Plaeobotany

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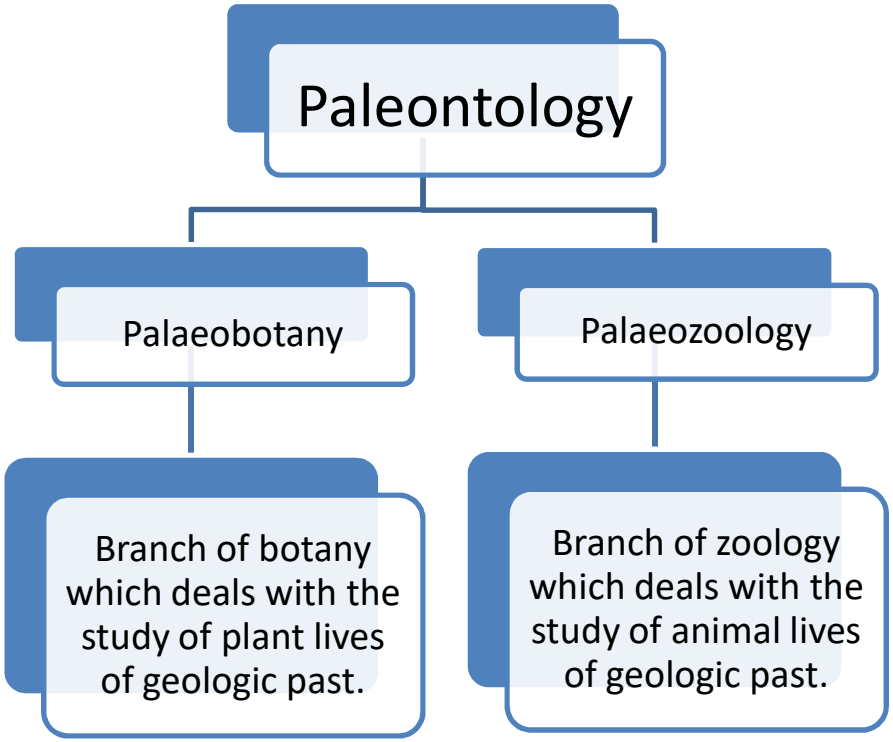
Definitions

<u>Palaeontology</u> –

Study of plant and animal fossils and the history they recall is called palaeontology.



Paleoecology

It is the study of relationship between prehistoric life forms and the prevailing environment of that time. Such a study gives idea about the prehistoric environment. For example, presence of thick cuticle and sunken stomata in fossil leaves, suggests a xerophytic condition of that time.

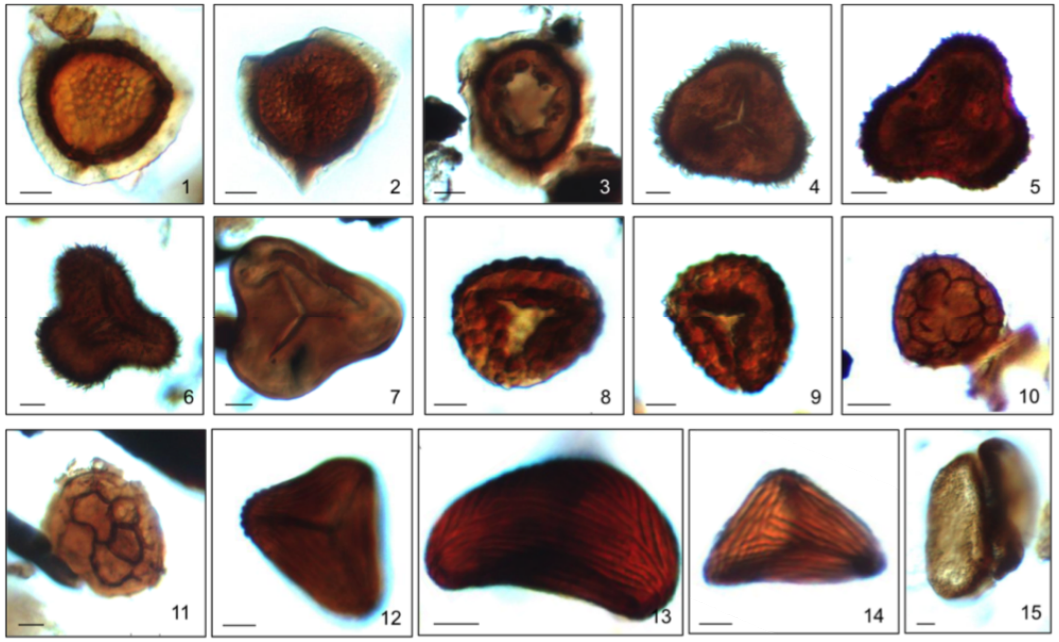
Paleofloristics

Study of fossil flora which may comprise of a tropical rain forest or temperate vegetation which may provide information about the past distribution of plant population and their migration in response to the changes in the ancient environment.

Palynology

Palynology – Subject which deals with the study of spores and pollen grains is called palynology.

Palaeopalynology – The study of fossilised spores and pollen grains is referred to as palaeopalynology.

