CHAPTER 3: Tectonics:

3.1 Concept of tectonics (soft and brittle)

3.1.1 Introduction:

Tectonics is the discipline devoted to the study of the structures acquired by rocks after their formation. It is therefore the science of the deformations of the Earth's crust, and is also known as Structural Geology.

Depending on their intensity and the nature of the rocks, tectonic forces (responsible for modifying the original layout of the layers) can produce folds or breaks, known as faults.

3.1.2. Geometric marking:

For a given layer, we define the direction, which is given by the intersection of the stratification plane of the layer with a horizontal plane, and the dip, which is expressed by the maximum angle made by the layer with the horizontal.

The dip therefore lies in the plane perpendicular to the direction; it is zero for a horizontal layer, and 90° for a vertical layer.

3.1.3. Description of tectonic faults:

The formation of mountain ranges or orogenesis (oro: mountain, relief) is the result of horizontal and vertical movements of the crust. The stresses to which the rocks are subjected result in two types of deformation:

- Some are continuous and flexible, the domain of folds,

- others are discontinuous and brittle, manifested by faults.

- There are other intermediate deformations, such as flexures and fissures, and others accompanied by subhorizontal displacement, such as thrust sheets.

3.2. Brittle deformation : Faults

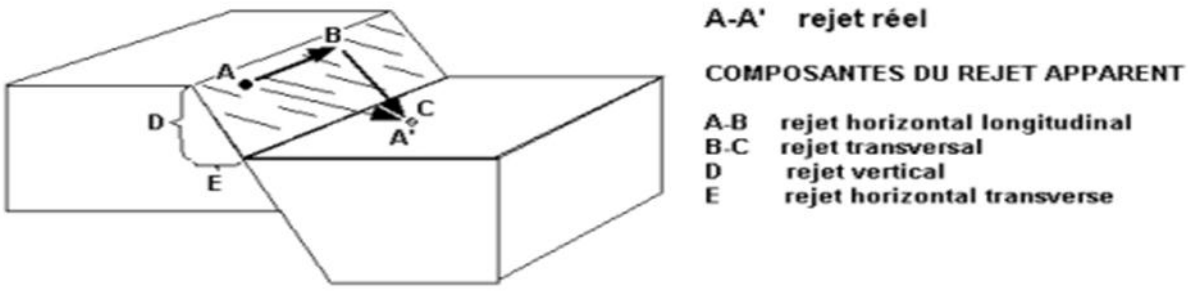


Figure 87: General appearance of breakable deformation

3.2.1. Definitions:

- A fault is a plane of rupture along which the two blocks of rock resulting from the fracture move relative to each other.

- This is due to the polishing of the rock by friction, which also leaves its mark in the form of parallel friction striations. The direction of relative movement of the blocks is known from the "little steps" of recrystallization that form during the play of the fault.

- The surface of rupture or slip is called the fault plane.

- Fault dimensions range from a few millimeters (microscopic) to hundreds of kilometers (tectonic plates).

