UNIT IV

STRUCTURAL GEOLOGY AND GEOPHYSICAL METHODS

4.1 STUDY OF STRUCTURES-FOLDS

SYLLABUS

Geological maps – attitude of beds, study of structures – folds, faults and joints – relevance to civil engineering - Geophysical methods – Seismic and electrical methods for subsurface investigations.

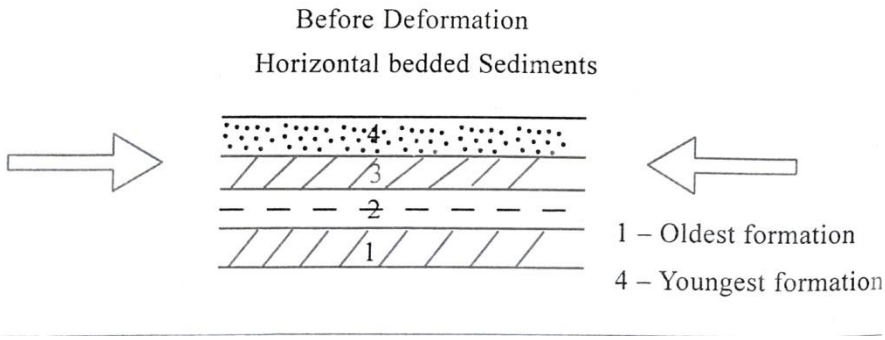
Dip: The dip direction is the direction along which the inclination of the bedding plane occurs. The dip amount is the angle of inclination between the bedding plane and a horizontal plane. For example the beds are inclined at 30^0 to the horizontal and the dip may be expressed as S 60^0 E; when the strike direction is N 30^0 E or S 60^0 W.

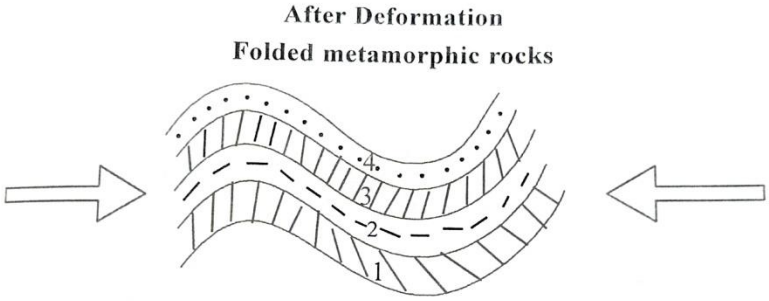
Strike: When a bedding plane (or a joint plane, or a fault plane) is cut by a horizontal plane, a line of intersection will be obtained at the surface. This direction is known as the strike, or the direction of the strike, or the line of the strike. Strike direction can obviously be represented as N 30^0 E or as S 30^0 W.

Study of Structures – Folds

Folds are wavy undulations developed in country rocks, whenever the region is subjected to severe pressure or stress.

The sides of a fold or the stretch of the rock beds lying between any crest and any of the adjacent troughs on either side are called a limb.





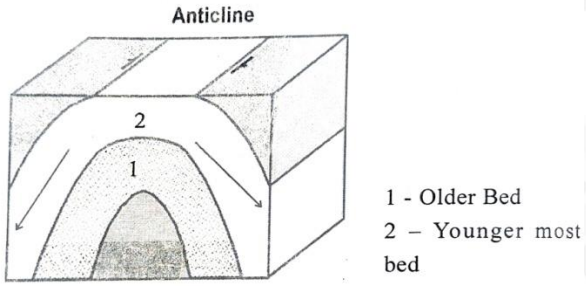
Types of folds

1. Anticline:

i. Anticline is the fold which is convex upwards.

ii. In anticlines, both the limbs are dipping away from each other.

iii. Progressively older beds are found to occur towards the center of curvature of the fold.

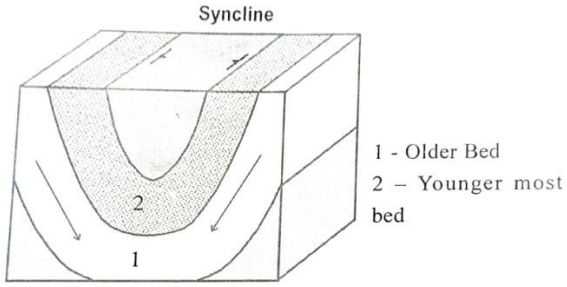


2. Syncline:

i. Syncline is a fold which is convex downwards.