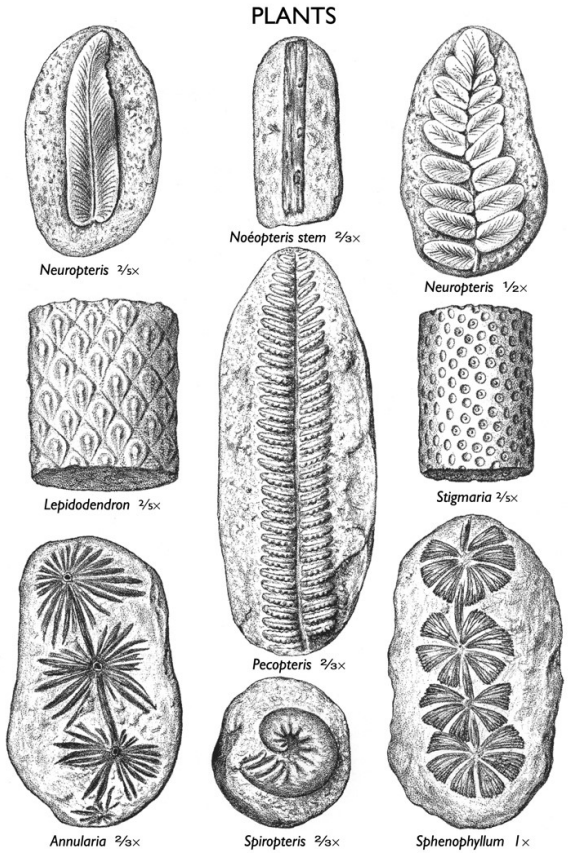


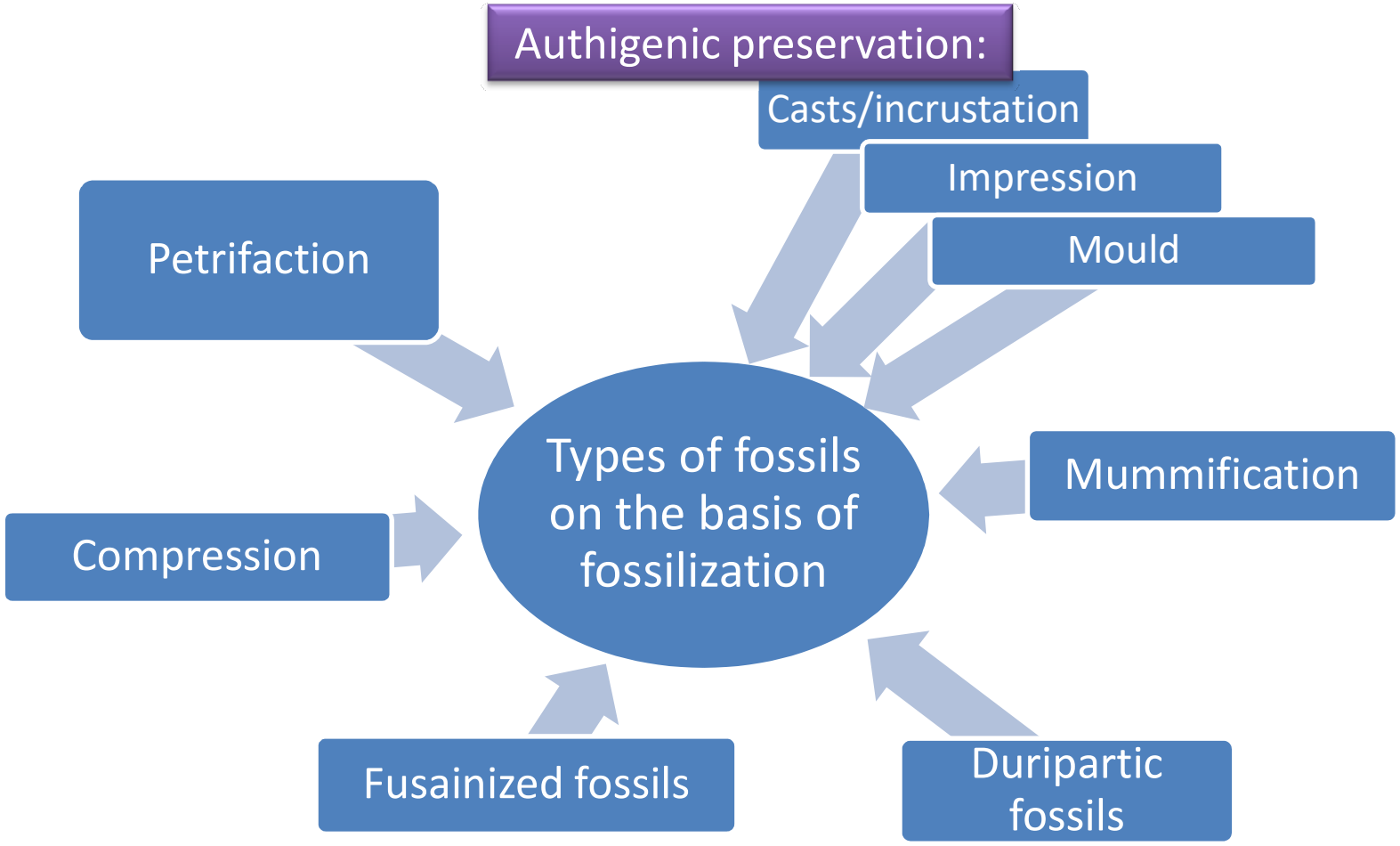
Fossils

The term fossil is derived from the word '*fossilis'* or '*fodere'*, which means *'to dig out'*. Thus, fossil is some object occurring inearth's crust which requires to be dug out. According to Schopf (1975), "any specimen which demonstrates the physical evidence of occurrence of ancient life forms i.e., Holocene or older, may be defined as fossil".

Steward (1983, '93)on the other hand, has defined fossils as, "any evidence of prehistoric life forms".

<u>Subfossil</u> – The life forms which are held within recent deposits (i.e., less than 6000years from now) are called subfossils. For example, Mammoths, *Tillites* etc.




