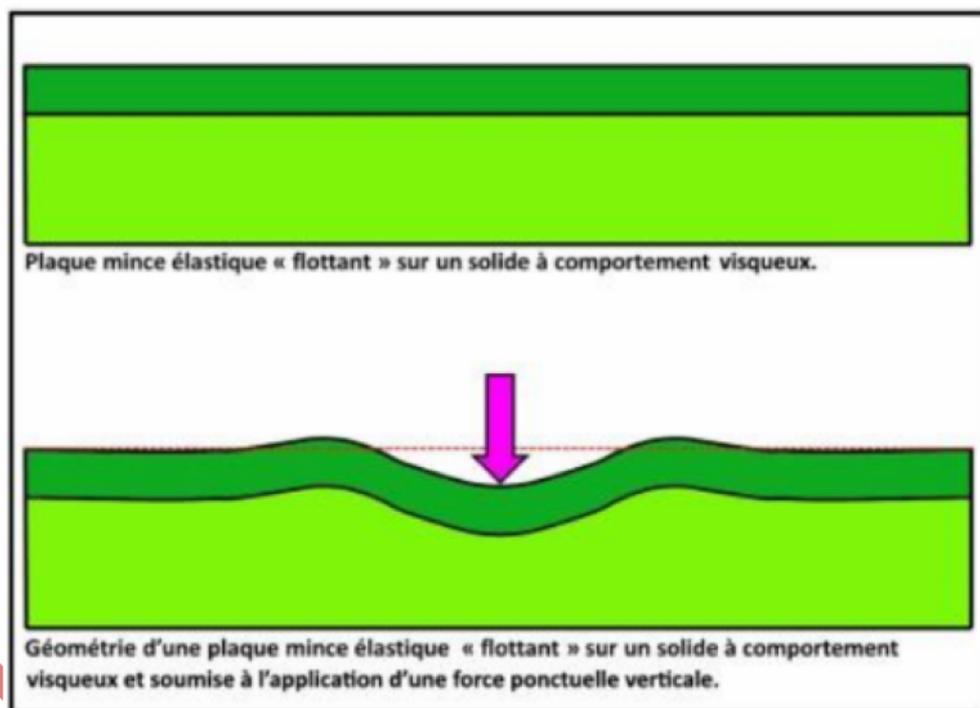


Chapter IV. Subsidence, transgressions and regressions

IV.1 Isostasy:

From the Greek word *isostasios*, *iso* (equal) and *statikos* (stable): it means “same stable equilibrium

everywhere”. Isostasy is a theory proposed in geophysics to explain anomalies in the gravitational field at the Earth's surface. It is in fact a simple application of Archimedes' principle of isostatic equilibrium.



“Isostatic equilibrium” means that elements of the crust (the lithosphere) buried at different depths (of the order of 100 km, for example) are subject to the same pressure, regardless of topographic irregularities at the surface.

The depth at which isostatic equilibrium is reached is called the “compensation depth”. This may vary from place to place.

Definition Isostasy :