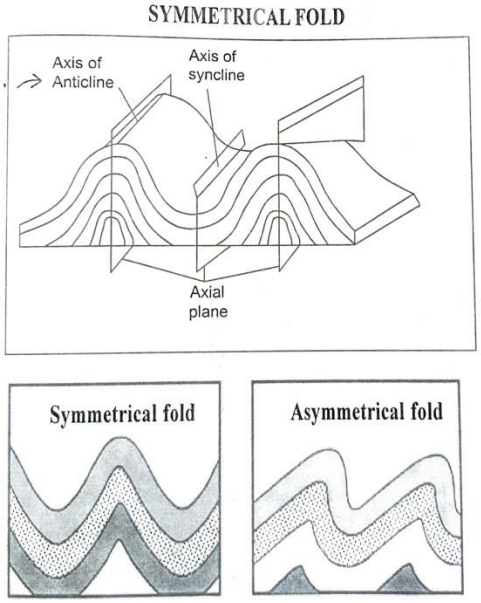
ii. The limbs of the fold are dipping towards each other.

iii. Progressively younger beds occur towards the center of curvature of the fold.



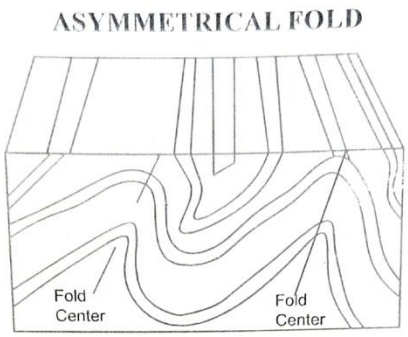
3. Symmetrical fold:

It is a fold in which the axial plane is essentially vertical and both the limbs have the same amount of dip.



4. Asymmetrical fold:

In asymmetrical fold (whether anticline or syncline), the axial plane never remains vertical. So, both the limbs have unequal dips.

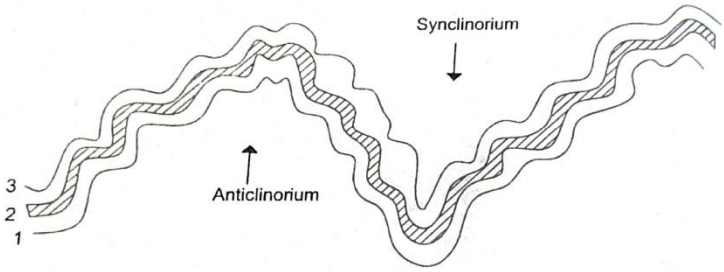


5. Anticlinorium:

A large anticline with a number of minor secondary folds developed on it is known as anticlinorium.

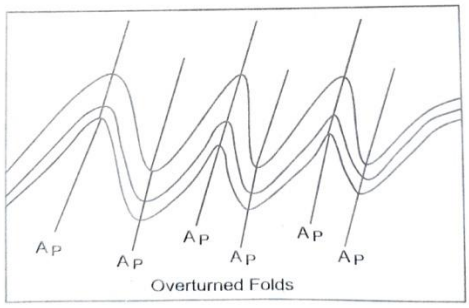
6. Synclinorium:

A large syncline in which a number of minor secondary folds are developed is called a synclinorium.



7. Overturned fold:

A fold in which one of the limbs appears to be rotated and completely overturned from its normal position, is called overturned fold.



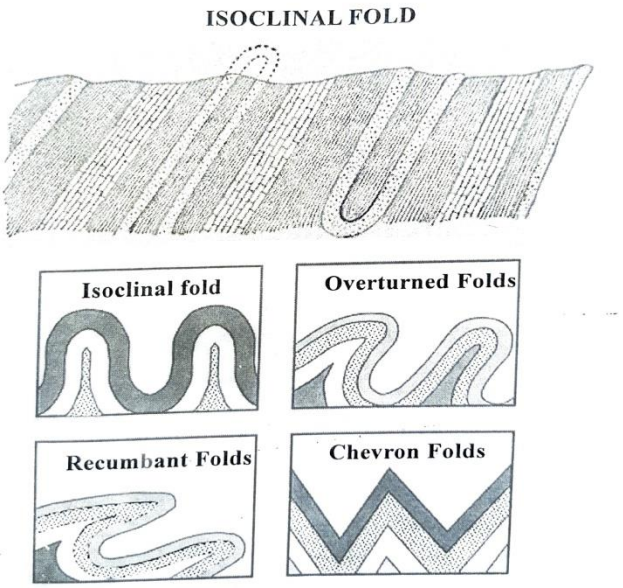
8. **Fan fold:**

If in any fold, both the limbs are overturned, the same assumes the shape of a fan and is known as fan fold.

FAN FOLD

9. Isoclinals fold:

If both the limbs of a fold have the same amount of dip towards same direction it is called an isoclinals fold.



10.Recumbent fold:

If the axial plane of a fold is horizontal, it is called recumbent fold.

