TOPIC: THE DEFORMATION OF ROCKS

1. DEFORMATION OF ROCKS

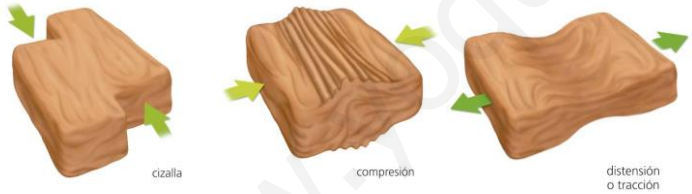
The deformation of the rocks results from the movements that occur in the earth's crust as a result of plate tectonics.
In the earth's crust the presence of deformed rocks (folded or fractured) is frequent, indicating that, at some point, they were subjected to intense forces. Rock deformations can be studied especially well in sedimentary rocks, because being arranged in layers or strata clearly reflect the changes they have undergone.

1.1. TYPES OF EFFORTS AND BEHAVIOR OF ROCKS

All material on which a force acts tends to deform first and if the effort is very intense or prolonged over time it can become fractured.

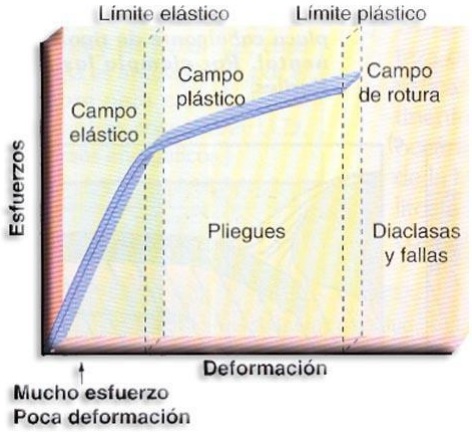
The stresses to which the rocks are subjected are determined by the relative movements between the tectonic plates. They may be:

- Compression when the forces that cause them are opposite and convergent.
- Of distension or traction when the forces are opposite and divergent
- Shear when forces are parallel, divergent or convergent



The deformation depends on the forces that act, the time they act and the behavior of the material on which they act. Materials may have a behavior:

- *Elastic:* if it deforms but when the forces cease it recovers its initial form
- *Plastic:* if it deforms but when the forces cease it does not recover its initial form and remains deformed
- *Fragile:* if it deforms breaking.



All materials subjected to stress tend to deform elastically, if the forces increase or persist, it behaves in a plastic way, but exceeding a threshold it fractures.

The behavior varies according to different factors:

- the pressure
- temperature
- time

Therefore fragile materials on the surface can behave like plastics in depth (with high temperature, pressure and in a long time). That is why it is possible that rocks as compact as limestones and quartzites are deformed.

2. THE FAULTS AND THEIR TYPES

En las deformaciones frágiles los materiales se fracturan. Hay dos tipos de fracturas:

– **Diaclases:** they are fractures of the rocks without displacement of the split blocks. They are an important element of the relief because erosion can progress through them. They can be produced by:
- Dehydration (for example clays)
- Cooling of a magma (for example spheroid or basalt columns)
- Decompression associated with plutonic rocks when erosion reduces the weight that deep materials support (for example granitic diaclassing). They can be orthogonal (and form towers) or spheroidal (forming domes).

– **Failures**: The failures are fractures of the rocks according to planes of weakness. They occur when the plastic deformation threshold of the materials has been exceeded. As a result, one block moves with respect to the other.

The movement of the blocks of a fault releases energy that propagates as seismic vibrations. The active faults are the places where the foci or hypocenter of earthquakes are located.

2.1. ELEMENTS OF A FAILURE

In the failures we can recognize the following elements:

