

DEFORMATION

Tectonic forces operating inside the Earth causes rocks to undergo **deformation**. It is a process in which rocks change in shape, size, location, tilt or break due to squeezing, stretching or shearing. It is the dominant process in the formation of mountain belts.

STRESS – a force applied per unit area.

PRESSURE – forces act uniformly from all directions it forms a uniform stress, also known as pressure.

TWO KINDS OF STRESS

- **UNIFORM STRESS** – a type of stress that has uniform or same type of stress/pressure on all sides
- **DIFFERENTIAL STRESS** – a type of stress that have different stress or pressures on different sides

FOUR (4) TYPES OF STRESS

- **TENSIONAL STRESS** – occurs when the dominant force is directed (pulling) away from each other. It stretches the rocks, causing as elongation parallel to the direction of stress and shortening perpendicular to direction of stress.
- **COMPRESSIONAL STRESS** – is formed when the dominant force is directed towards each other. It squeezes the rocks, causing shortening parallel to the direction of stress and elongation perpendicular to the stress direction.
- **SHEAR STRESS** – develops when the two dominant forces are directed towards each other but not along the same axis. It results to slippage and translation.
- **CONFINING STRESS** – a type of stress where there is uniform stress on all sides that causes the rock to be squeezed.



STRAIN – refers to the resulting change in rocks due to subjection to different types of stress.

There are different kinds of strain. An object can become longer by stretching and it can be shorter through shortening or contraction.

Shear strain occurs when the change in shape involves movement in one part of an object relative to its other parts, such that there is change in angles between features.

Elastic strain is when rocks can also temporarily change shape when subjected to stress but can change back to its original form when the stress is removed.

THREE STAGES OF DEFORMATION

1. **ELASTIC DEFORMATION** – the strain is temporary and reversible. The rock can return nearly its original size & shape when the stress is removed.
2. **DUCTILE DEFORMATION** – the strain is irreversible and is permanently deformed.
3. **FRACTURE** – the deformation is permanent leading to material breaks.

BRITTLE MATERIALS – have small region of ductile behavior before fracture but could have small or large region of elastic behavior.

DUCTILE MATERIALS – have large region of ductile behavior prior to the stress but only small region of elastic behavior.

At a depth of about 15 km below the surface, the rocks deformed in a ductile manner due to increasing temperature and pressure. This is called the **BRITTLE-DUCTILE TRANSITION**. Earthquakes occur only above this zone.

Deformation mostly happens deep within Earth, and the products are only revealed when the rocks are exposed due to erosion. The branch of geology concerned with the study of rock deformation is called **STRUCTURAL GEOLOGY**.

STRUCTURES PRODUCED BY DEFORMATION

Most of the structures resulting from deformation are planar structures and their orientation can be described based on how they are positioned with respect to a horizontal plane.

STRIKE is the compass direction (reckoned from the North) of the line formed by the intersection of an inclined plane and the horizontal plane.

DIP is the angle between the inclined plane and the horizontal plane. The direction of dip is perpendicular to the strike.

JOINTS are natural cracks in the rocks produced by brittle deformation. The rocks on both sides of a joint do not slide past each other.

FAULTS are also planar structures resulting from brittle deformation, but there is sliding between the rocks.

- **Active Fault** – A fault wherein there is sliding in recent geologic times.

Faults are classified based on the movement of the rocks with respect to one another. In an *inclined fault*, the block of rock on top of the fault is called **hanging wall** while the block below is called **footwall**.

TYPES OF FAULTS

- **NORMAL FAULT** – When the hanging wall moves down with respect to the footwall
- **REVERSE FAULT** – If the hanging wall moves up.
- **STRIKE-SLIP FAULT** – the blocks slide past each other.

A reverse fault with an inclination below 35° is called a **THRUST FAULT**. These faults are also classified as *dip-slip fault*.

When a block on the opposite side of the fault moves towards the right, it is called right-lateral strike-slip fault. When the block opposite the fault moves to the left, it is referred to as left-lateral strike-slip fault. If the movement of the blocks along the fault plane is diagonal, it is an oblique slip fault.

FOLDS – are produced by deformation of ductile materials. Folds are contortions of rock layers forming wave-like curves.

- **HINGE LINE/FOLD AXIS** – is the part of the fold where the curvature is greatest.
- **LIMBS** – are the sides of the folds with least curvature.
- **AXIAL PLANE** – contains fold axis of each folded layer.
- **ANTICLINE** – the limbs of the folds are inclined away from the hinge forming an arch-like shape.
- **SYNCLINE** – the limbs are inclined toward the hinge, forming a trough-like shape
- **MONOCLINE** – is a bend in a generally flat-lying rock layer.
- **OVERTURNED** – the axial plane is inclined and one limb is steeper than the other

MOUNTAIN BUILDING

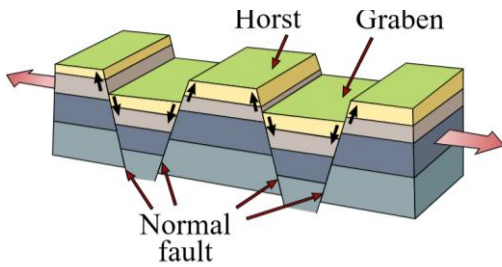
UPLIFT – The process by which the Earth's surface moves from a lower elevation to a higher elevation.

OROGENESIS – the process of mountain building. *Continental lithosphere* has lower density and floats over the higher density mantle rocks in the asthenosphere. *Continental collision* results into a mountain belt with thick continental crust.

A continental crust is typically **35 km to 40 km** thick but beneath mountain belts, it can reach a thickness of **50 km to 70 km**.

HORSTS – are **elevated landforms**, comprising the mountains and are bounded by normal faults that are inclined in opposite directions.

GRABENS – these are the lower landforms and are **valleys filled with sediments** and bounded by normal faults inclined toward each other.



ISOSTASY – refers to the **adjustment to maintain buoyancy**, when a very old mountain belts are eroded, the continental lithosphere, including the crustal root, slowly rises to compensate for the removal of mass.

“Do not fear: I am with you;
do not be anxious: I am your God.
I will strengthen you, I will help you,
I will uphold you with my victorious right hand.”

Isaiah 41:10