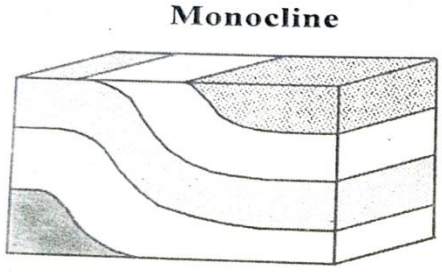
11. Chevron fold:

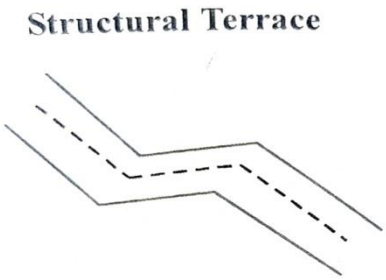
If the crests and toughs of a fold are sharp and angular, it is described as chevron folds.

12.Monocline and structural terrace:

In monocline, the bed is relatively flat, but appears to be bent locally to exhibit higher dips.

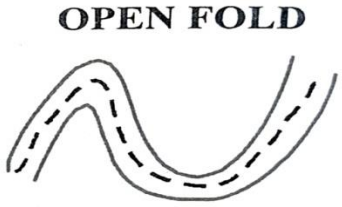
In a structural terrace, the dipping bed becomes horizontal at a particular place and then continues to follow their original dip.





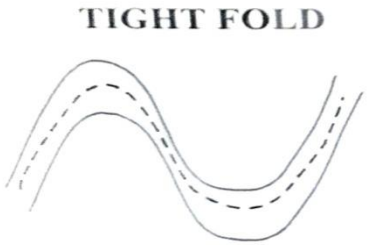
13.Open fold:

The constituent beds have uniform thickness everywhere within the fold.



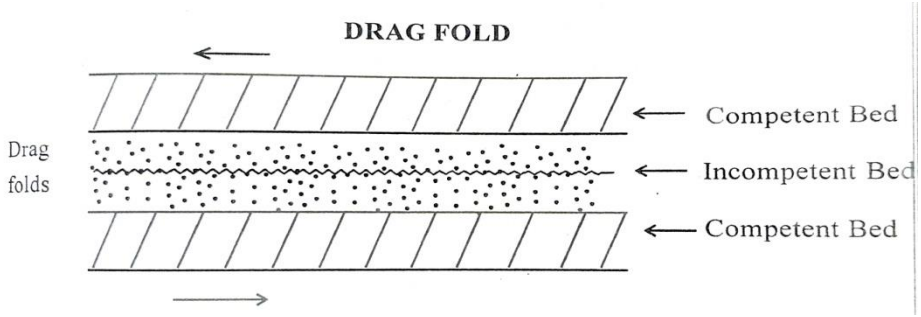
14.Tight fold:

In a tight or closed fold, the relatively mobile beds thin out at the limbs and thicken at the crests and troughs due to plastic flow of constituent beds.



15.Drag fold:

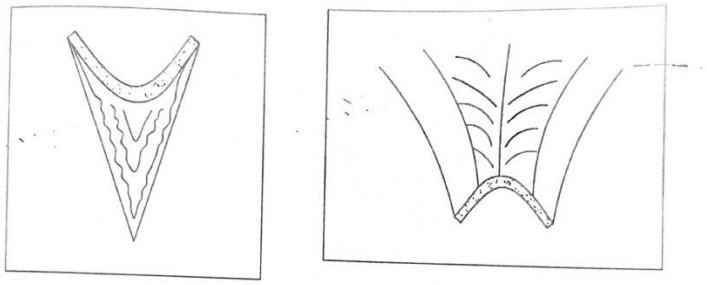
When a comparatively weak bed (incompetent) lies between two strong (competent) beds, any sliding motion in the stronger beds leads to the development of minor asymmetric folds known as drag fold within the weaker bed.



16.Plunging and doubly plunging fold:

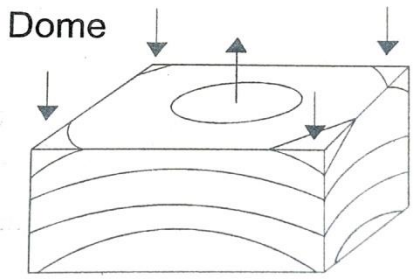
When the axis of a fold slopes towards some direction, it is said to be a plunging fold.

When folds often plunge along two opposite directions, they are called doubly plunging folds.



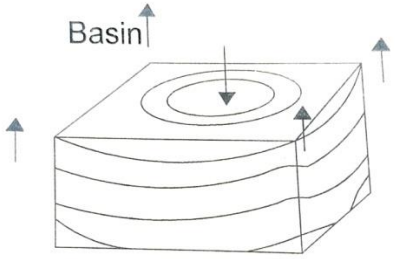
17.Dome:

An anticlinal uplift with quaquaversal dip (i.e., dip in all directions from a central region) is known as a dome.