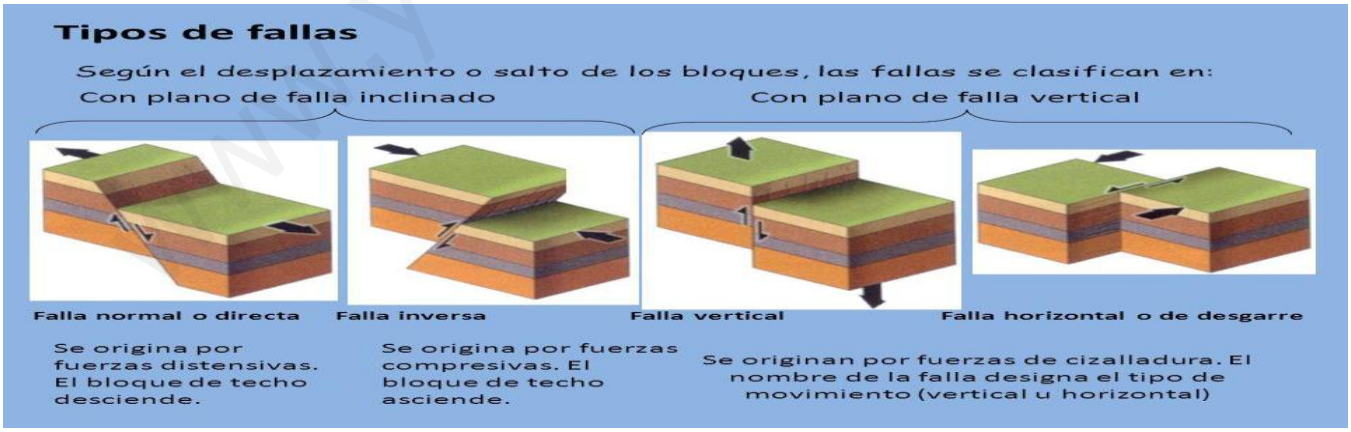
– **Fault plane**: it is the surface along which the displacement of the rocky blocks occurs
– On its surface you can recognize:
- *Failure mirror:* areas polished by the friction of the displaced blocks
- *Failure stretch marks:* parallel grooves that indicate the direction of movement of the blocks when a stronger element scratches on the fault plane.

– **Failure lips:** these are the blocks that have moved along the plane: According to the relative movement they have suffered, we can identify a block / lip raised and another block / lip sunk.
– **Escarpment or fault jump:** it is the displacement (measured in the vertical) that occurs between two points that were previously contiguous in the blocks.

2.2. TYPES OF FAILURES

The main types of failures are:

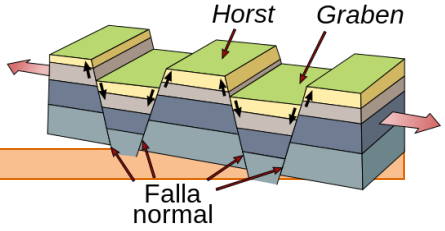
- DIRECT / NORMAL: originates by distension and in it one of the blocks sinks in favor of the fault plane. Your fault plane is inclined.
- REVERSE: originate by understanding and one of the blocks rises respect of the other against the plane of failure. Your fault plane is inclined.
- STRAIGHT / VERTICAL: those that have the vertical fault plane. One block sinks and the other rises.
- STEERING / WEAR: the fault lips move horizontally with respect to each other.



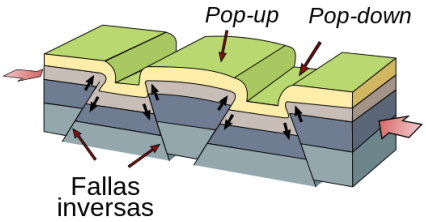
2.3. FAILURE COMBINATIONS. RELAYS ASSOCIATED WITH FAILURES

The failures are usually grouped together forming associations that raise some blocks and others sink them. They can be by efforts of two types:

- If the efforts are distensive they are formed by associations of normal failures:



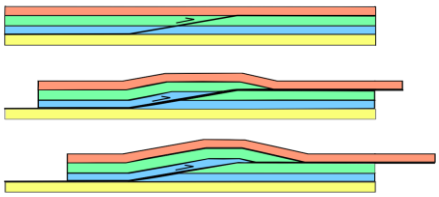
- TECTONIC PHOSES (GRABENS): they consist of a sunken block from which the other blocks rise more or less staggered.
- HECT TACTICIANS (HORST): it consists of a raised block from which the other blocks descend more or less staggered.

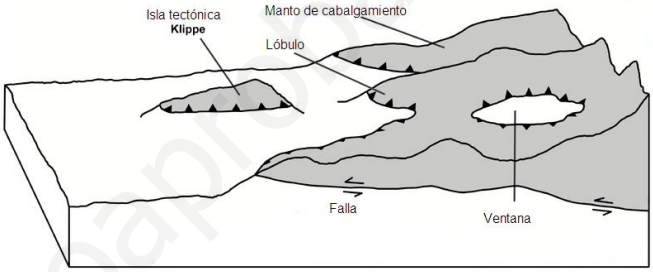


- If the efforts are compressive, associations of inverse failures are formed that generate:
  - Elevated blocks or POP-UP
  - Sunken blocks that generate POP-DOWN depressions.

When in the reverse faults the inclination of the fault plane is with very little inclination, almost horizontal, and the raised lip is mounted on the sunken there is a HORSE. The stratigraphic series is repeated in the riding. If the ride has kilometric dimensions, it is spoken of a HAND OF CORRECTION.