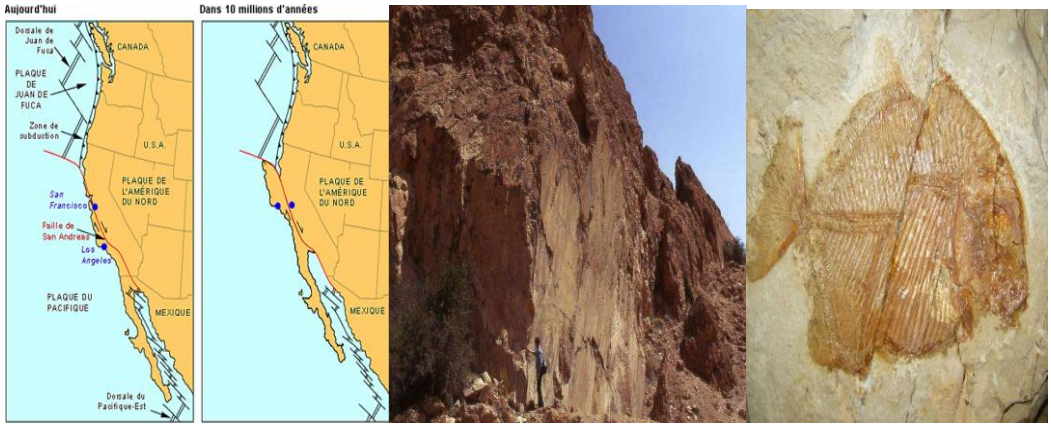


Figure 88: Different fault dimensions.

- Rock failure is due to the action of stresses. When the rock's capacity for resistance reaches its limit, it fractures.

- This is the result of "shearing", the effects of which are localized on a surface.

Note:

- Active faults are responsible for the majority of earthquakes.

- They can be distinguished as follows:

- Diaclases, which are breaks with no visible displacement.

- Flexures are abrupt changes in dip along a given surface, but without fracture.

- Depending on the orientation of the stresses, the resulting rock fractures reveal three types of fracture:

Normal fault,

Reverse fault

Striking fault

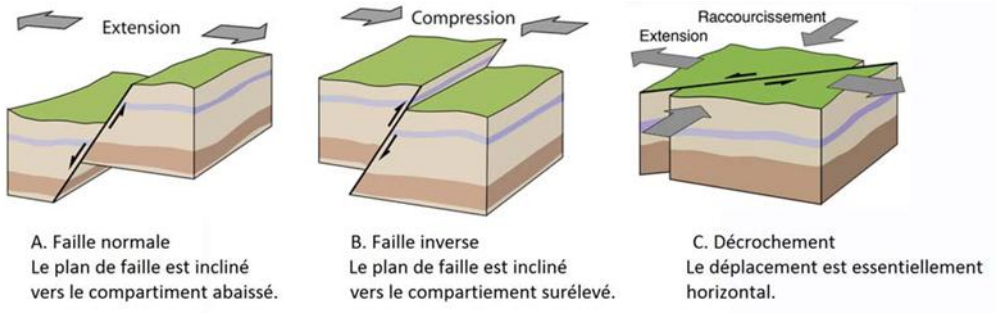


Figure 89: Three types of fault (Wikipedia).

3.2.2. Fault characteristics:

- Fault plane: surface along which displacement has taken place. It is also known as the fault mirror, which undergoes mechanical polishing, sometimes striated, depending on the direction of relative movement.

Figure 90: Fault structure.

It corresponds to an anomalous contact plane, which is represented by a thick line on a geological map. This plane is defined by its direction and dip, which are measured with a compass.

- Fault top: compartment above the fault plane.

Figure 91: Photo of a fault

- Fault wall: compartment below the fault plane.

- Rejection: The fault rejection measures the offset of the blocks in relation to each other. It is the distance separating two points on either side of the fault plane that were previously in contact.

Rejection is the relative displacement of a given reference layer in the vertical or horizontal direction.

- Dip: the angle between the fault plane and the horizontal.

- The lips of a fault: represent the extremities of each of the two blocks separated by the fault:

3.2.3. Different types of fault:

Depending on the type of relative movement, three types of fault are defined: from

Normal fault

Reverse fault

Stripping fault (sliding fault)

3.2.3.1. Normal (or extensional) faults:

A normal fault accompanies an extension; the compartment above the fault ("roof") descends relative to the compartment below the fault ("wall"). The fault plane is inclined towards the lowered compartment.

A set of normal faults can form structures called horsts and grabens.