Authigenic preservation:
Casts/incrustation
Impression
Mould
Petrifaction
Types of fossils on the basis of fossilization
Mummification
Compression
Fusainized fossils
Duripartic fossils

Petrifaction

This literally means transformation into stone. It is rarest but most informative type of fossil. In this case, the tissues are partially replaced by mineral matters with the preservation of the cellular structures. It is also called **permineralization**. It results due to infiltration followed by precipitation of soluble mineral like silicates, carbonates, sulphates, phosphates of calcium and magnesium and iron compounds into the intercellular space and sometimes within the cells. In this way the whole tissue and organ gets petrified with all its cellular details.

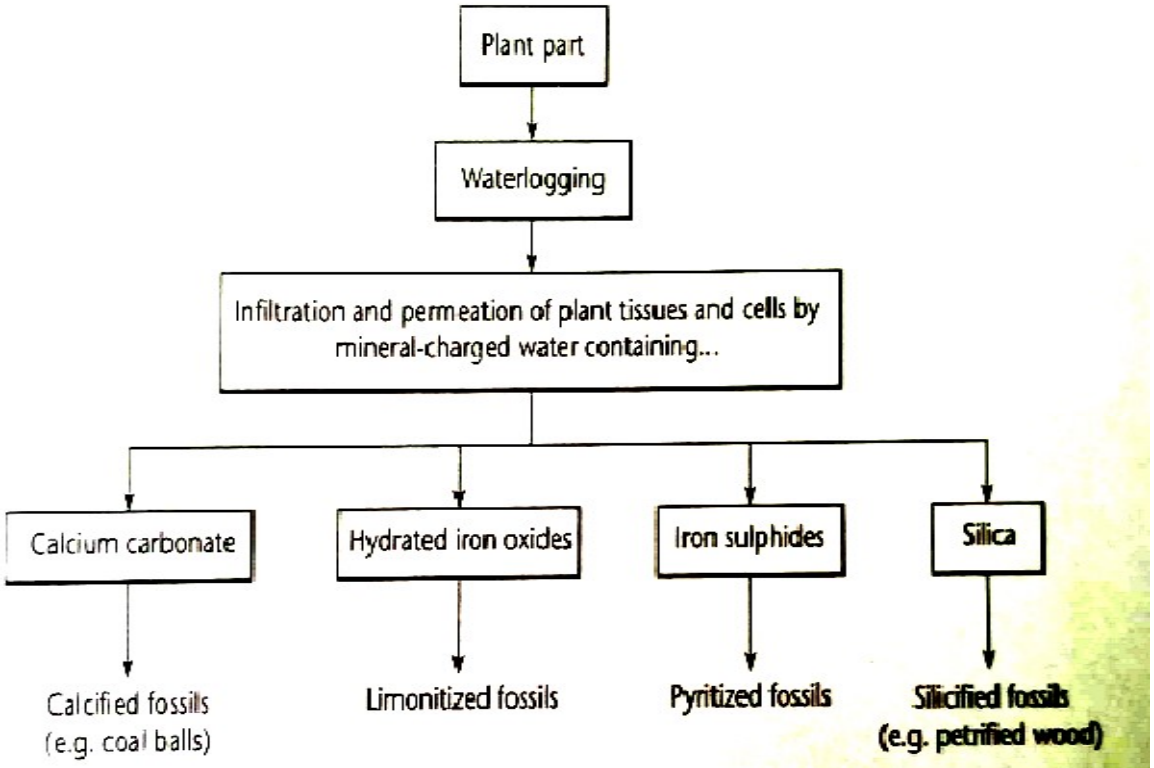


Figure 1.5 Most common types of permineralized plant fossils found in the geological record.

