
Topic: Concept of Earth's Movement: Folds and Faults

**B.A HONOURS IN GEOGRAPHY: 1ST SEMESTER
C-1: GEOMORPHOLOGY**

Mr. Sahidul Karim

Assistant Professor, Department of Geography
Acharya Brojendra Nath Seal College, Cooch Behar,
West Bengal - 736101

FOLD

- Meaning of Fold
- Parts of a Fold
- Classification of Fold
- Fold Systems.

FAULT

- Meaning of Fault
 - Parts of a Fault
 - Classification of Fault
 - Evidence of Faulting
-

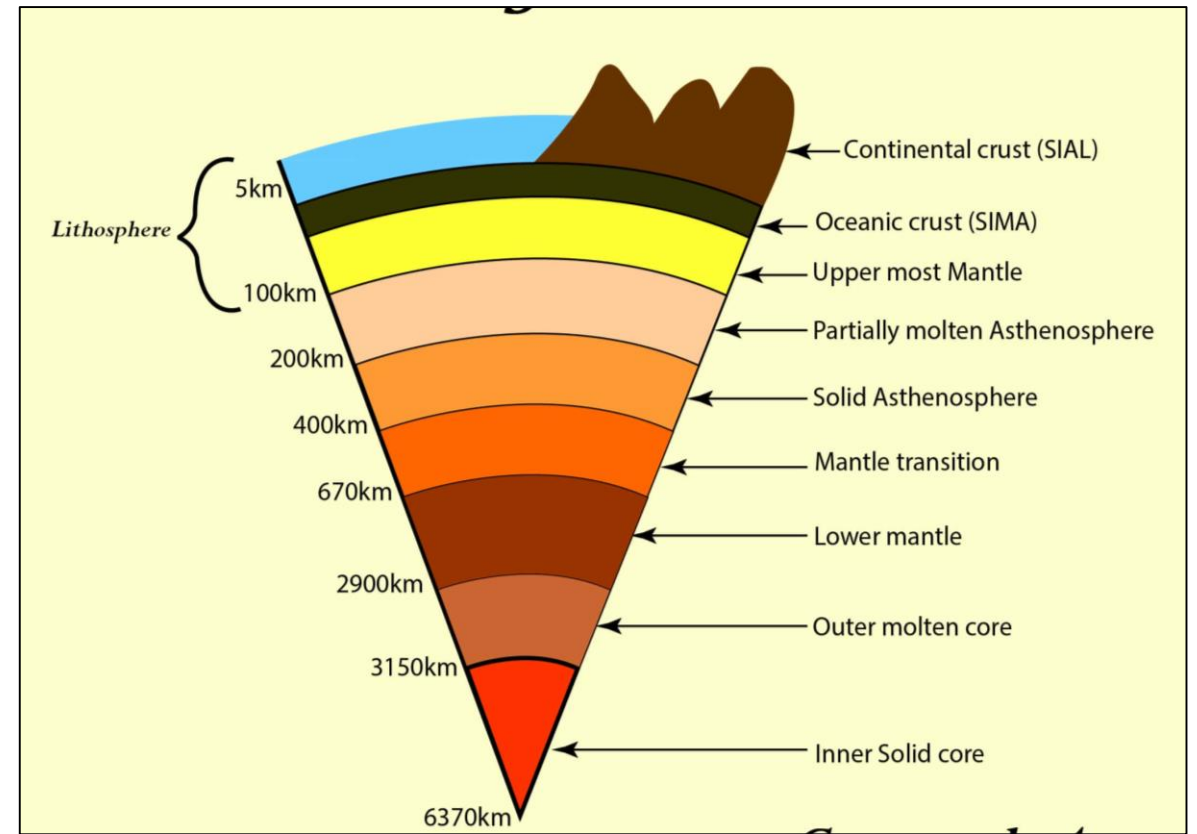
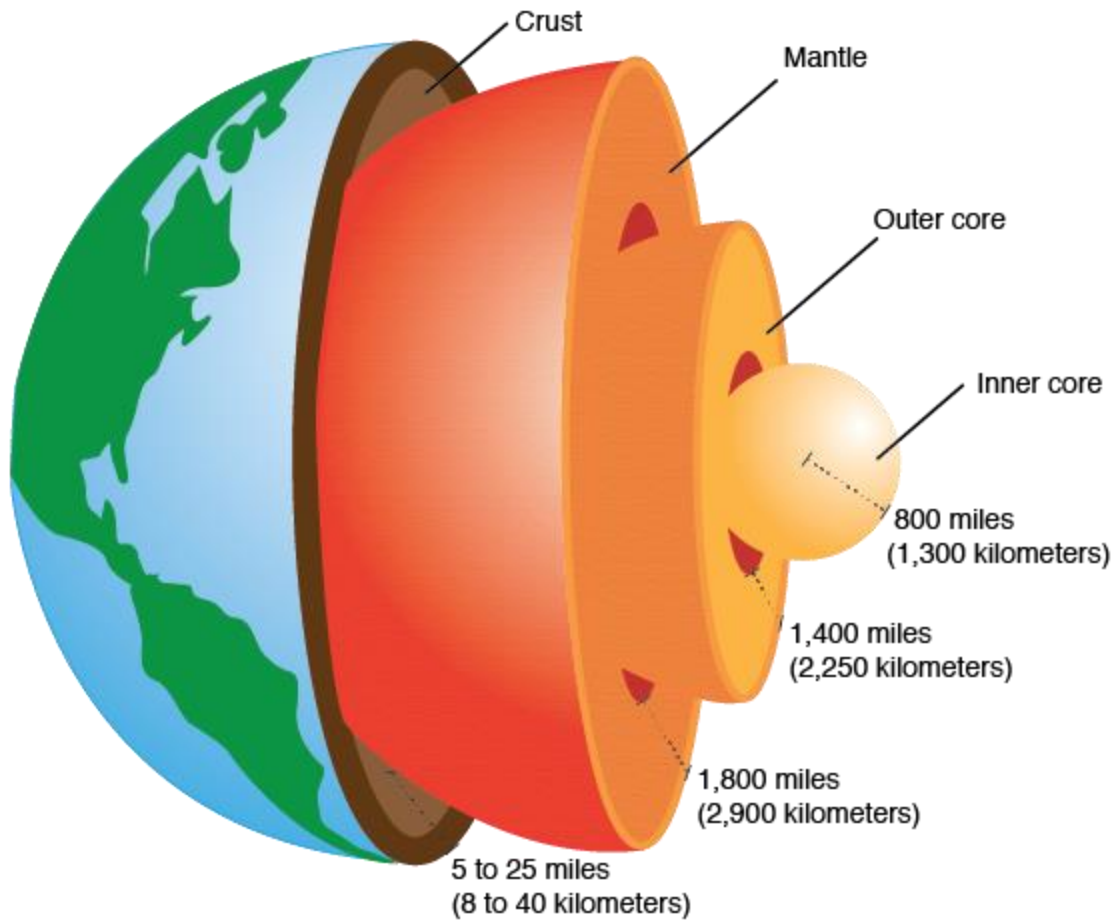
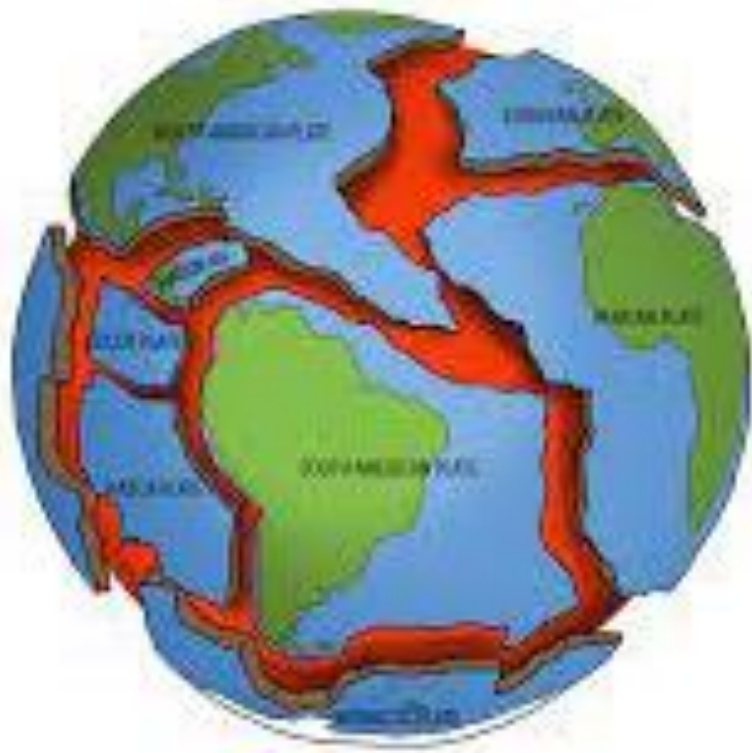
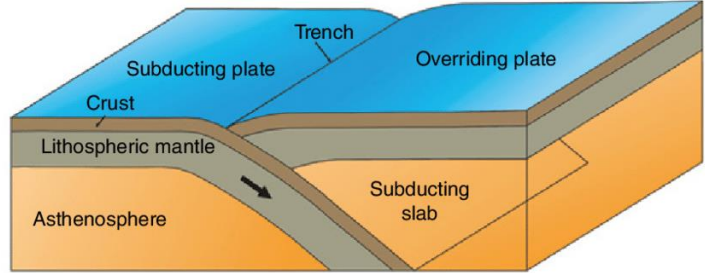