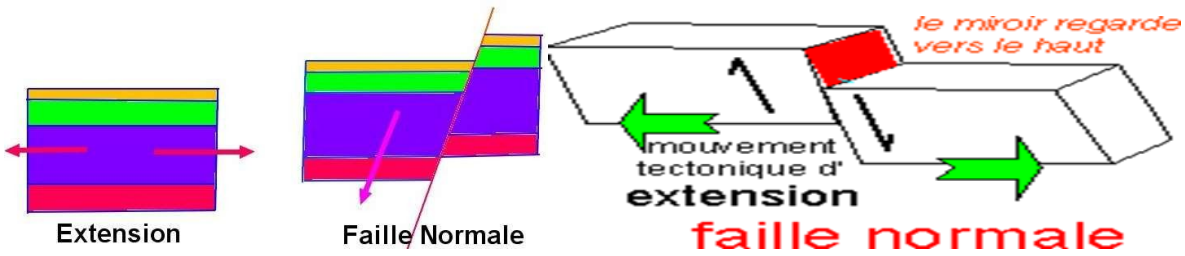


Figure 92: Normal fault

3.2.3.2. Reverse faults:

A reverse fault, or thrust fault, accompanies compression; the compartment above the fault ("roof") rises relative to the compartment below the fault ("wall"). The fault plane is then inclined towards the raised compartment and appears to dip below.

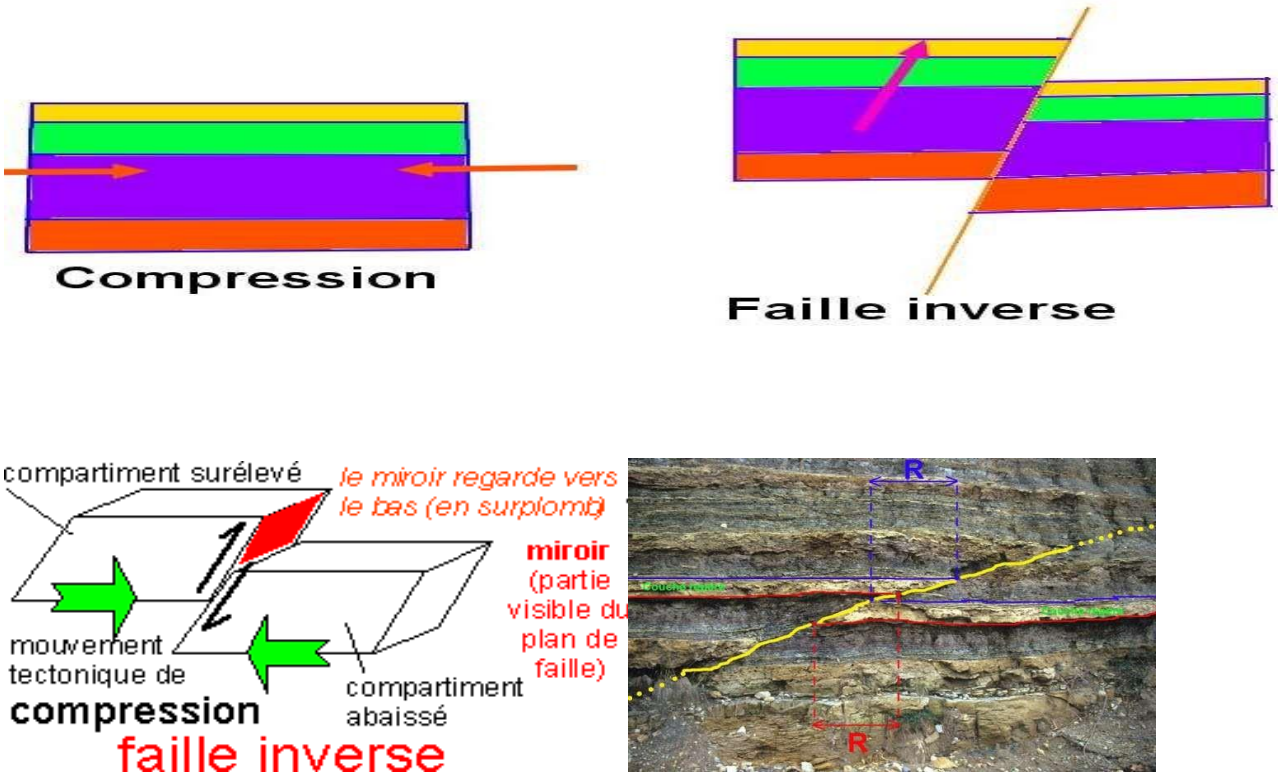


Figure 93: Reverse fault

One of the compartments will rise relative to the other, reducing the space created by compression.