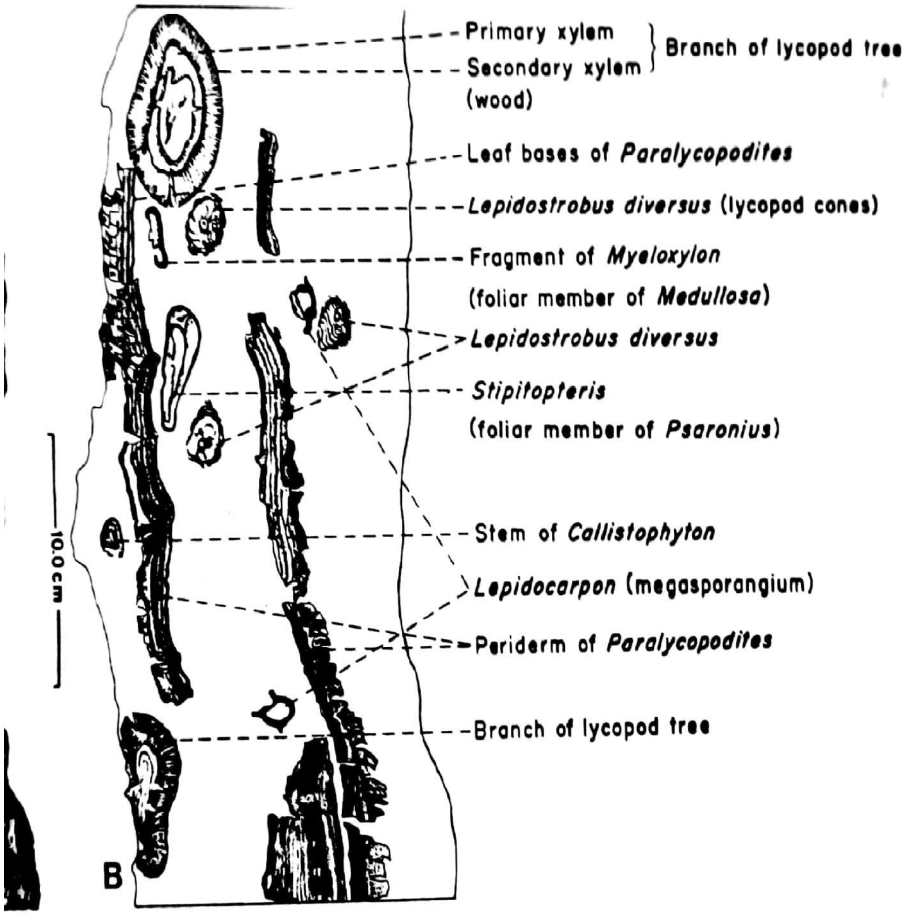
Permineralization

The best-known and most-studied petrified wood specimens are those that are mineralized with polymorphs of silica: opal-A, opal-C, chalcedony, and quartz. Less familiar are fossil woods preserved with non-silica minerals. Non-silica minerals that cause wood petrifaction include calcite, apatite, iron pyrites, siderite, hematite, manganese oxide, various copper minerals, fluorite, barite, natrolite, and the chromiumrich smectite clay mineral, volkonskoite.

Regardless of composition, the processes of mineralization involve the same factors: availability of dissolved elements, pH, Eh, and burial temperature. Permeability of the wood and anatomical features also plays important roles in determining mineralization. When precipitation occurs in several episodes, fossil wood may have complex mineralogy.

Coal Ball

One of the important example of petrifaction is the "**coal ball**". Coal balls are calcified fossils formed due to deposition of $CaCO_3$. They are more or less rounded bodies of ~20-40cm diameter found exclusively in the peats of Carboniferous – permean period. Coal balls are composed of numeraous plant fragments embedded within a calcium carbonate matrix, which on dissection reveal the structural details of the organ.



Authigenic preservation (Cementation)

In this case the **surface morphology** is preserved.

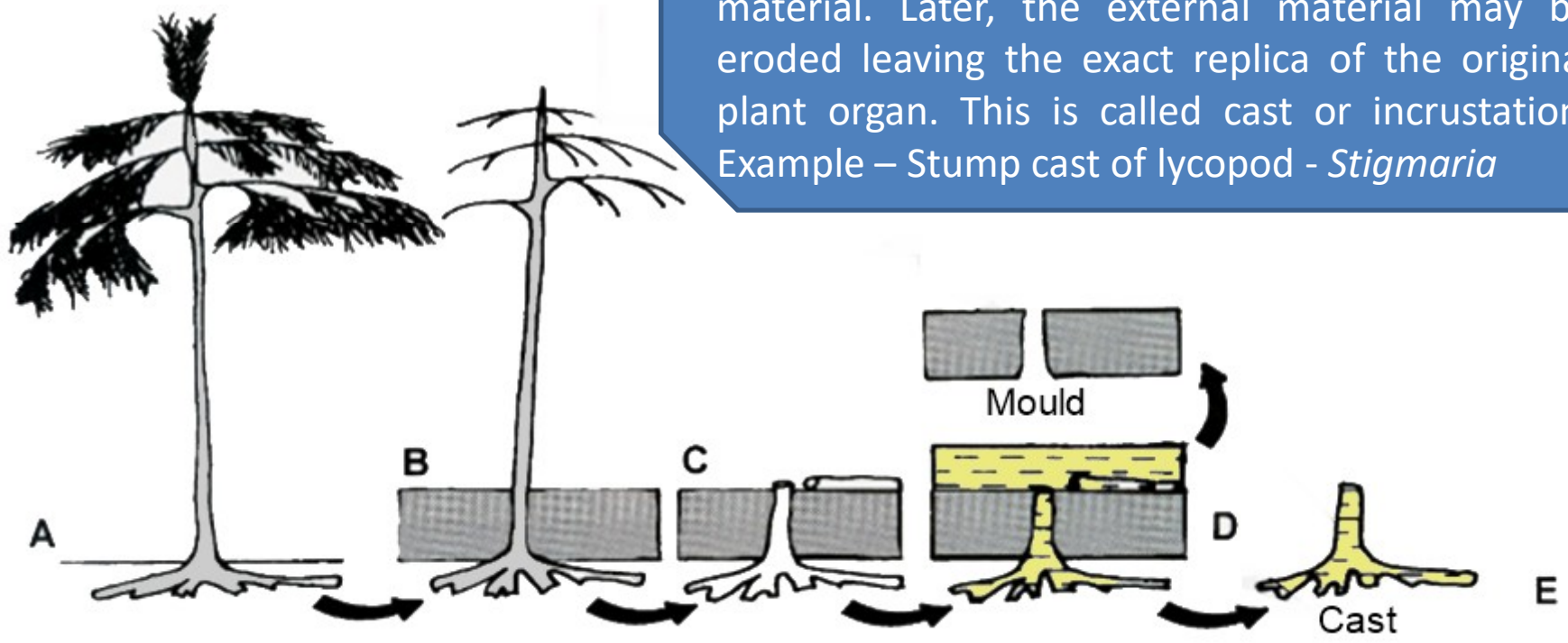
The process is basically **cementation**.

The decaying plant materials develop electrical charges and attract oppositely charged mineral particles composed of iron and carbonate deposits. These materials accumulate and become cemented around the plant organ yielding **three different types of fossils – Impression, mould and casts**

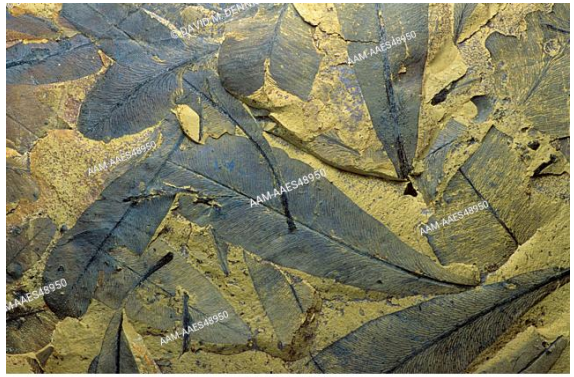
Impression – The negative imprint of the morphological structures of flat, two dimensional organs, like leaves, sporophylls etc. In case of leaves, the venation pattern and some times the morphology of epidermal hairs are often preserved. Example – *Sphenopteris*, *Neuropteris*, *Pterophyllum* etc.