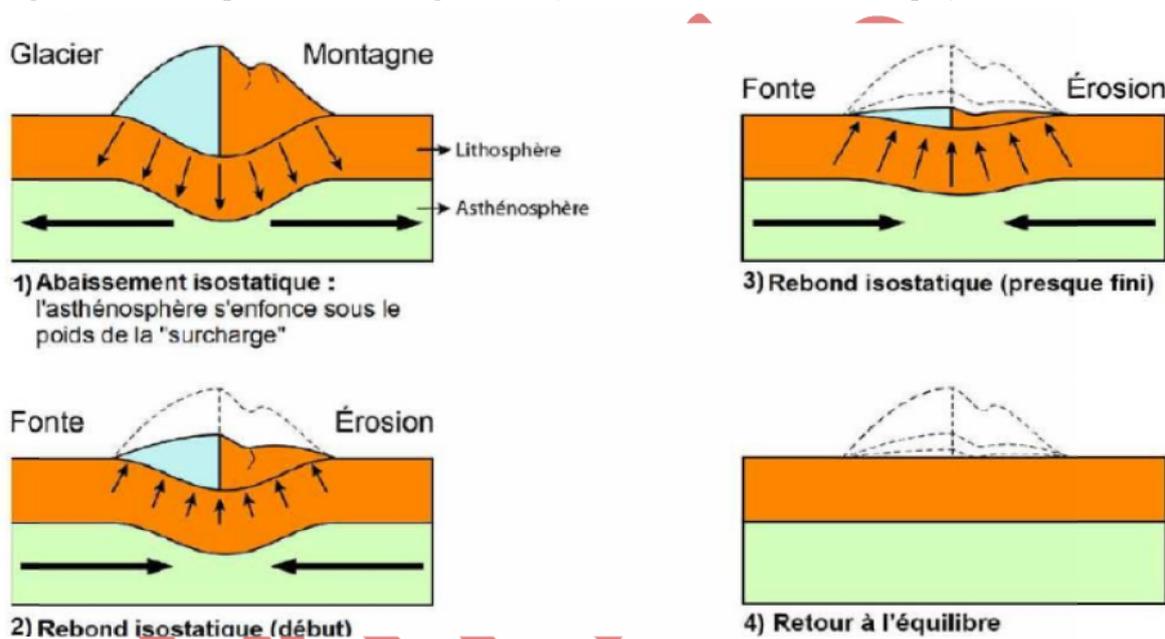
State of equilibrium of the rigid lithosphere on the more deformable deep layer: the asthenosphere. There is therefore a permanent equilibrium between the thickness of the Earth's crust and the sinking into the asthenosphere that takes place beneath it.

As oceanic crust is much thinner than continental crust (5 to 7 km on average, as opposed to around 30 km), the asthenosphere (and therefore the mantle) will be a little deeper on the continents in general.

Principle:

The lithosphere (upper mantle surmounted by the earth's crust, which is rigid) rests on the asthenosphere (lower mantle, which is slightly less rigid).

Because the asthenosphere is slightly less rigid than the lithosphere, it will deform under the weight of the lithosphere if this is significant (below a mountain, for example).



The Moho (the boundary between the Earth's crust and mantle, the lithosphere) will sink deeper beneath the mountains, so the lithosphere will sink into the asthenosphere too.

Note:

If the asthenosphere were as rigid as the lithosphere, there would be no deformation. This deformation takes place on a geological time scale, the unit of which is the million year. There is therefore a permanent equilibrium

IV.2 Tectonic subsidence

The word subsidence comes from the Latin *subsidere*: to sink. Subsidence is a progressive, regular or jerky subsidence of the earth's crust.

It can be linked to tectonic plate movements (faulting, stretching of the lithosphere, etc.) or to the accumulation of thick sedimentary series in shallow basins.

In geology, subsidence is the slow subsidence of the lithosphere, resulting in the progressive deposition of sediments beneath a constant depth of water.

Different types:

Subsidence is based on two successive phases:

Tectonic Subsidence: this is an instantaneous thinning of the lithosphere inducing initial (or tectonic) subsidence; followed by subsequent evolution.