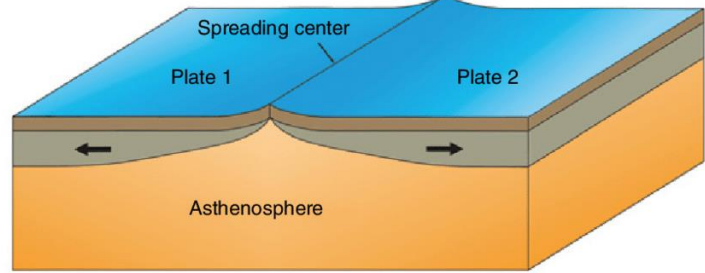
Fig: The internal structure of Earth



Convergent plate boundary: subduction zone



Divergent plate boundary



Transform plate boundary

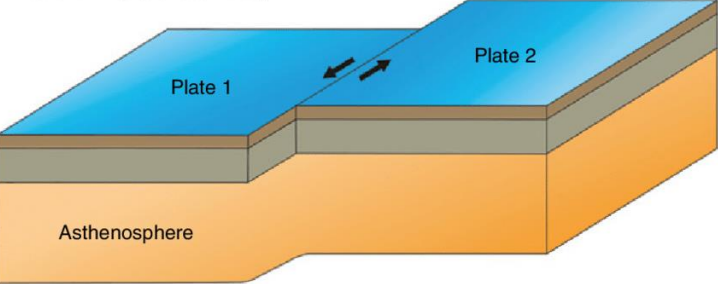


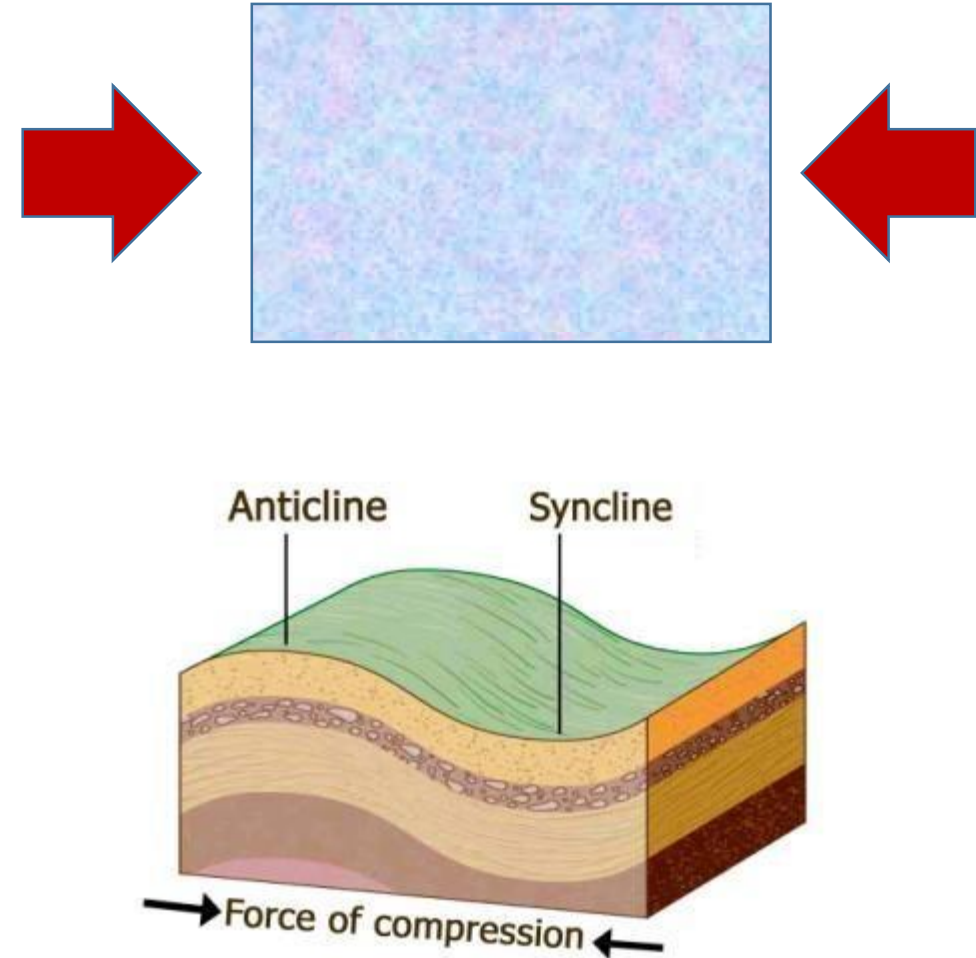
Fig: Structure of lithospheric plates

FOLD

Meaning of Folds:

Flexible deformation of a layered rock forms bends or warps called folds. Folding is caused due to compressive stresses. When a layered rock folds, it crinkles similar to bunched up fabric. Folds generally occur at great depths in the earth's crust where the rock layers are exposed to high temperatures and pressures.

When these rocks are compressed by convergent plate movements they respond plastically by crumpling or folding. In many cases folds occur in series. They generally cover great lengths as well as breadths. A fold in some cases may also be a single local bend.