Mould – It is formed in case of three dimensional organs such as stem. When plant part falls on ground, it becomes surrounded by rock forming materials which later solidify. In the course of time, the plant organ becomes decomposed leaving a hollow cavity inside. This hollow cavity like structure is the mould which also contains the negative imprint of the surface structures of the organ. Example – *Lepidodendron*.

Cast or incrustation – In course of time the hollow mould may become filled with cementing materials consisting of silica, clay, lime etc. which become lithified and more solid than the external material. Later, the external material may be eroded leaving the exact replica of the original plant organ. This is called cast or incrustation. Example – Stump cast of lycopod - *Stigmaria*



Authigenic preservation



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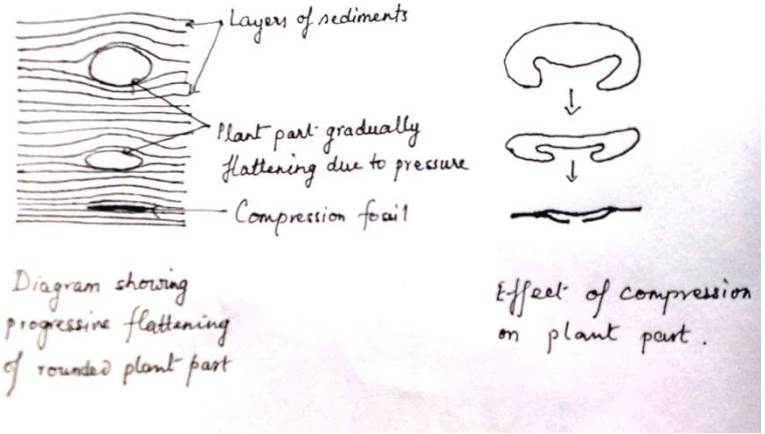
Compression

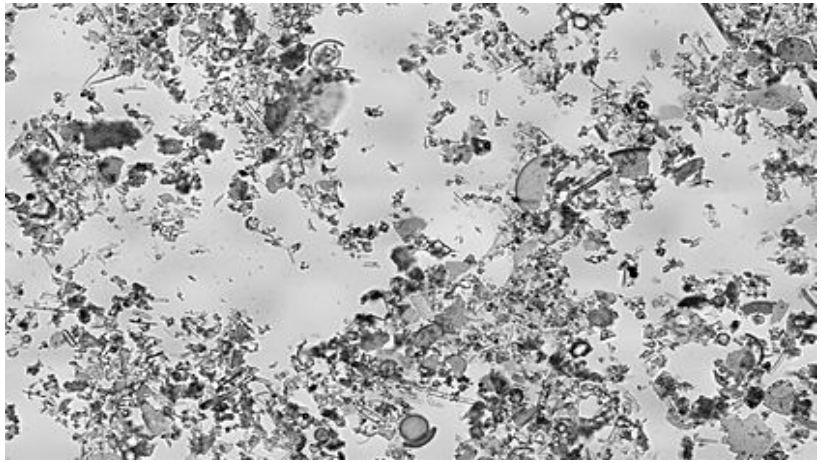


The bulk of plant material gets compressed within deposits. As additional sediments are laid down over the organ, it becomes more compact and flattened, the water inside is squeezed out and what remains is a thin film of carbonaceous material representing the original outline of the plant organ. But unlike impression, compression contains the organic matter and cellular details are some times preserved.

They are usually preserved within "**clay- nodules"**. Clay-nodules are smooth oval masses of fine grained rock, varying in length from an inch to a foot which on splitting open along the plane of bedding reveal compression on one half and impression on the other. Ex.– Leaves of *Metasequoia occidentalis*, Fertile fronds of *Senftenbergia* etc.

Duripartic fossil

Hard part preservation is called duripartic preservation. Coralline algae belonging to red and green algae, as well as some cyanophyceae whose calcareous hard parts are preserved directly are good example. Diatomaceous earth is another example.



