GEPM 203

Geology and Geomorphology

Structural Geology

What is structural geology:

- Deals primarily with the **deformation of rock masses**, **their shapes** and the **stresses** **that caused the deformation.**
- Sedimentary rocks and some igneous rocks form apparently approximately **horizontal layers**.
- But when they are found **tilted, folded** in between, they provide **evidence of deformation of rocks**.

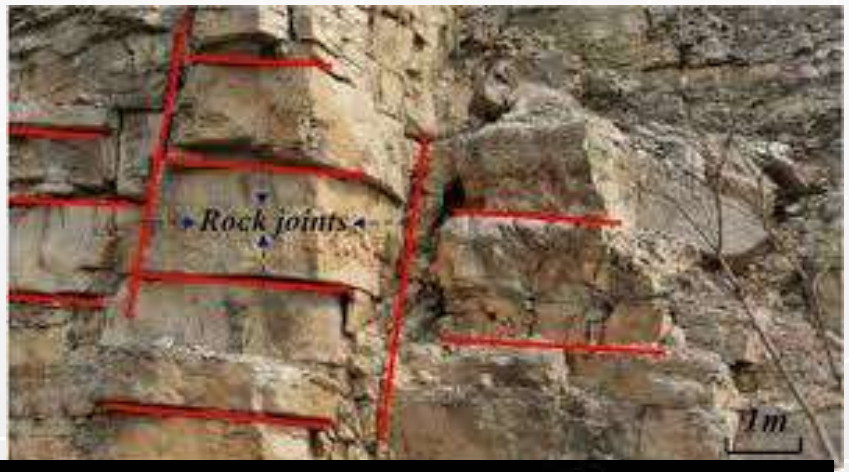


Structural Geology

Types of deformation features:

- Folds
- Joints
- Faults
- Unconformities.









Terms used to describe structural geology

Structural Relief:

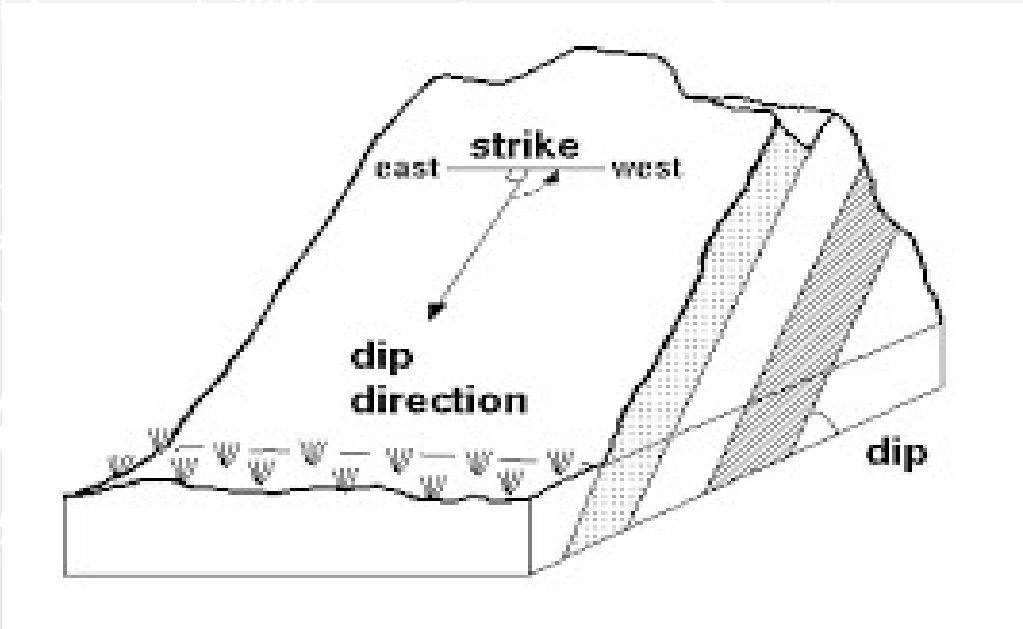
- **Difference in elevation** of parts of deformed bed.
- Measure of the extent of deformation.