3.2.3.3. Decrochement fault:

An offset accompanies an essentially horizontal sliding movement. They can be dextral or senestial, depending on whether the compartment opposite the observer is moving to the right or left (respectively).

The fracture surfaces of strike-slip faults are almost vertical and invisible.

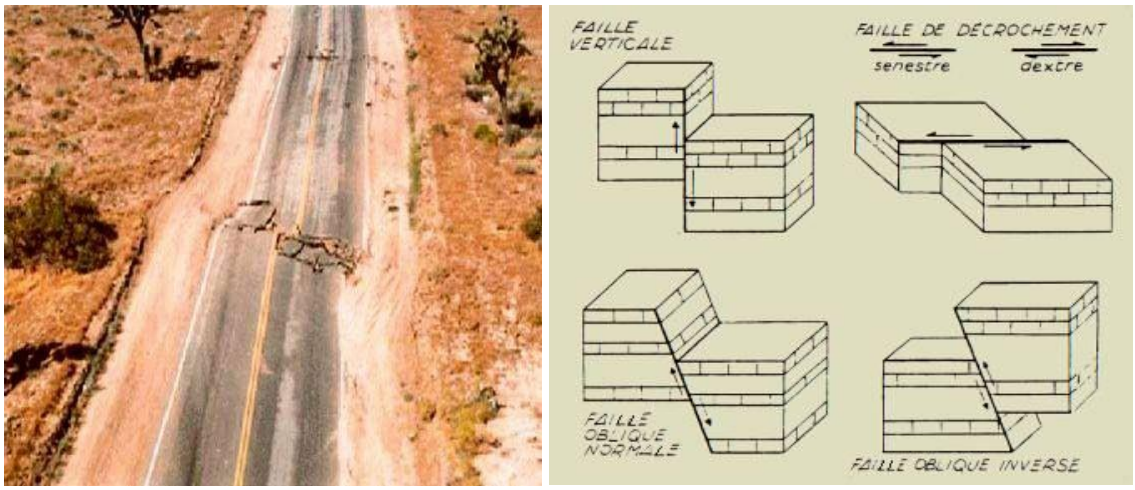
Figure 94: Strike - slip fault:

Other types of fault:

- The fault is vertical: if the horizontal rejection is zero.

- Conformal faults: their plane is inclined in the direction of the dip of the layers.

- Contrary (non-conforming) faults: if their plane is inclined in the opposite direction to the dip of the layers.