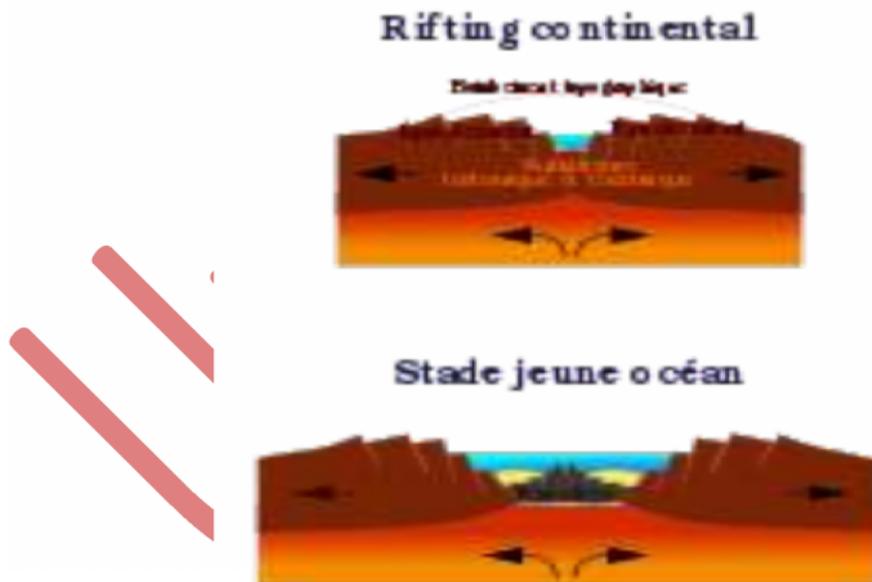
Tectonic subsidence occurs in two different geological contexts:

- **divergence**, with the formation of trenches (graben, rift). In this case, the lithosphere thins. Normal faults are the main markers of such a context.

- **convergence** in fore-chain basins (e.g. Molasse basin in the Alps).

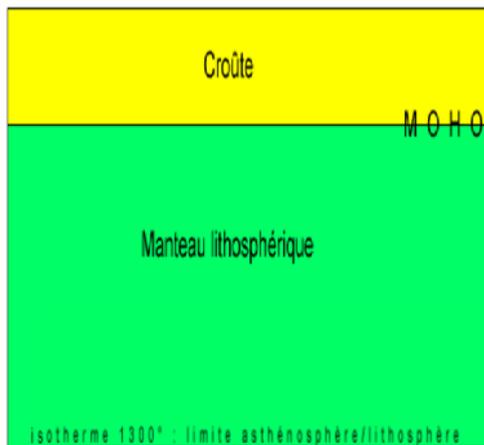
Sedimentary basins formed in this way are characterized by:

- the power of sedimentation.
- the persistence of shallow facies (essentially detrital, characteristic of continental fluvial and/or shallow lacustrine or marine environments) throughout the stratigraphic series.
- the presence of tectonic markers of distension such as normal faults.

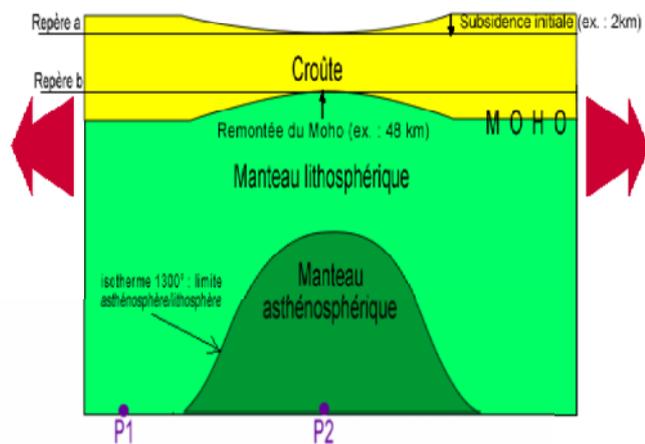


Thermal subsidence: following the upwelling of heated matter, followed by cooling and thickening of the lithosphere, equilibrium is restored: Total final subsidence is the sum of initial (or tectonic) subsidence and thermal subsidence.