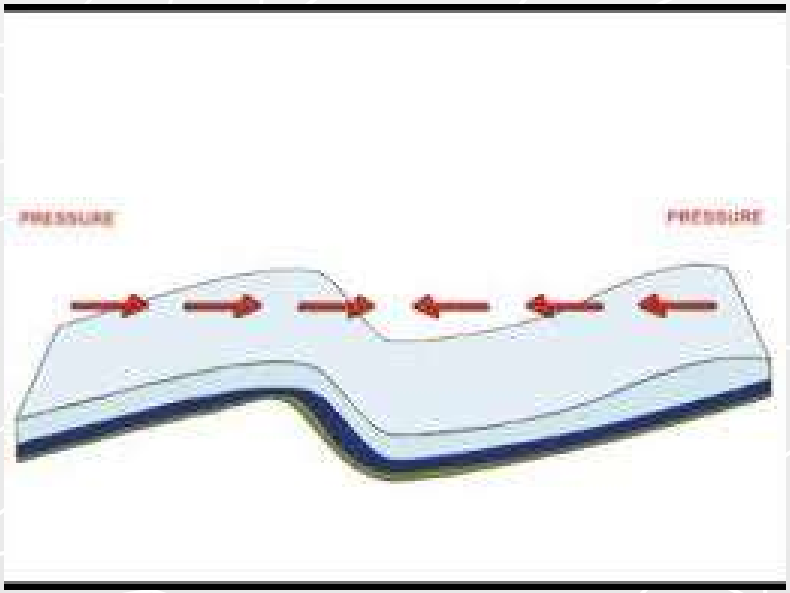
Dip and Strike:

- **Dip:**

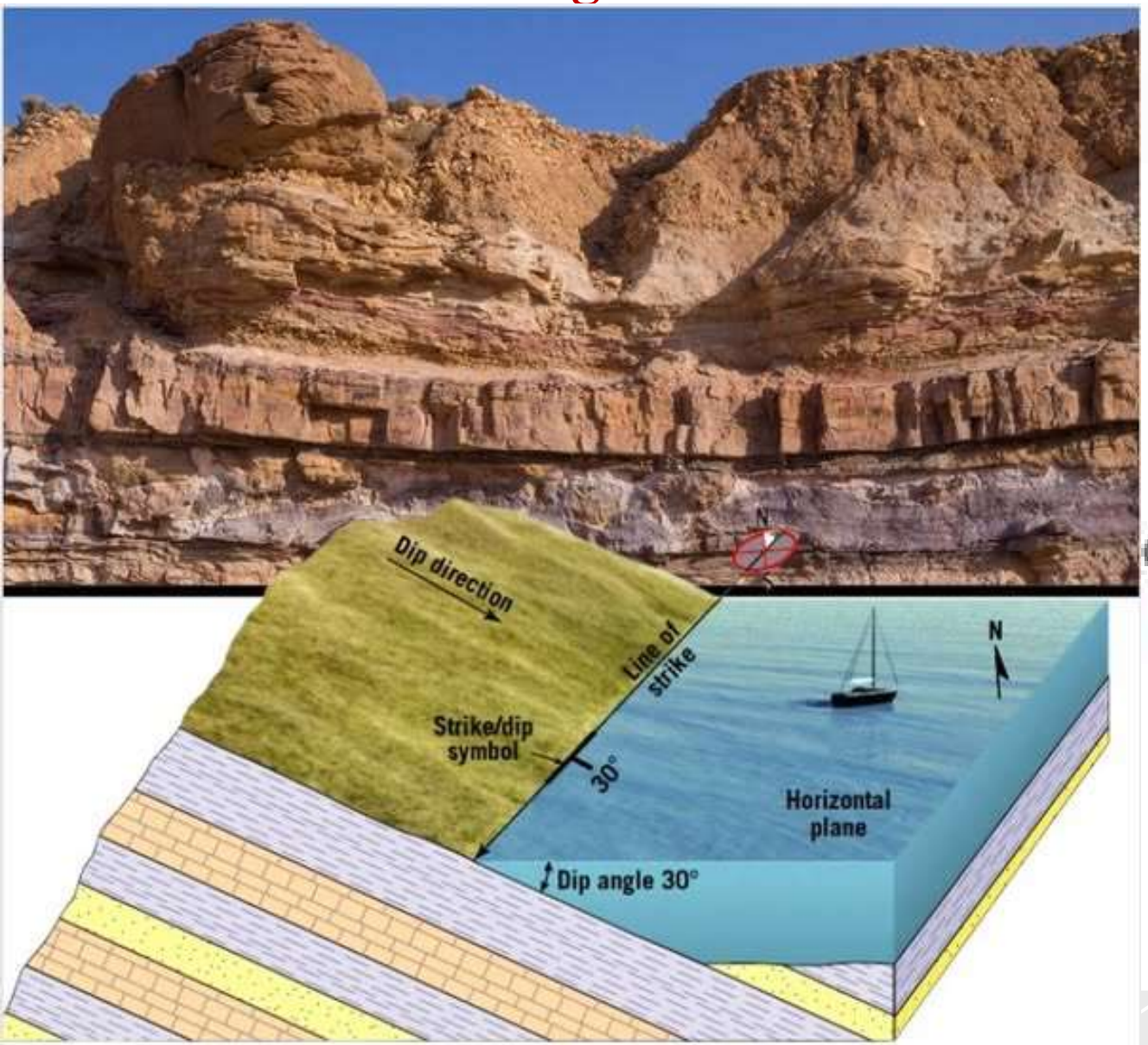
  -Describing the **attitude** **of the structural features**