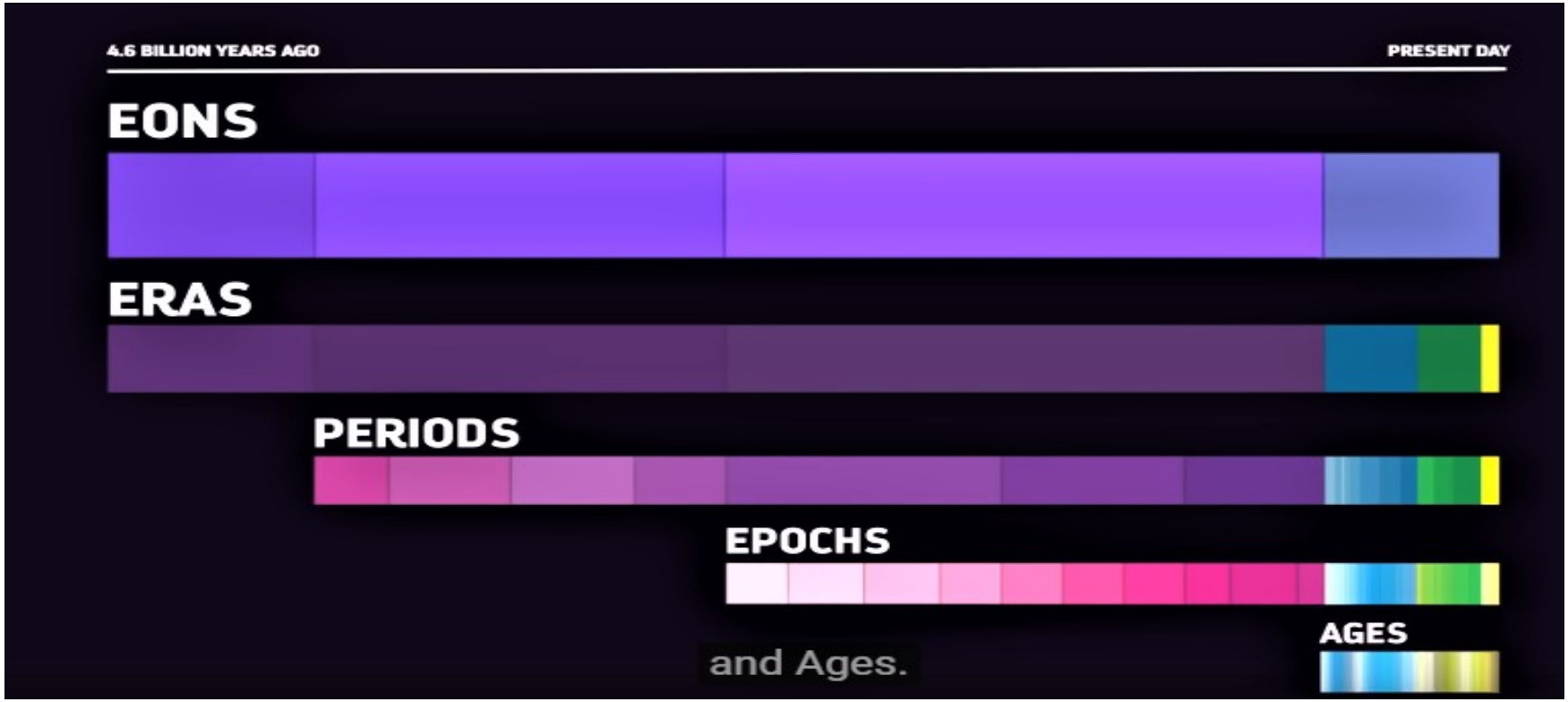
Fusainized fossils

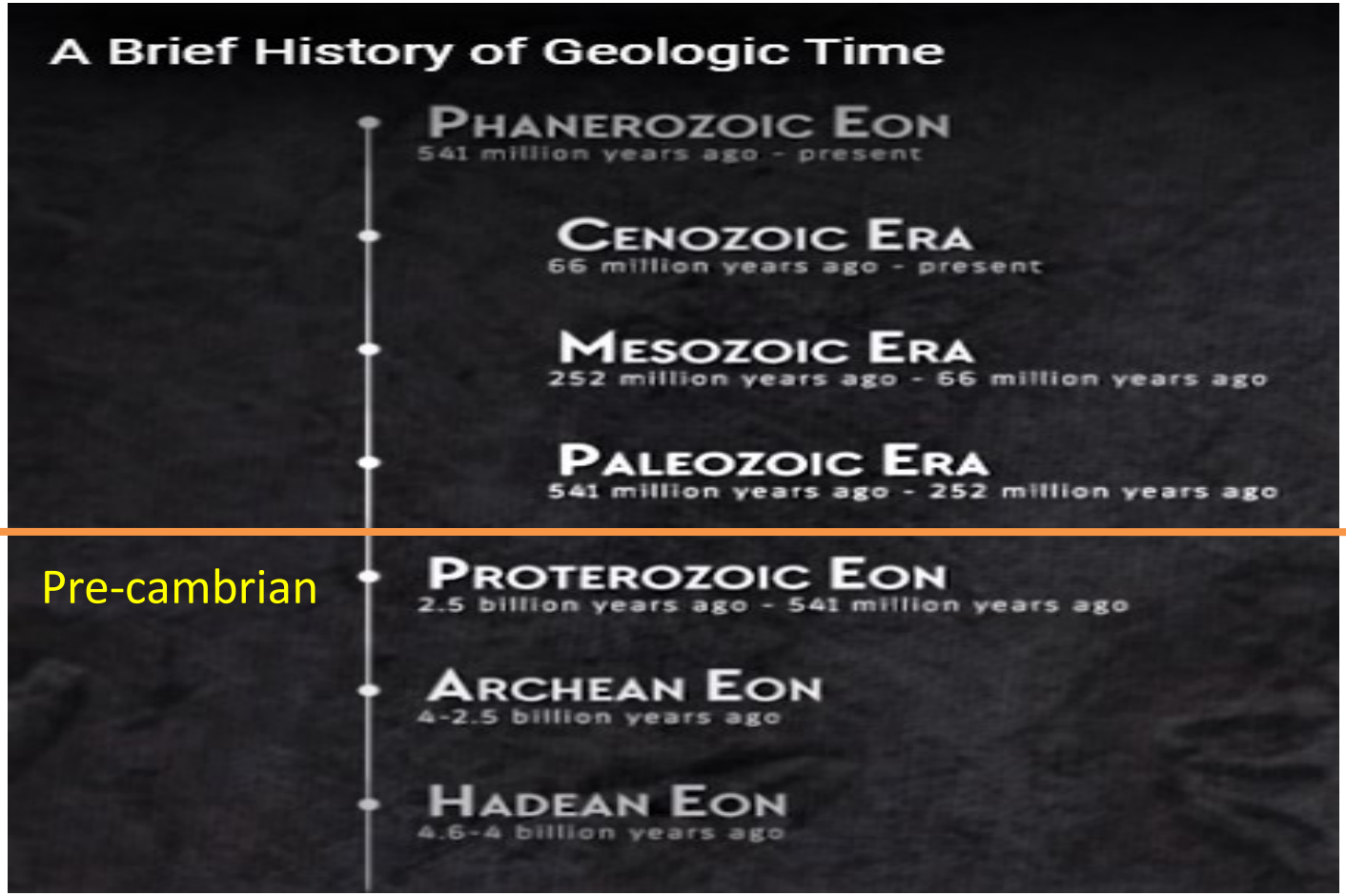
The coalified remains of plant parts fossilized after forest fire due to charring are called fusainites. Example – Flower bud of *Silvianthemum*.