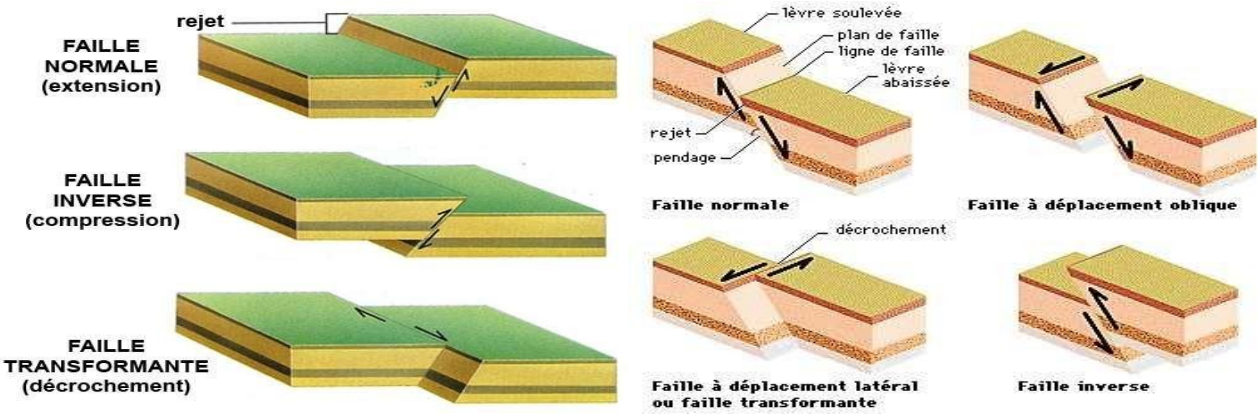


Figure 95: Different types of fault

3.2.4. Fault grouping:

Faults can be grouped together to form a fault field. The raised compartment between two lowered compartments is called a Horst or Mole, and the lowered compartment between two moles is called a Graben.

A graben is a collapse trough bounded by normal faults.

The term rift is used for grabens.

A horst comprises a series of fault-bounded, elevated compartments.

3.2.4.1. Graben structure:

Graben: tectonic structure formed by normal faults running in the same direction.

These faults delimit compartments that become lower and lower towards the middle of the structure.

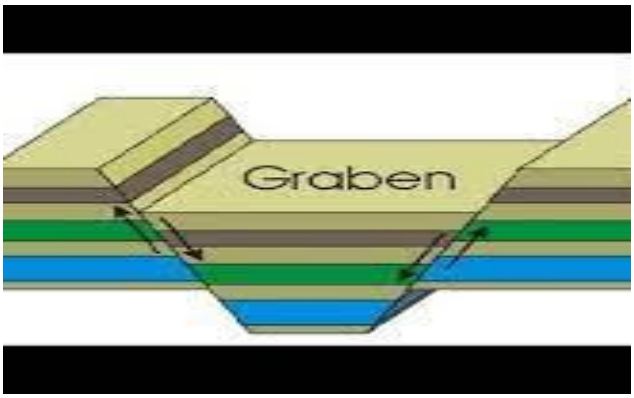


Figure 96: Graben structure

3.2.4.2. Horst structure:

Horst: tectonic structure formed by faults of the same direction.

These faults delimit compartments that become lower and lower as they move away from the middle of the structure.