□ Geometric description of folds

Axis

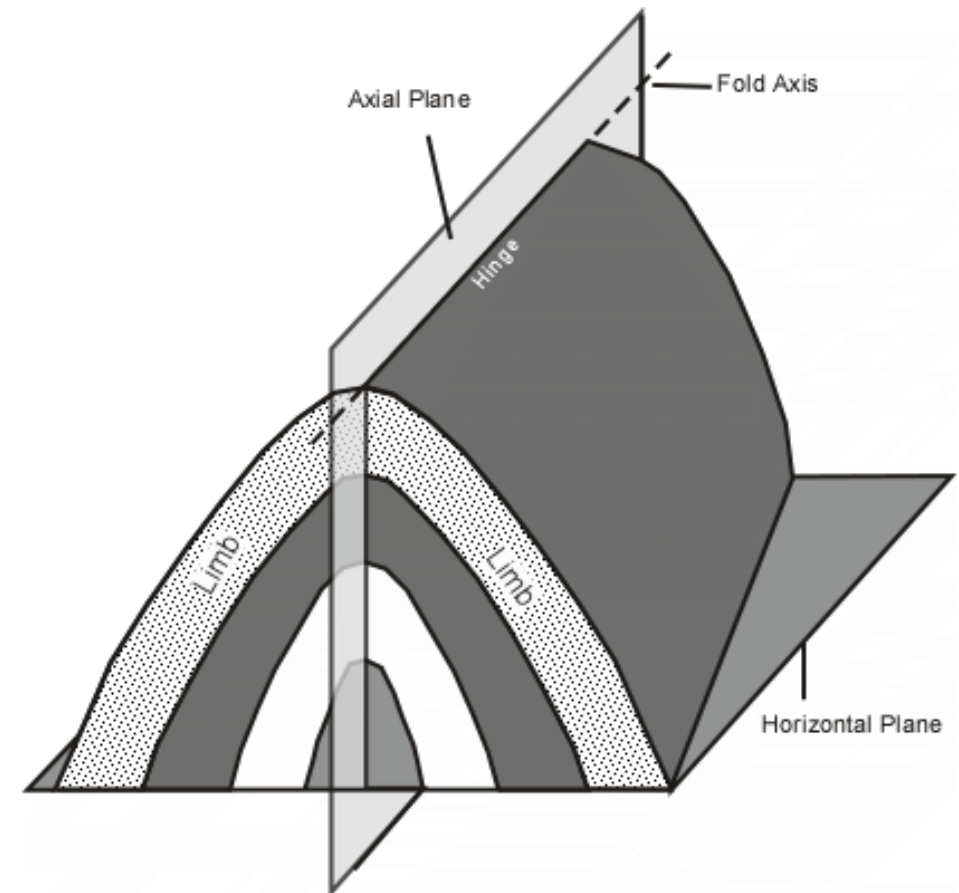
This is the median line about which the strata has folded. The axis of a fold may be horizontal, inclined or vertical. If the axis of the fold is horizontal then it is parallel to the strike of the fold.

Axial Plane

This is a plane dividing the fold into two somewhat symmetrical parts. The axial plane may be vertical, inclined or horizontal. The line of intersection of the axial plane with any bedding plane is called the fold axis or the axial line.

Limbs of a Fold

Two sides of a fold (on either side of the axial plane) are called the limbs of the fold. In the usual cases the limbs are inclined. However in particular cases they may be vertical or horizontal. The limbs may dip either way from each other or towards each other. The angle between the limbs is called the inter-limb angle.



FOLD

Crest and Trough

Crest is the upper portion of an up-fold and Trough is the lower portion of a down-fold.

Wavelength

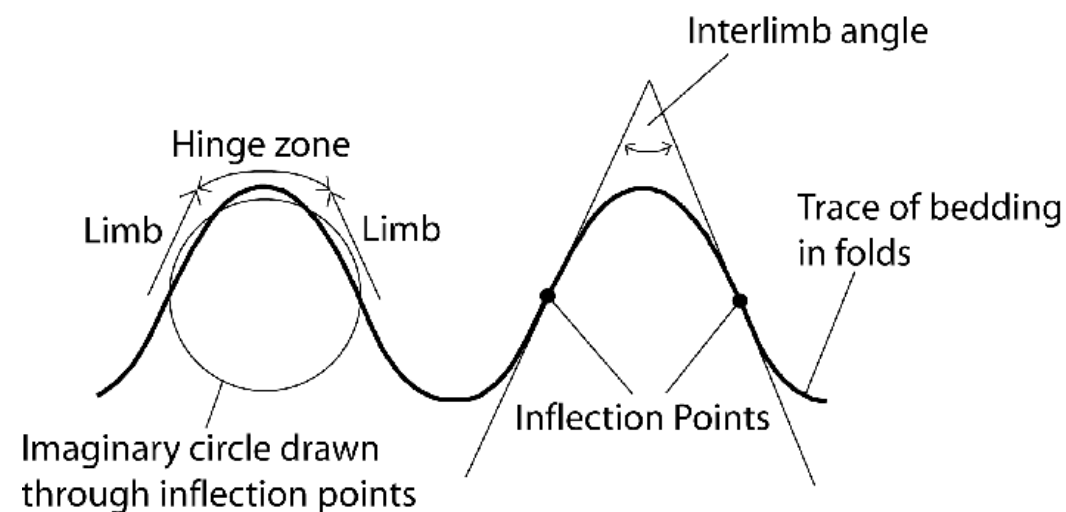
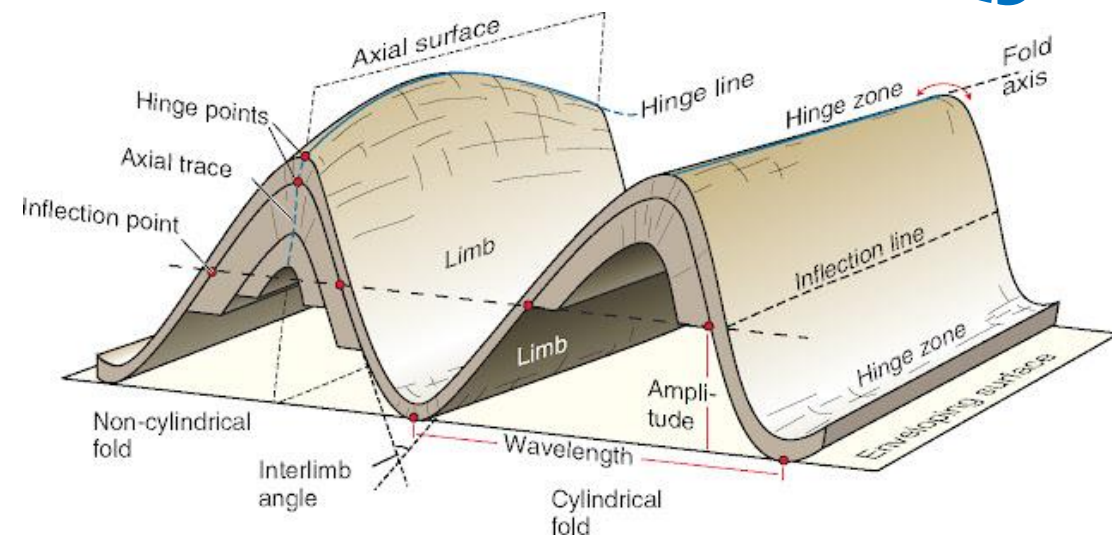
This is the distance between successive crests or troughs of the fold.

Hinge Point and Hinge Line

The point of maximum curvature of a folded layer is called the hinge point. folds are made up of a hinge that connects two differently oriented limbs. The hinge may be sharp and abrupt, but more commonly the curvature of the hinge is gradual, and a hinge zone is formed. Hinge points are connected in three dimensions by a hinge line. The hinge line is commonly found to be curved, but where it appears as a straight line it is called the fold axis.

Inflection Point

The inflection point of a fold is the point on a limb at which the concavity reverses; on regular folds, this is the midpoint of the limb



Classification of Fold

Anticline and Syncline

An anticline is a structure where the limbs dip down and away from the hinge zone, whereas a syncline is the opposite, trough-like shape. In case of anticline the rock layers get younger away from the axial surface of the fold whereas in syncline layers get younger toward the axial surface.