  -Also described with reference to the layered rock.

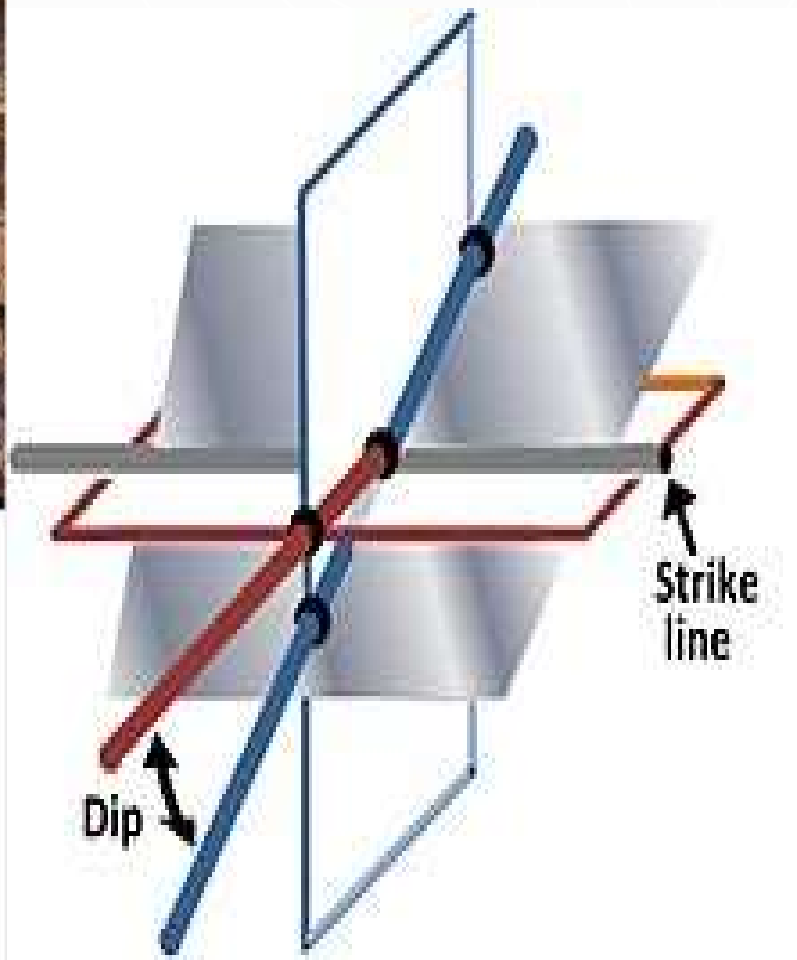




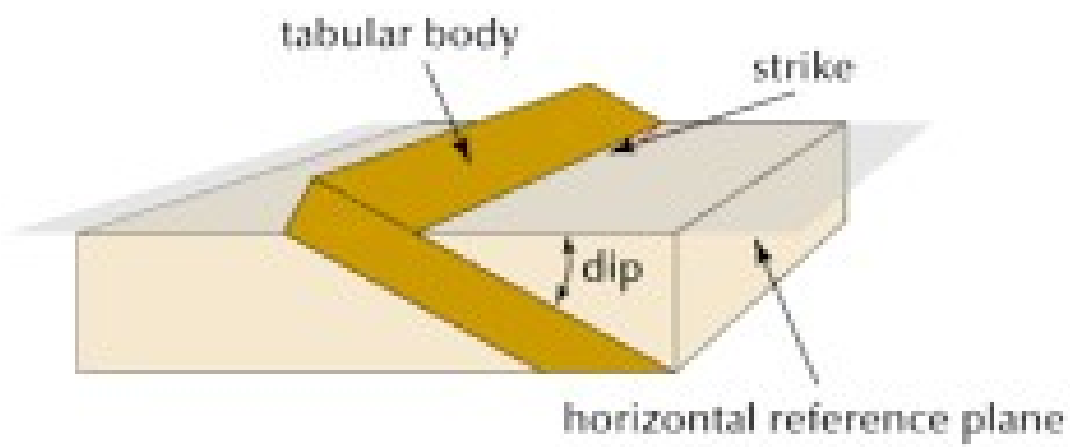
- Dip is both the **direction** of maximum slope down an inclined surface and the **angle** between the maximum slope and a horizontal



What is Strike and Dip?