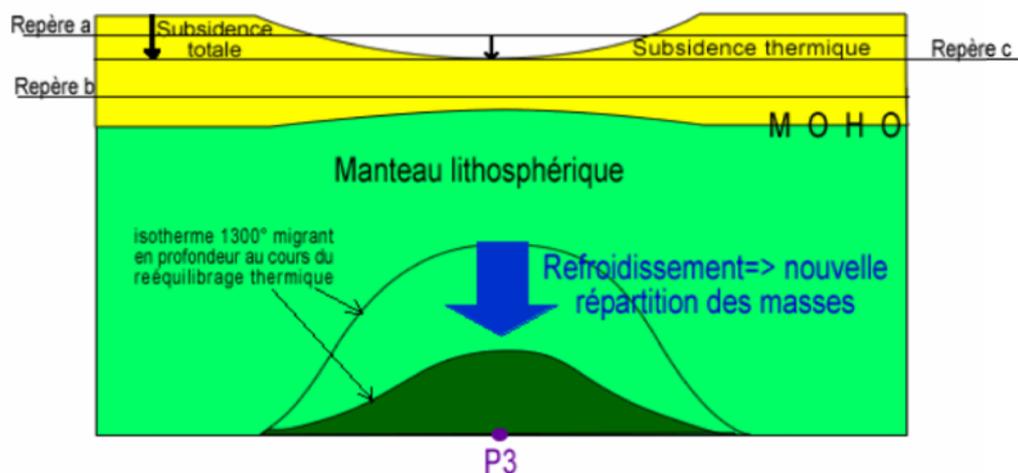
1- Stade initial avant l'étirement mécanique et l'amincissement



2- Phase de subsidence initiale quasi simultanée de l'étirement



3- Phase de subsidence thermique après rééquilibrage thermique



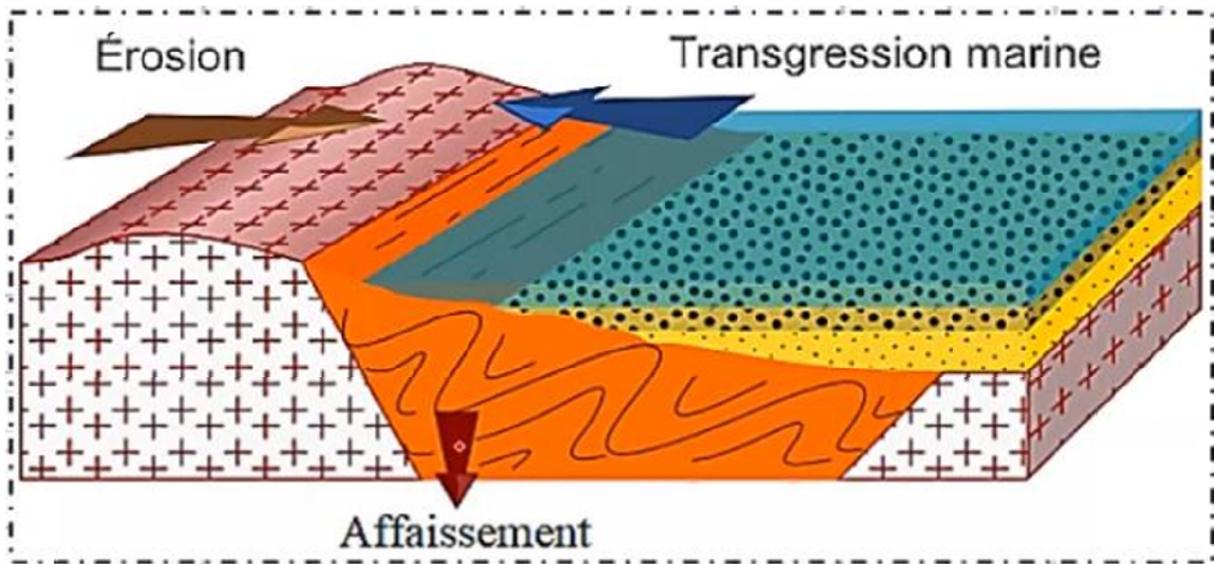
Attention : échelles non respectées

IV.3 Transgression and regression:

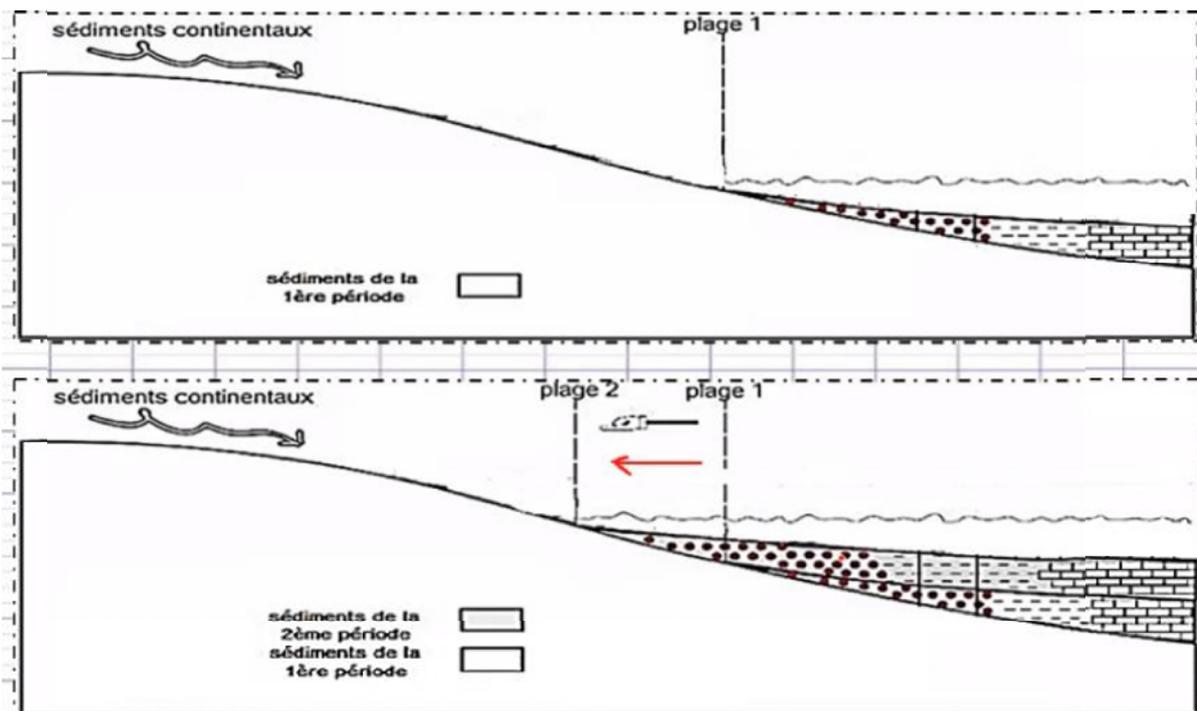
These are sedimentary processes which take the form of a landward or seaward displacement of the shoreline.