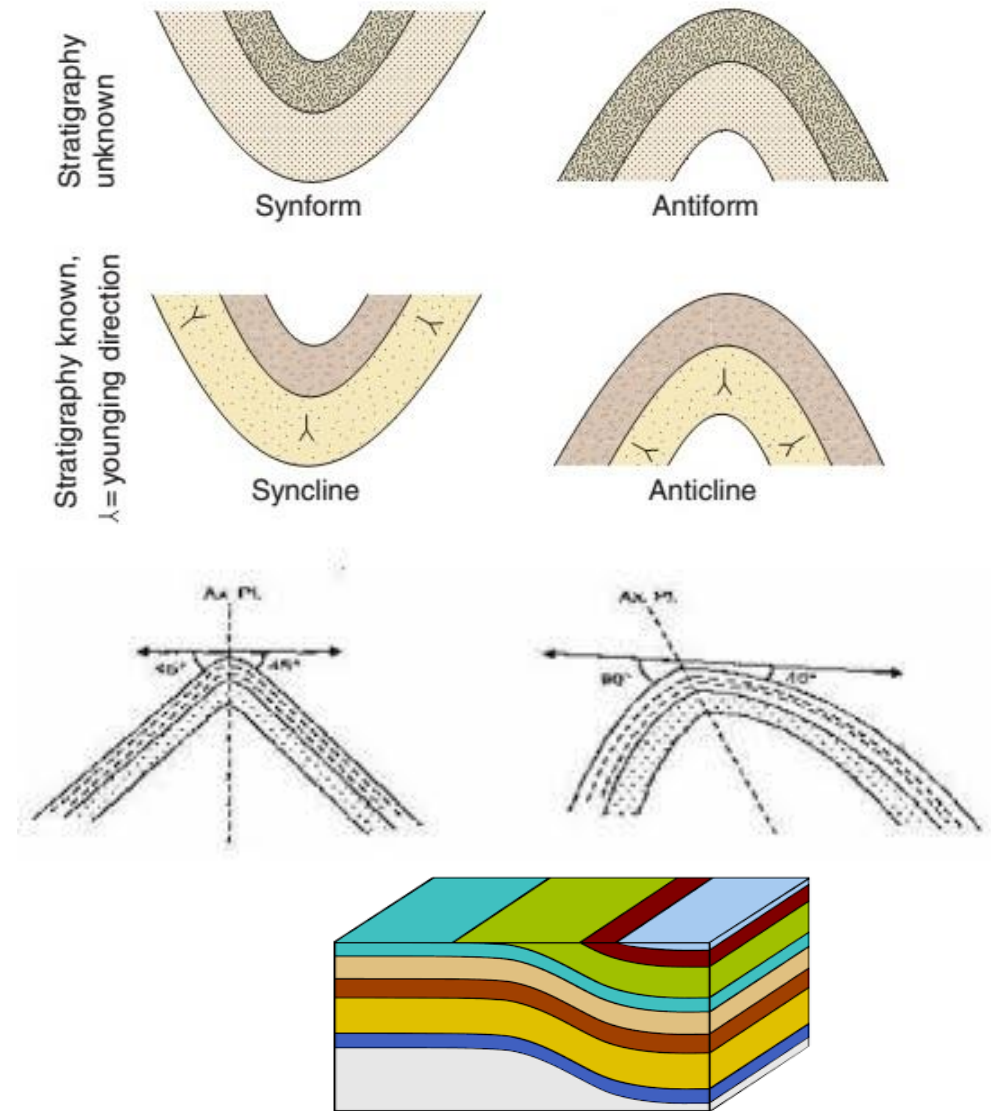
When the direction of rock layer/stratigraphy is unknown such formation is known as Antiform and Synform.

Symmetrical Fold and Asymmetrical Fold

A symmetrical fold is a fold whose axial plane is vertical and the limbs dip equally. The axial plane in this case divides the fold into two equal halves. If the two limbs dip at different angles the fold is an Asymmetrical fold.

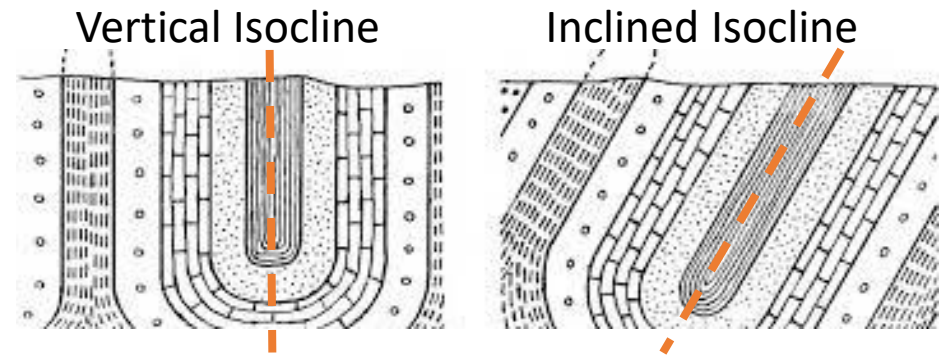
Monocline Fold

Fold in which only one limb is bent. This is a case when a rock-bed bends abruptly and resumes the original attitude at the lower level.



Isocline Fold

This is a fold whose limbs dip at the same angle in the same direction. The two limbs in this case are parallel. The axial plane may be vertical, inclined or horizontal.



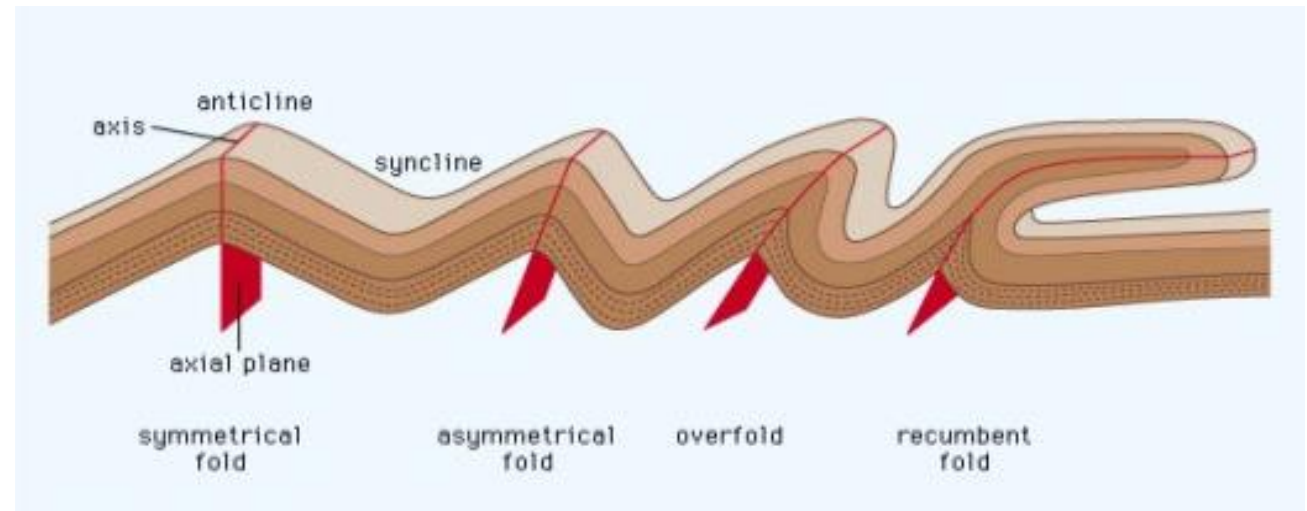
FOLD

Overtaken Fold

These are folds with inclined axial planes in which both the limbs are dipping essentially in the same general direction. The amount of dip of the two limbs may or may not be the same. Over folding indicates very severe degree of folding. One of the two limbs (which are termed the reversed limb) comes to occupy the present position after having suffered a rotation through more than 90 degrees. The other limb is known as the normal limb.