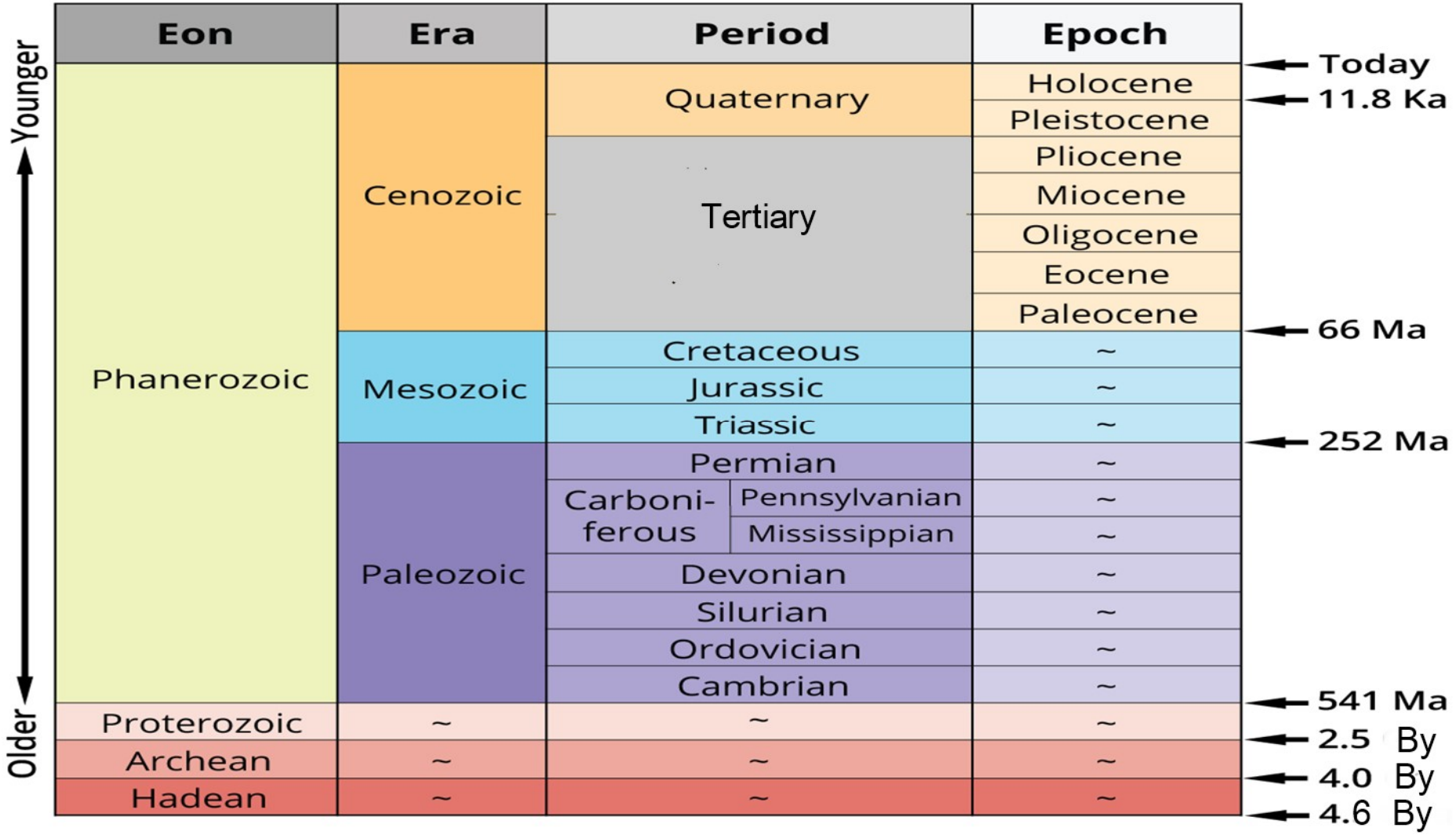
Mummification & Ambers

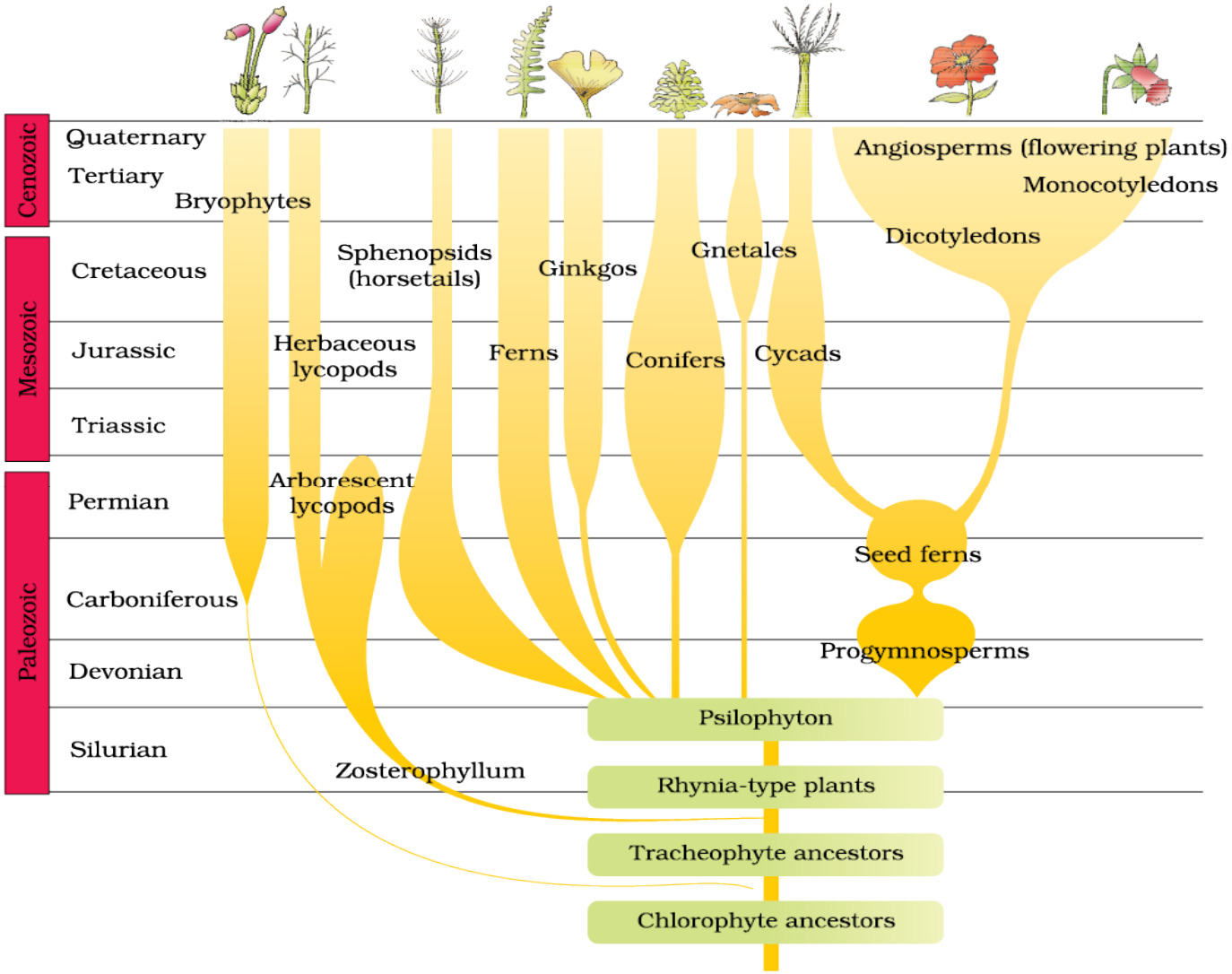
When the entire organism or the whole organ gets preserved under cryo-condition or under oil saturated environment, it is called mummification. Example - Mammoths. Amber is another type of mummification. In this case intact bodies of insects, fungal spores, pollen grains, floral parts get preserved within resins produced by some fossilized coniferous member viz., *Pinus succinifera*. Since the resin itself is a fossil embedding another fossil within it, it is called fossil within a fossil.

Geological The time scale




A Brief History of Geologic Time
Phanerozoic Eon
541 million years ago - present
Cenozoic Era
66 million years ago - present
Mesozoic Era
252 million years ago - 66 million years ago
Paleozoic Era
541 million years ago - 252 million years ago
Pre-cambrian
Proterozoic Eon
2.5 billion years ago - 541 million years ago
Archean Eon
4-2.5 billion years ago
Hadean Eon
4.6-4 billion years ago


Younger
Older
Eon
Era
Period
Epoch
Phanerozoic
Cenozoic
Quaternary
Holocene
Pleistocene
Tertiary
Pliocene
Miocene
Oligocene
Eocene
Paleocene
Mesozoic
Cretaceous
Jurassic
Triassic
Paleozoic
Permian
Carboni-ferous
Pennsylvanian
Mississippian
Devonian