- If a rock layer is not horizontal, the **amount of its slope with the horizontal** is dip.
- Measured by specifying the **acute angle** that the layer makes with the horizontal
- Also measured in the **direction** **of the greatest amount of inclination.**



Strike:

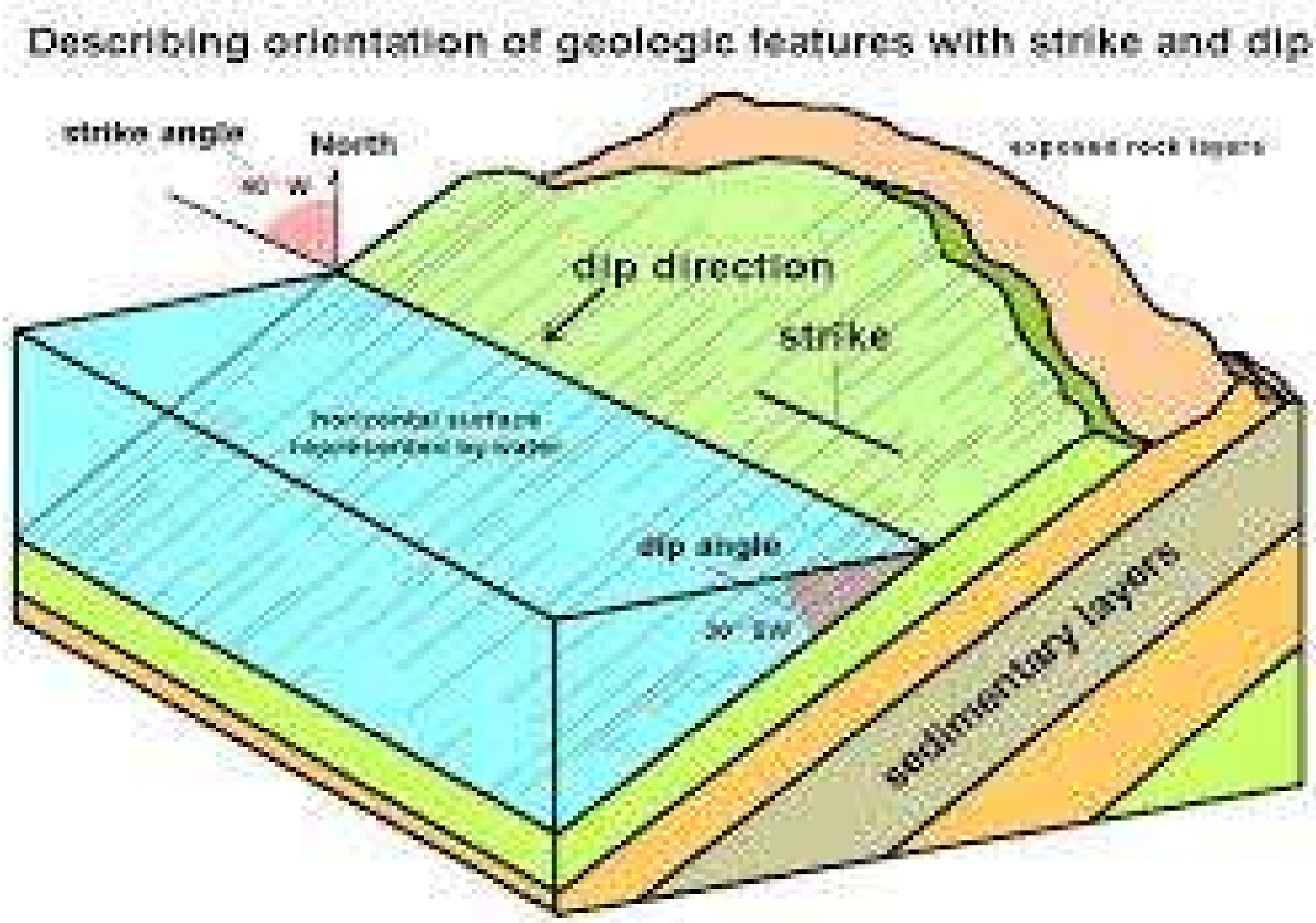
- Strike is the **direction of intersection of an inclined surface with any horizontal plane.**

- **Bearing of an outcrop** of an inclined bed or a structure on a level surface.