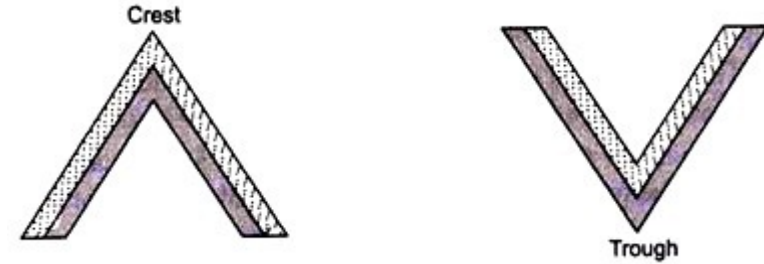
Recumbent Folds:

These may be described as extreme types of overturned folds in which the axial plane acquires an almost horizontal attitude. In such folds, one limb comes to lie exactly under the other limb so that a drill hole dug at the surface in the upper limb passes through the lower limb also. The lower limb is often called the inverted limb or the reversed limb.



Chevron Folds

These are characterized with well-defined, sharp hinge points and straight planar limbs. Sharp angular crest or trough is normally found.

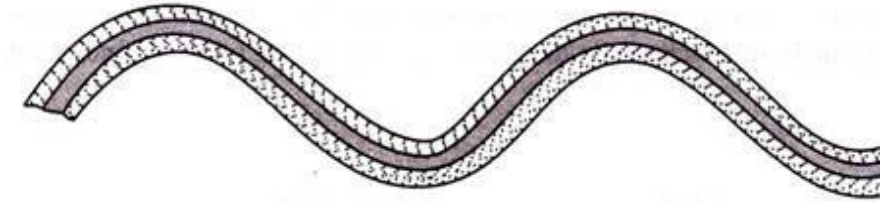


Different Fold Systems:

A rock strata is unlikely to form a single fold. In most cases it forms a series or a group of folds. Such a series of folds brought about by the same earth movement extending to great distances is called a fold system.

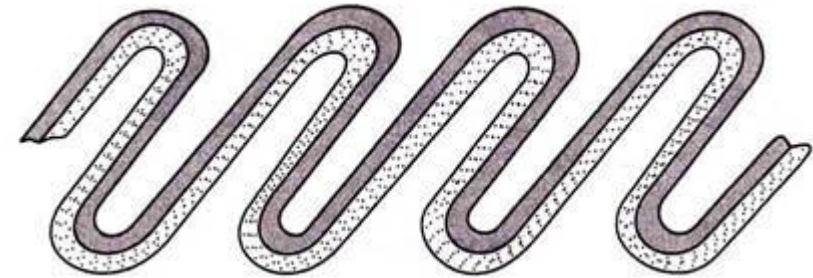
Non-plunging Fold System

A fold system consisting of a number of symmetrical anticlines and synclines, with their axes horizontal and parallel is called a non-plunging fold system.



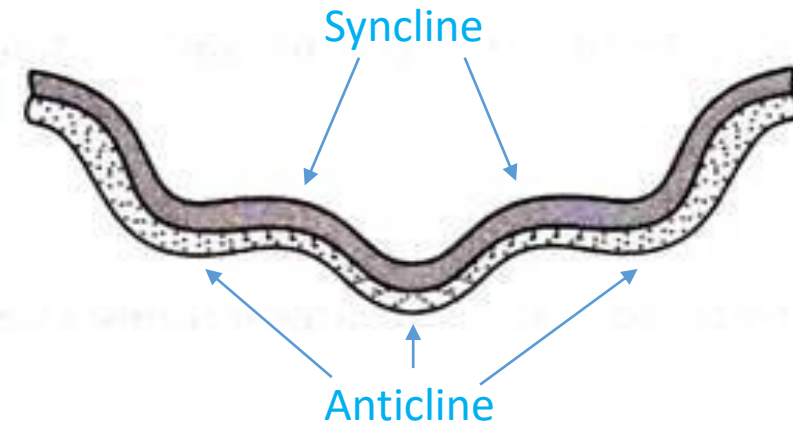
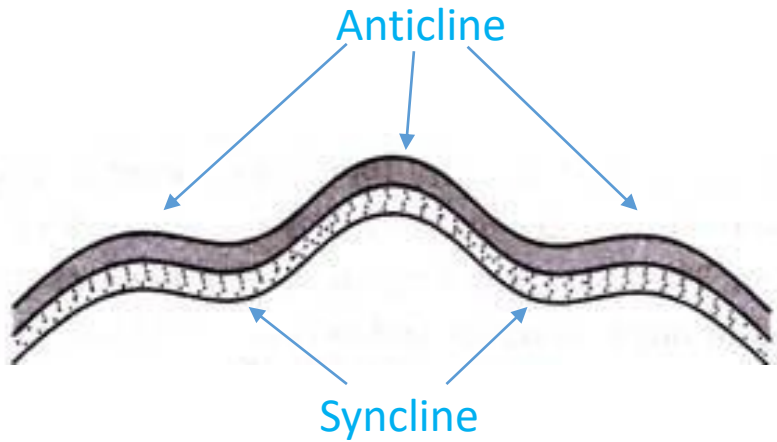
Plunging Fold System

This is a fold system with plunging anticlines and synclines. The limbs of the folds dip in one direction.



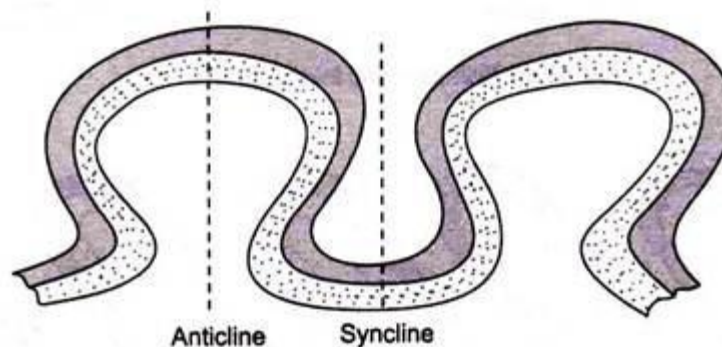
Anticlinorium and Synclinorium

This is a system of anticlines and synclines which are all arched up into a major up-fold and arched down into a major down-fold.



Fan Fold:

This is a system of folds consisting of anticlines and synclines but with limbs having contrasting features. In this case the limbs of anticlines dip towards each other and the limbs of synclines dip away from each other.



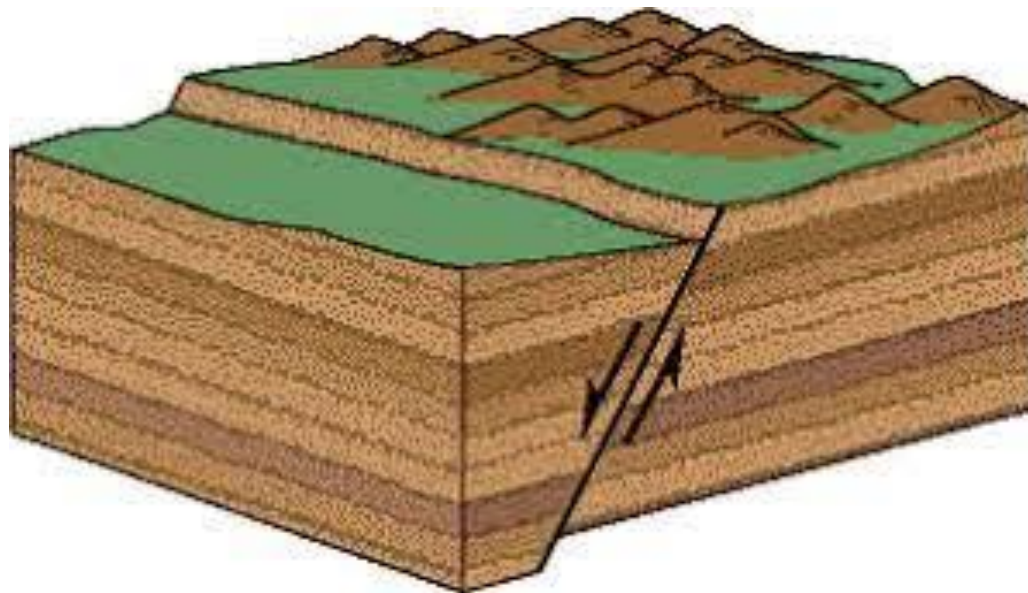
Identification of folds



What is Fault?