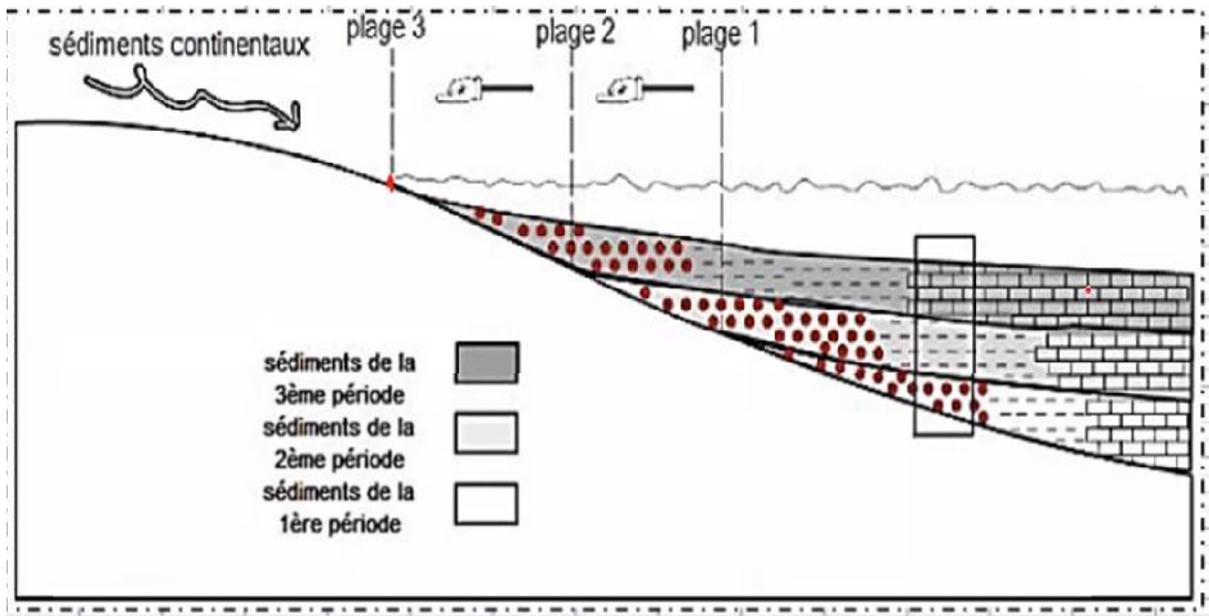
IV.3.1. Transgression:

This is the advance of the sea towards the continent and the invasion of coastal areas, due to the subsidence of land (tectonic forces) or to a general rise in sea level (change in climatic conditions). The Transgression Surface is often marked by the presence of phosphate nodules and glauconite grains linked to the intervention of bottom currents (upwellings) carrying ions (P, K, Fe...).