Silurian
Ordovician
Cambrian
Proterozoic
Archean
Hadean
~
Today
11.8 Ka
66 Ma
252 Ma
541 Ma
2.5 By
4.0 By
4.6 By


Cenozoic
Mesozoic
Paleozoic
Quaternary
Tertiary
Cretaceous
Jurassic
Triassic
Permian
Carboniferous
Devonian
Silurian
Bryophytes
Herbaceous lycopods
Arborescent lycopods
Zosterophyllum
Sphenopsids (horsetails)
Ferns
Ginkgos
Conifers
Gnetales
Cycads
Angiosperms (flowering plants)
Monocotyledons
Dicotyledons
Seed ferns
Progymnosperms
Psilophyton
Rhynia-type plants
Tracheophyte ancestors
Chlorophyte ancestors

Conditions for fossilization

Conditions of Fossilisation:

It is a rare instance that an organism is preserved intact. Most of the known fossils are imperfect, where only external features are preserved. The perfect permineralised fossils showing cellular details are very rare.

The conditions for perfect fossilisation process can be categorised under the following heads:

1. Sites of fossilisation; Less physical disturbances; Anaerobic; Low microbial activity.
2. Nature of the tissue undergoing fossilisation. (Intrinsic factors)
3. Events that occur before, during and after fossilisation. (Extrinsic factors) –
   Time and Intensity
   Time - How long the force is acting
   Intensity – What is the intensity of the damaging force.


Thank
you