A fault is a fracture or zone of fractures between two blocks of rock. Faults allow the blocks to move relative to each other. This movement may occur rapidly, in the form of an earthquake - or may occur slowly, in the form of creep. Both the compressional and tensional forces work for the formation of fault.

Faults may range in length from a few millimeters to thousands of kilometers. Most faults produce repeated displacements over geologic time. During an earthquake, the rock on one side of the fault suddenly slips with respect to the other. The fault surface can be horizontal or vertical or some arbitrary angle in between.





Different parts of Fault

Fault plane:

A plane along which the rupture has actually taken place or where one block is moved with respect to other is known as 'Fault Plane'. It may be noted that such a plane is generally formed along the line of least resistance.

Hanging wall and Footwall:

The upper block or, in other words, the block above the fault plane is called 'Hanging wall'. The block below the fault plane or, in other words, beneath the fault plane is called the Footwall.

Hade:

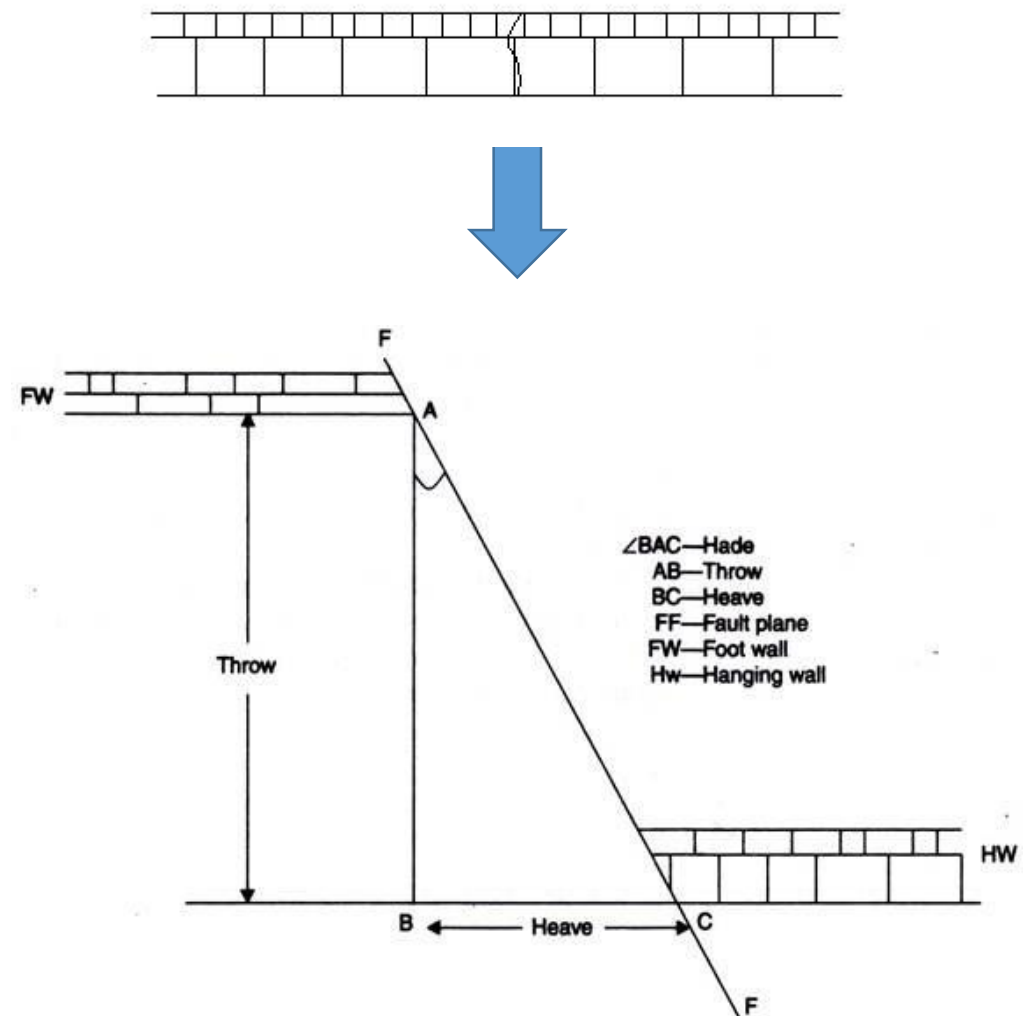
It is the inclination of the fault plane that is vertical.

Throw:

It is the vertical displacement between the Hanging wall and Footwall.

Heave:

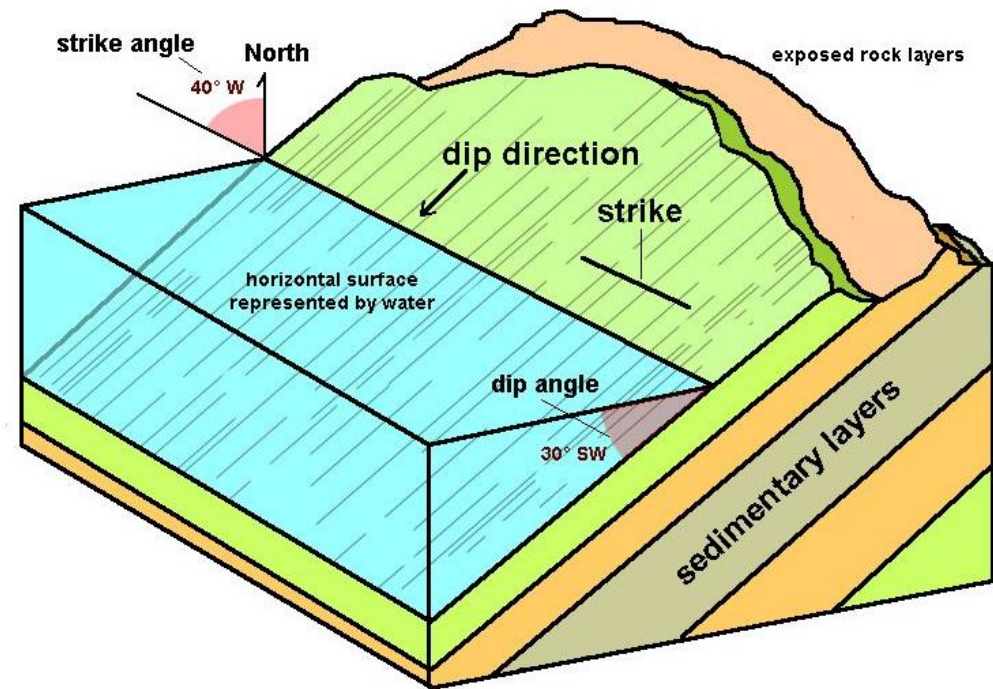
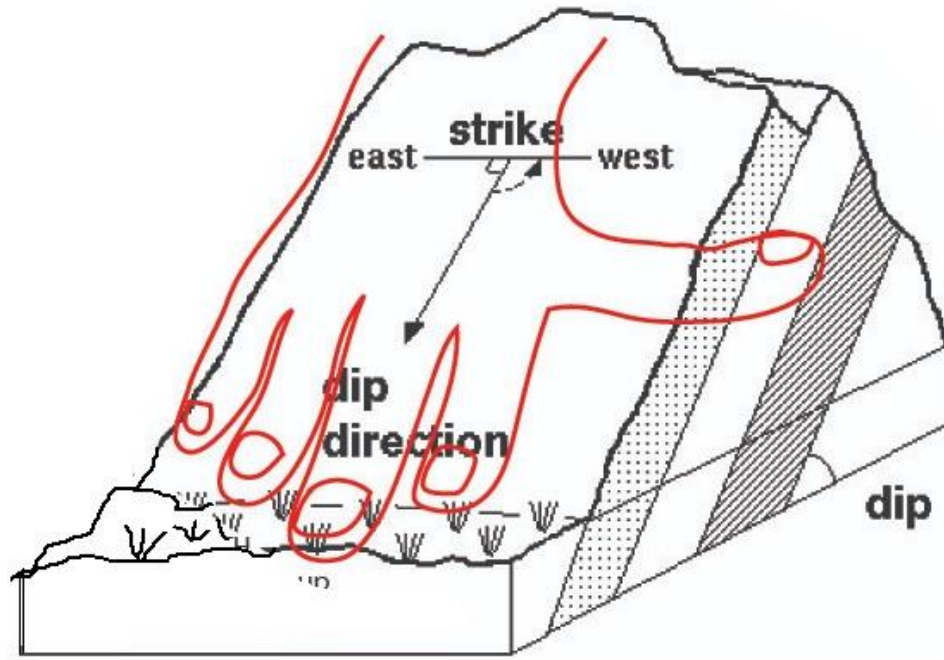
It is the horizontal displacement between the Hanging wall and Footwall.