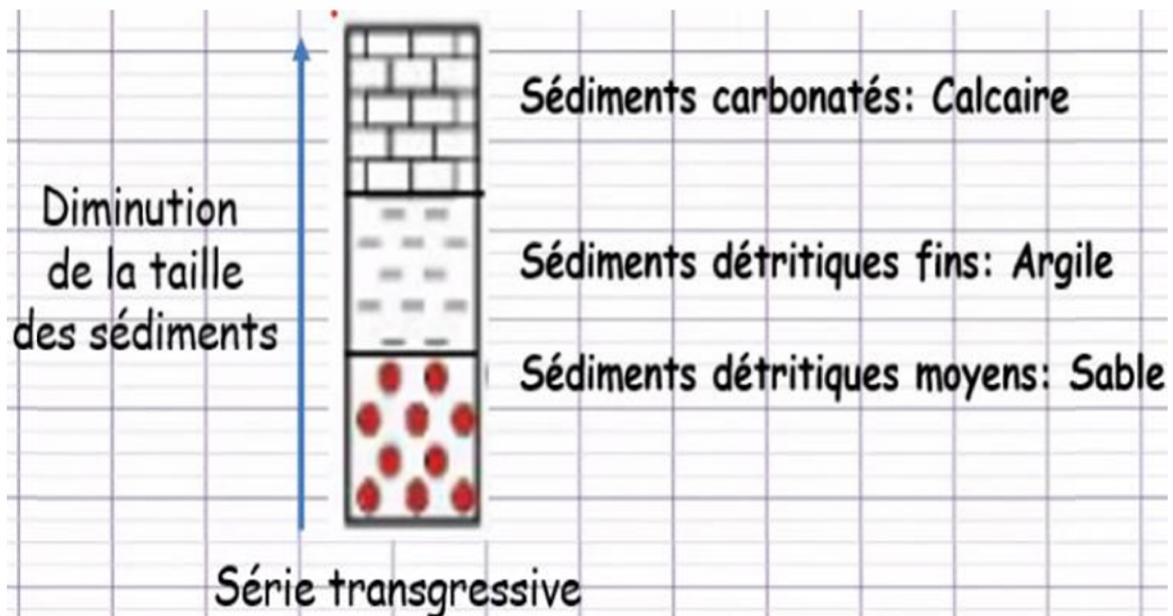


Sedimentary characteristics of the transgressive series



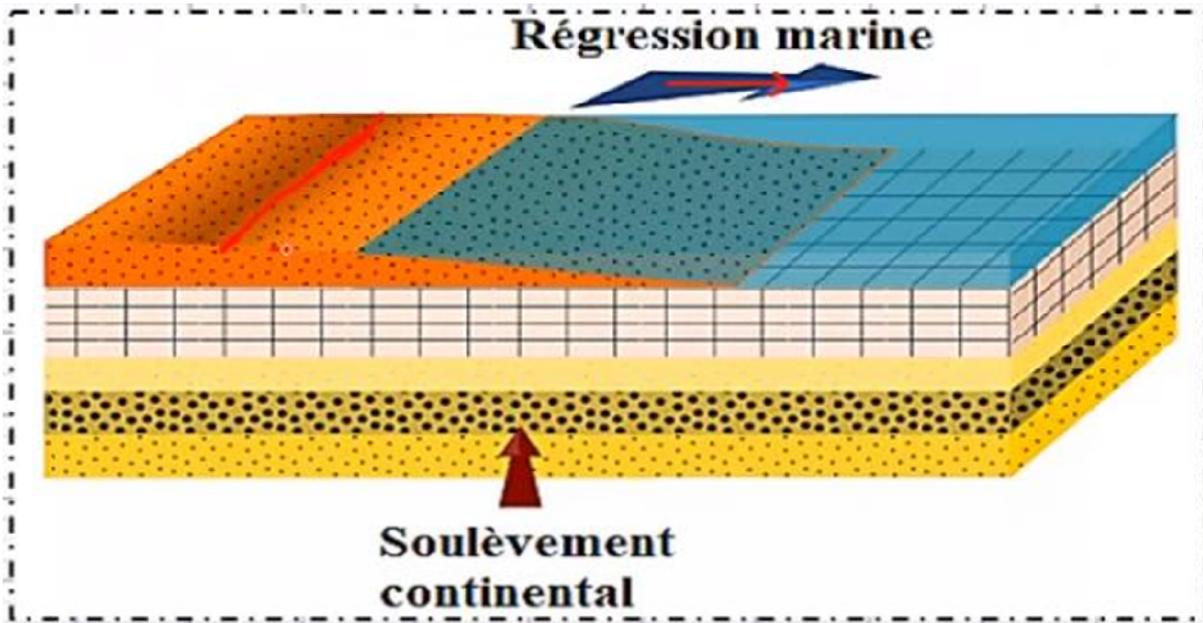


The transgressive series is characterized by a decrease in sediment size from bottom to top (decreasing granulo-classification) Sand clay limestone