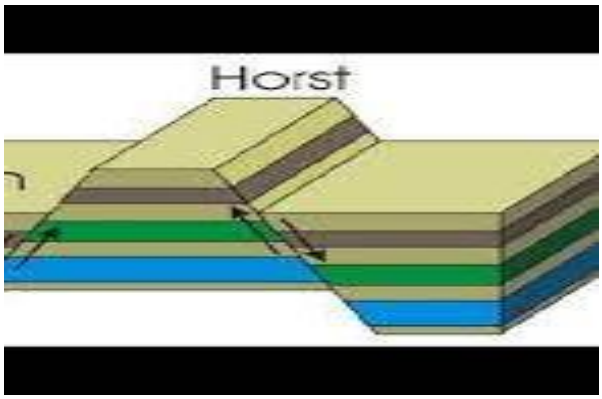


Figure 97: Horst structure

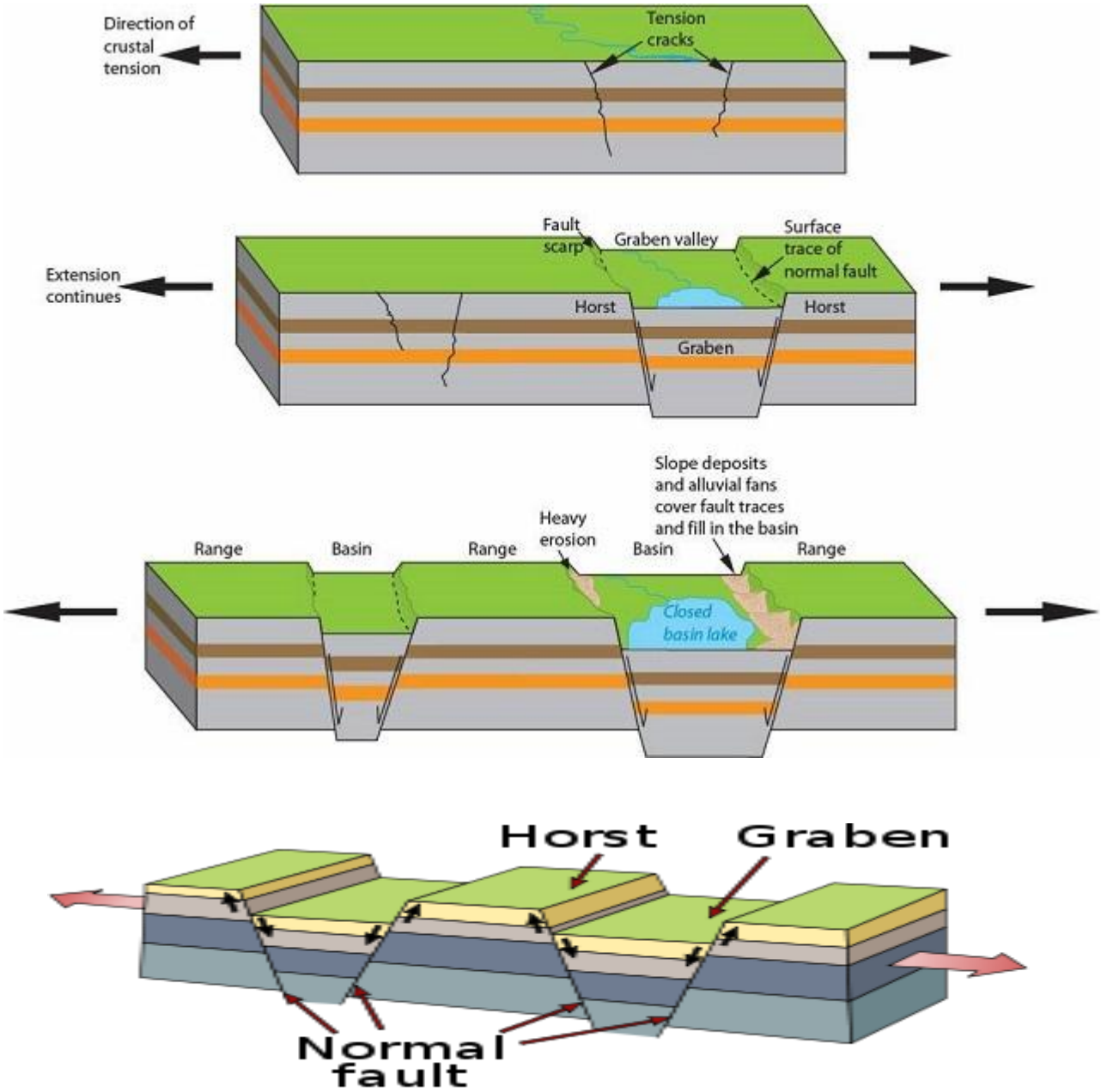


Figure 98: Diagram of a horst / graben structure (Wikipedia).

In geology, a graben (a term of German origin meaning "ditch") is a tectonic collapse ditch between normal faults. The compartment raised above the graben is called a "horst". A long graben or a series of grabens can produce a Rift Valley.

3.2.5. Relationship of faults to earthquakes and volcanoes:

The relationship between earthquakes and volcanoes is obvious: the internal fault fields of orogenic belts are the most seismic.

Volcanoes are closely linked to extensional fault fields in the crust of fissures, which bring the ground surface into contact with the superficial part of the mantle.