Strike and Dip

Any fault plane can be completely described with two measurements: its strike and its dip. The **strike** is the direction of the fault trace on the Earth's surface. The **dip** is the measurement of how steeply the fault plane slopes.

For example, if you dropped a marble on the fault plane, it would roll exactly down the direction of dip.



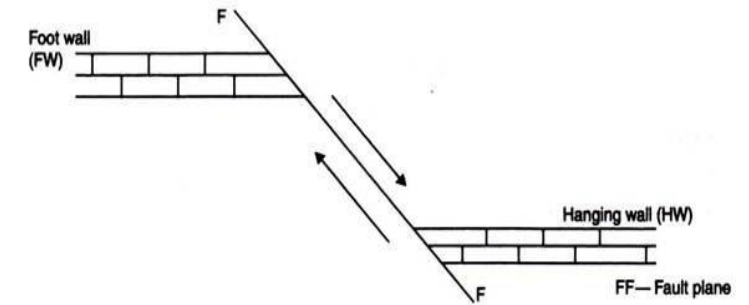
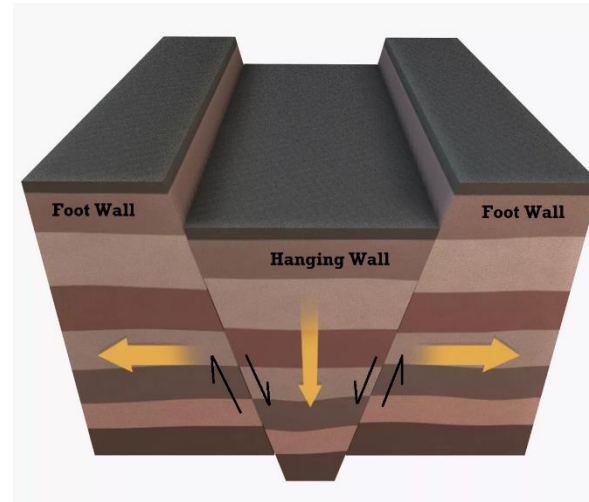
Types of Fault

Normal faults

It forms when the hanging wall drops down in relation to the footwall. Extensional forces, those that pull the plates apart, and gravity are the forces that create normal faults. They are most common at divergent boundaries.

These faults are "normal" because they follow the gravitational pull of the fault plane, not because they are the most common type.

The Sierra Nevada of California and the East African Rift are two examples of normal fault.

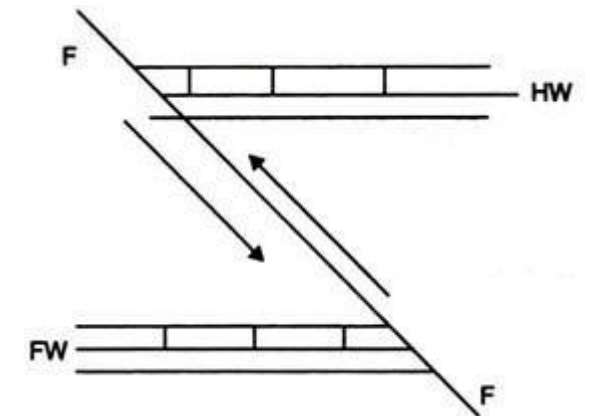
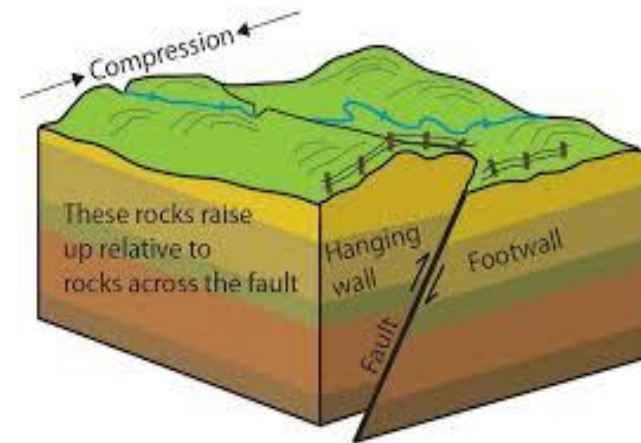


Reverse faults

It forms when the hanging wall moves up. The forces creating reverse faults are compressional, pushing the sides together. They are common at convergent boundaries.

Together, normal and reverse faults are called dip-slip faults, because the movement on them occurs along the dip direction -- either down or up, respectively.

Reverse faults create some of the world's highest mountain chains, including the Himalaya Mountains and the Rocky Mountains.



Strike-Slip Fault

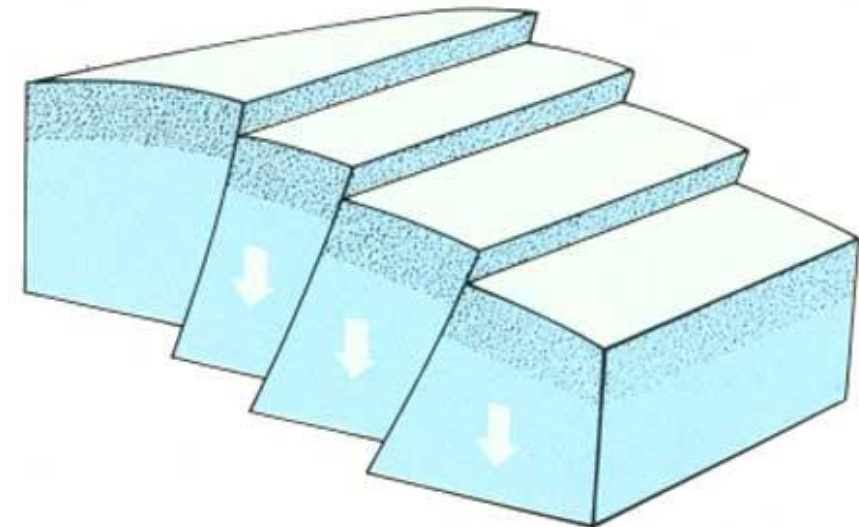
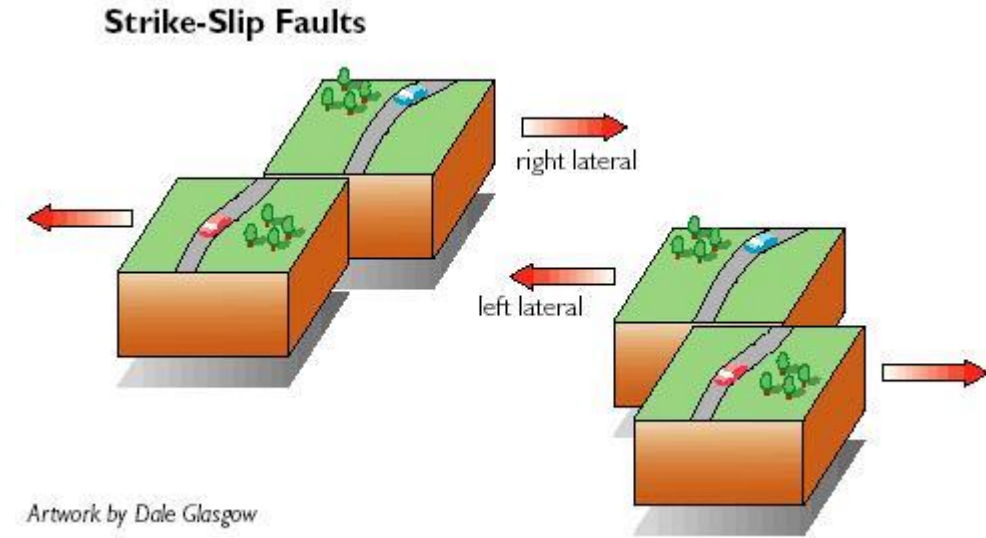
In this type of fault, the separated blocks on either sides of the fault plane move shearing off in the direction of the strike.