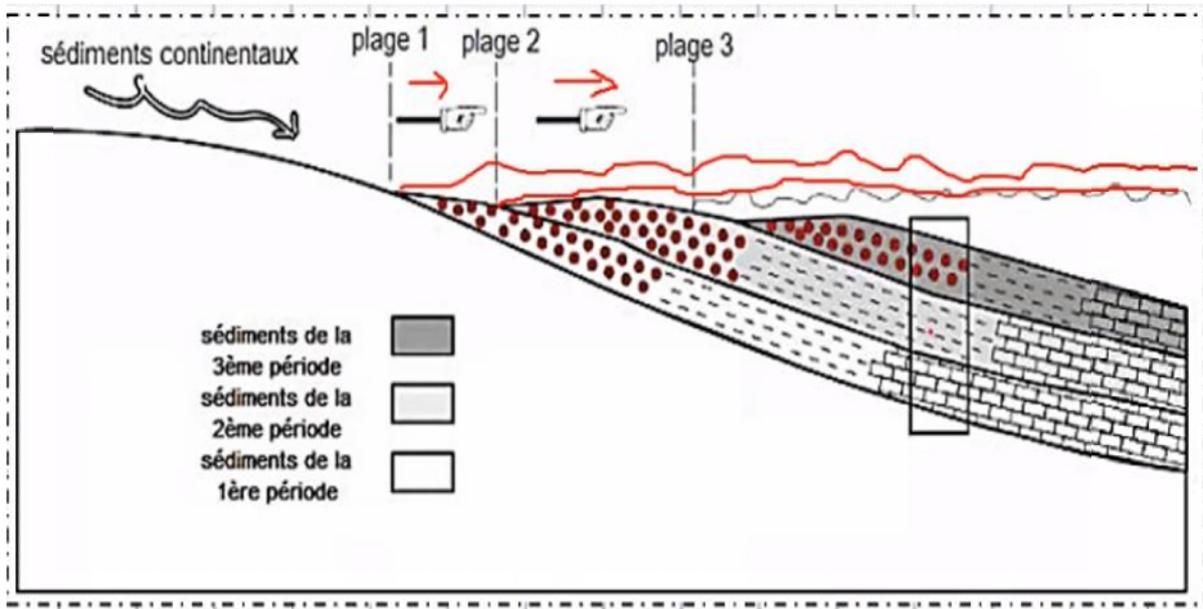


IV.3.2. Regression:

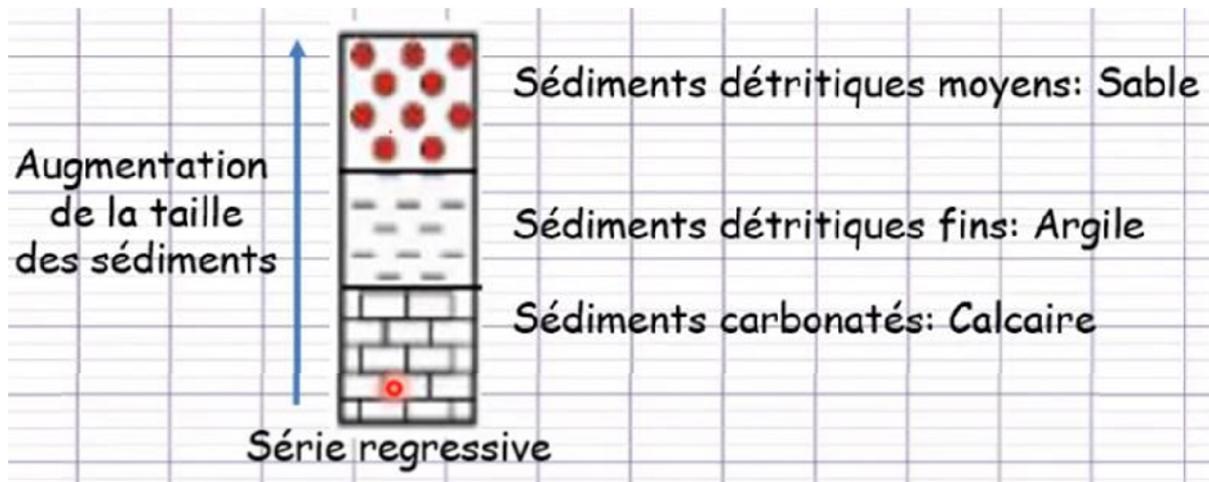
This is the opposite of transgression: retreat of the sea due to lowering of sea levels or continental uplift (in the case of orogens). (Detrital sedimentation: made up of sands and clays rich in fossil debris from the continent and from the exundated platform.



Sedimentary characteristics of the regressive series



The regressive series is characterized by an increase in sediment size from bottom to top (increasing granulo-classification) Limestone Clay Sand



Sediment cycle and sedimentation cycle

Sedimentary cycle: refers to the period between a marine transgression and the marine regression that follows it, in the same region.

Sedimentation cycle: refers to all the sediments formed by the succession of a transgressive series and a regressive series, or vice versa.