The following elements can be recognized in riding or blankets of bleed:
- **Klippe:** it is a part of the mantle that by erosion, has been separated from the mantle and on the stratigraphic series of the sunken lip.
- **Window:** it is the appearance of materials of the sunken lip inside the raised lip of a blanket of bleed due to erosion.
- **Front of the mantle:** is the line where the lip lifted in a mantle of bleed ends.



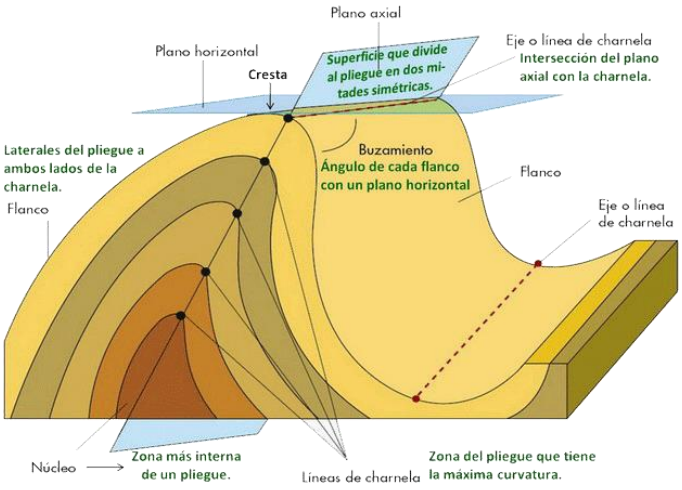


3. THE FOLDINGS AND THEIR TYPES

The folds are deformations of the rocks in a wavy way. They are caused by stress, usually compressive, slow and in conditions of high temperature, pressure. These conditions allow these deformations that correspond to a plastic behavior of the rocks to originate.

3.1. ELEMENTS OF A FOLD

In a fold we can recognize the following elements:
- **Hinge:** zone of greater curvature of the fold.
- **Hinge line:** line or fold axis: line that joins the points of greatest curvature of a fold surface.
- **Axial plane: plane that contains all the hinge lines and cuts the crease.**
- **Flanks:** halves in which it divides the axial plane to a fold.
- **Core:** most compressed and innermost part of the fold.
- **Crest:** highest area of a convex fold up.
- **Valley:** lower area of a concave fold up.



We can recognize the following angles:
- **Direction:** angle that forms the axis of the fold with the north-south geographical direction.
- **Diving:** angle formed by the surfaces of each flank with the horizontal (always taking the maximum slope for each point).

3.2. TYPES OF FOLDINGS

The main types of folds are:
- ANTI-LINES / ANTIFORMES: vault-shaped fold (convex up) in whose core are the oldest materials.

- SINCLINAL / SINFORME: cuvette-shaped fold (convex down) in whose core are the most modern materials.

According to the inclination of the axial plane we will talk about:

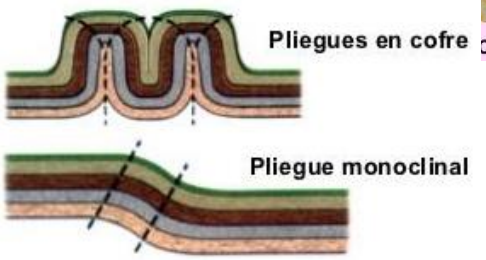
- Straight folds
- Slanted folds
- Folds lying or lying down

For its symmetry:

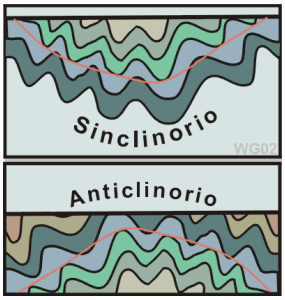
- Symmetrical
- Asymmetric

Other types of particular folds are:

- In “zig-zag”, accordion, chevron
- On knee
- In chest



3.3. COMBINATIONS OF FOLDINGS. RELIEFS ASSOCIATED WITH FOLDINGS



Folded reliefs are frequent where rocks have suffered compression.

When many folds are associated, the assembly can also present a deformation:

- ANTICLINORY: set of associated folds whose axial planes converge in depth (it is a fan-shaped association). The set is shaped like an anticline.
- SYNCINORY: set of associated folds whose axial planes converge upwards (above them). The set is shaped like a syncline.

When hard and soft rocks alternate, the first ones stand out in the relief when erosion has occurred. The following situations may occur:

- Conforming relief: in which the antiforms coincide with the highest areas and those that are deformed with the depressions of the terrain.
- Inverted relief: in which the reports coincide with the highest areas of the terrain.