They are classified as either right-lateral or left-lateral. A **left-lateral strike-slip fault** is one on which the displacement of the far block is to the left whereas A **right-lateral strike-slip fault** is one on which the displacement of the far block is to the right when viewed from either side.

Strike-slip faults have walls that move sideways, not up or down. That is, the slip occurs along the strike, not up or down the dip. In these faults, the fault plane is usually vertical so there is no hanging wall or footwall. The forces creating these faults are lateral or horizontal, carrying the sides past each other.

Step Fault

This is a fault system consisting of a number of faults with parallel fault planes, the separated blocks slipping in the same direction along parallel planes giving a step-like feature. This fault is also called a fault terrace.



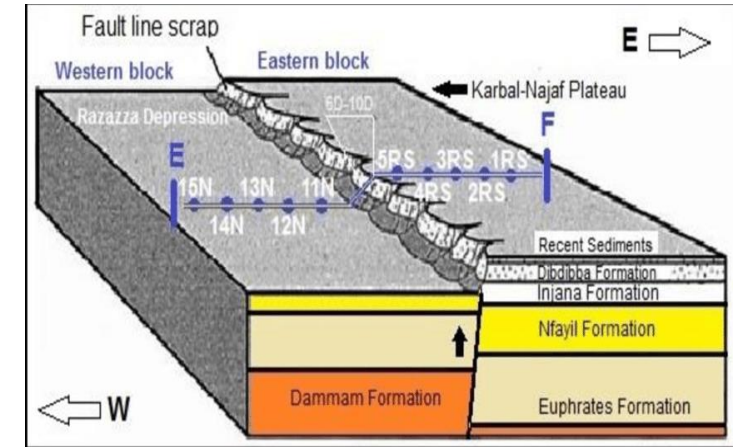
Field Evidence of Faulting



Field evidence of faulting can be divided into two groups. They are:

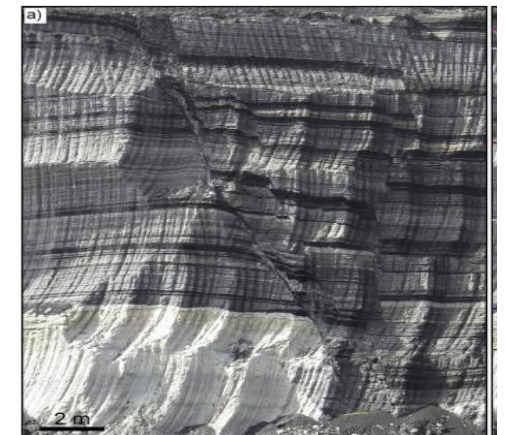
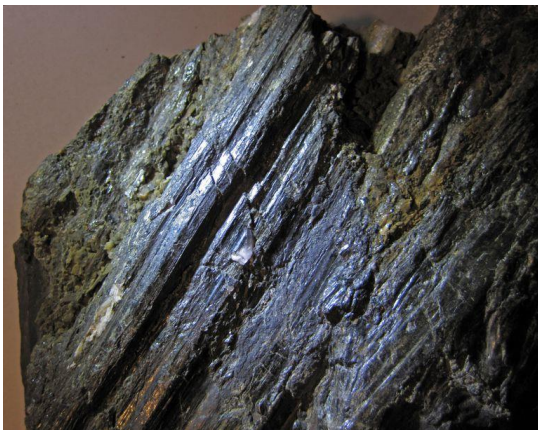
1. Lithological Evidence:

- i. Slickensides
- ii. Fault Breccia and Gouge,
- iii. Drag,
- iv. Dislocations,
- v. Repetition and Omission of Beds,
- vi. Abrupt Termination of Structures
- vii. Silicification and Mineralization.



2. Physiographic Evidence:

- i. Fault Scrap,
- ii. Fault Line Scrap, and
- iii. Fault Control of Streams



1. When the rock layers bend downwards, they form a -

- a) Limbs
- b) Syncline
- c) Anticline
- d) cliff

2. Rocks under compressional force are -

- a) pushed apart
- b) Crushed
- c) Transformed
- d) diverged

3. Which of the following is not a tectonic force responsible for folding or faulting rocks?

- a) compressive force
- b) tensional force
- c) shear force
- d) all of these are tectonic forces

4. The two sides of a fold are called its –

- a) Anticlines
- b) Synclines
- c) Limbs
- d) axial planes

5. Which of the following is an example of a fault where the motion is primarily horizontal?

- a) a strike slip fault
- b) a right-lateral fault
- c) a transform fault
- d) all of these

6. At convergent plate boundaries one would expect to find -

- a) Folds
- b) Faults
- c) folds and faults
- d) neither folds or faults

7. An overturned fold is characterized by –

- a) two limbs at right angles to one another
- b) two limbs dipping in the same direction - with one tilted beyond vertical
- c) two limbs dipping in opposite directions
- d) two limbs not parallel to each other

8. Which two measurements describe the orientation of a fault plane at a given location?

- a) axis and plane
- b) strike and dip
- c) lateral and thrust
- d) trend and plunge

9. In normal fault, the displacement that takes place is –

- a) Vertical
- b) Horizontal
- c) Diagonal
- d) all of them

10. The reverse fault is caused due to -

- a) Compression
- b) Tension
- c) Expansion
- d) collision

11. If the compressional force is unequal, then the folding that will take place would be -

- a) Equal
- b) Asymmetrical
- c) Symmetrical
- d) slower

12. Rift valleys and block mountains are landforms that are formed by

- a) Folding
- b) Faulting
- c) Displacement
- d) collision

13. When the stronger compressional forces push the over thrust fold to move along the fracture line, it forms a -

- a) Gap
- b) Layer
- c) Nappe
- d) fracture

14. Which factor does not affect whether folding is severe or gentle?

- a) the magnitude of the applied forces
- b) length of time the force was applied
- c) age of the rock units
- d) the ability of the rocks to resist deformation

15. In a syncline, the oldest rocks will be found -

- a) on the limbs of the fold.
- b) near the axis of the fold.
- c) at the bottom of the fold
- d) none of these.

16. In an Anticline, the youngest rock layers are found -

- a) on the limbs of the fold.
- b) near the fold axis.
- c) away from the fold axis.
- d) None of these