colours, known as onyx or agate).
- Transformation of aragonite (orthorhombic) into calcite (rhombohedral). Limestone tests can also become silicified, dolomitised or pyritised.