18.Basin:

A synclinal depression with centraversal dip (i.e., dip from all directions towards a central region) is known as a basin.



19. Geosynclines:

It is a very large, shallow and linear depression which accommodates a considerable thickness of sediments.

20. Geanticlines:

It is an area from which sediments are derived and deposited in the geosynclines.

Engineering importance:

Folded regions are always under strain. The outer layers (peak) of the trough & crest will be always under tension and the inner layers of the crest and trough will be under compression. Hence there will be shattering & jointing of strata along axial planes. So, dams aligned along axial regions of folds would be resting on unsound rocks, leading to failure of the project.

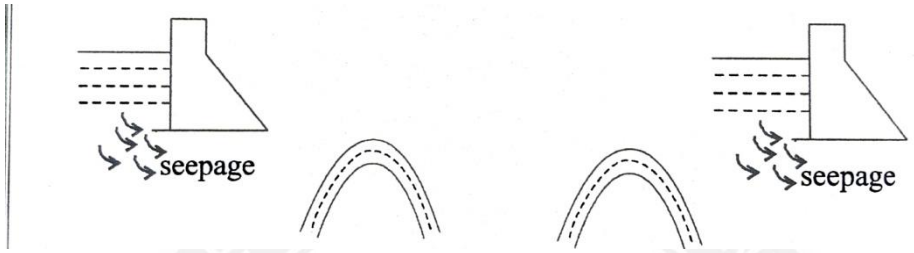
Dams constructed on synclinal upstream limbs lead to leakage of water beneath the dam.

Similarly, strain energy will be always stored in the curvature of folds. Whenever, for tunneling project, the rocks in folded region are excavated, there is possibility of sudden release of strain energy, leading to bursting of rocks. Hence, proper care to be taken while designing tunneling project and also other civil engineering projects.

Fold – Favourable situations for civil engineering projects:

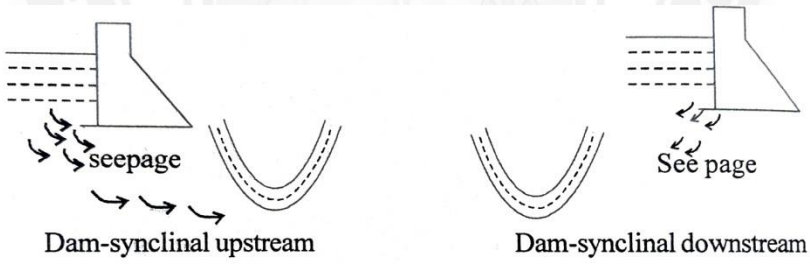
1. Dam along upstream side of anticline:

The upstream side of the anticline will be a favourable site for dam, because, seepage from reservoir, if any, will be along the upstream side of the anticline, i.e., within the reservoir side itself.

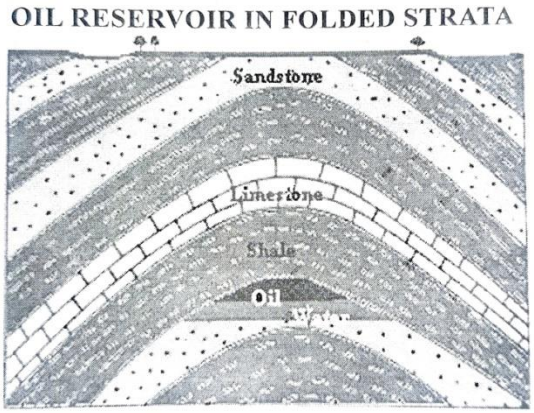


2. Dam along downstream side of syncline:

The downstream side of the syncline will be a favourable site for dam, because, seepage from reservoir, if any, will be along the downstream side of the syncline, i.e., within the reservoir side itself.



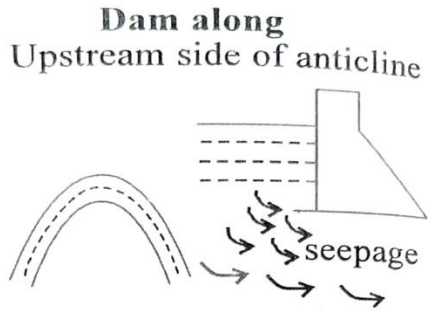
Folded strata are found favourable for accumulation of oil and natural gas.



Fold – Unfavourable situations for civil engineering projects:

1. **The downstream side of anticline:**

   Unfavourable for dam project, because, there will be loss of water to reservoir, due to seepage towards the downstream side of the dam.



2. **The upstream side of syncline:**

   Unfavourable for dam project, because, there will be loss of water to reservoir, due to seepage towards the downstream side of the syncline as well as dam.