Deformation of rocks

How Rocks Become Deformed

Rocks are deformed by: 
- folding and 
- faulting.

Deformation of rock involves changes in the shape and/or volume of these substances.

Changes in shape and volume occur when stress and strain causes rock to buckle and fracture or crumple into folds.
There are three types of tectonic forces or stresses that deform rocks:

• Compressional forces

• Tensional forces

• Shearing forces

Compressional forces

Compressional forces – squeeze and shorten bodies creating:
• anticlines,
• synclines and
• thrust faults.

Associated with convergent boundaries.
Tensional forces

Tensional forces – stretch a body and pull it apart, creating:
normal or extensional faults.

Associated with divergent boundaries where plates are moving apart.

Shearing forces

• Shearing forces – push two sides of a body in opposite directions causing
shearing zones in rocks and occurring at transform fault boundaries.
For plastic deformation of rock to occur a number of conditions must be met, including:

- The rock material must have the ability to deform under pressure and heat.
- The higher the temperature of the rock the more plastic it becomes.
- Pressure must not exceed the internal strength of the rock. If it does, fracturing occurs.
- Deformation must be applied slowly.

Fold

A fold can be defined as a bend in rock that is the response to compressional forces.

Folds are most visible in rocks that contain layering.
A number of different folds have been recognized and classified by geologists:

- Monocline
- Anticline
- Syncline

The simplest type of fold is called a **monocline**.

This fold involves a slight bend in otherwise parallel layers of rock.
An **anticline** is a convex up fold in rock that resembles an arch.

A **syncline** is a fold where the rock layers are warped downward.
Synclinal folds in bedrock, near Saint-Godard-de-Lejeune, Canada.

Folds can be classified based on their appearance.

- Symmetrical Folds
- Asymmetrical Folds
- Isoclinal Folds
- Overturned Folds
- Recumbent Folds
- Chevron Folds
Faults

- Faults form in rocks when the stresses overcome the internal strength of the rock resulting in a fracture.

Faults occur from both:

- tensional (shearing) and
- compressional forces.

Location of some of the major faults on the Earth. Note that many of these faults are in mountainous regions.
**Hanging wall and Footwall**

For any inclined fault plane:
- the block **above the fault** is the **hanging wall** block
- the block **below the fault** is the **footwall** block.

![Diagram of hanging wall and footwall](image)

**Different kinds of faults:**
These faults are named according to the **type of stress** that acts on the rock and by the **nature of the movement** of the rock blocks either side of the fault plane.

- Normal fault
- Reverse fault
- Thrust fault
- Strike-slip fault
**Normal Faults**

- are faults that result from horizontal tensional stresses in brittle rocks.
- the hanging-wall block moves down relative to the footwall block.
Normal fault

Grabens AND Horsts
- the down-dropped blocks form grabens
  - the grabens may form rift valleys: (The East African Rift Valley)
the uplifted blocks form horsts.
– may form linear mountain ranges.
Ex: The basin and range province of the western U.S. (Nevada, Utah, and Idaho).

Reverse Faults
are faults that result from horizontal compressional stresses in brittle rocks, where the hanging-wall block has moved up relative the footwall block.
Reverse Faults

A Thrust Fault

- A Thrust Fault is a special case of a reverse fault where the dip of the fault is less than 15° and
- can result in older strata overlying younger strata.

![Diagram of a Thrust Fault](image)
**Strike Slip Faults**

- relative motion on the fault has taken place *along a horizontal direction*.
- result from shear stresses acting in the crust.

**Two varieties, depending on the sense of displacement:**

- If the block on the other side has moved to the left, - the fault is a **left-lateral strike-slip** fault
- If the block on the other side has moved to the right, a **right-lateral** strike-slip fault.
• The famous San Andreas Fault in California is an example of a right-lateral strike-slip fault.

• Displacements on the San Andreas fault are estimated at over 600 km.