Example:

- If a rock layer is tilted so that it disappears below the surface, but protruded somewhat because of resistance of weathering;

- the **strike is the direction in which the resulting ridge is run.**


Describing orientation of geologic features with strike and dip
strike angle
North
dip direction
strike
dip angle
sedimentary layers

What is fold?

- **Common features** of rock deformation.

- **Produced by compressive stress**.

- **Size varies** from a **microscopic wrinkles** in a piece of metamorphic rocks to a **huge fold involving of meters** of thickness for a distance of 100km.

- **Hardly isolated rock structures** but generally **occurs in closely related groups.**

Folds



Mechanics of Folding

Concentric

- **An elastic bending** of an originally horizontal sheet.
- Occurs in **surface layers** of the earth.
- **Size is determined by the thickness of beds** involved and their elastic properties.
- Beds are **buckled** but the **thickness of beds and the volume remain same.**
- **Large amplitude folds** form from thick strata.



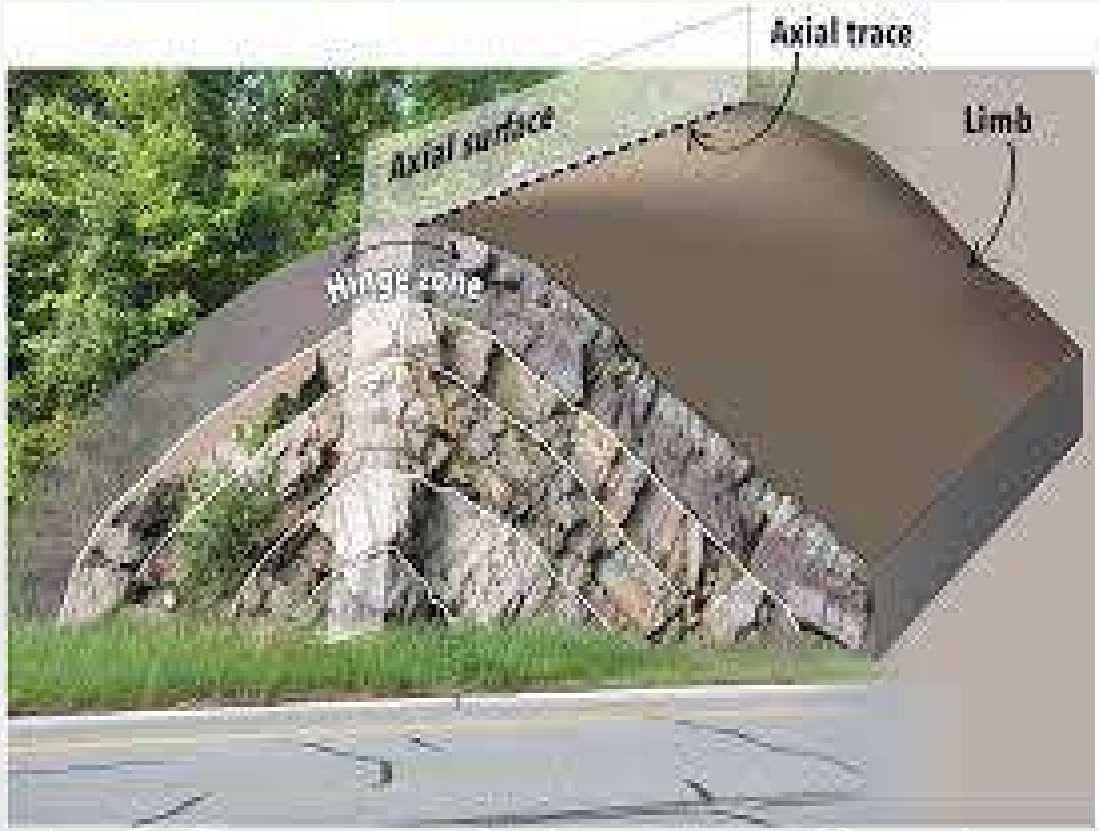
Flow:

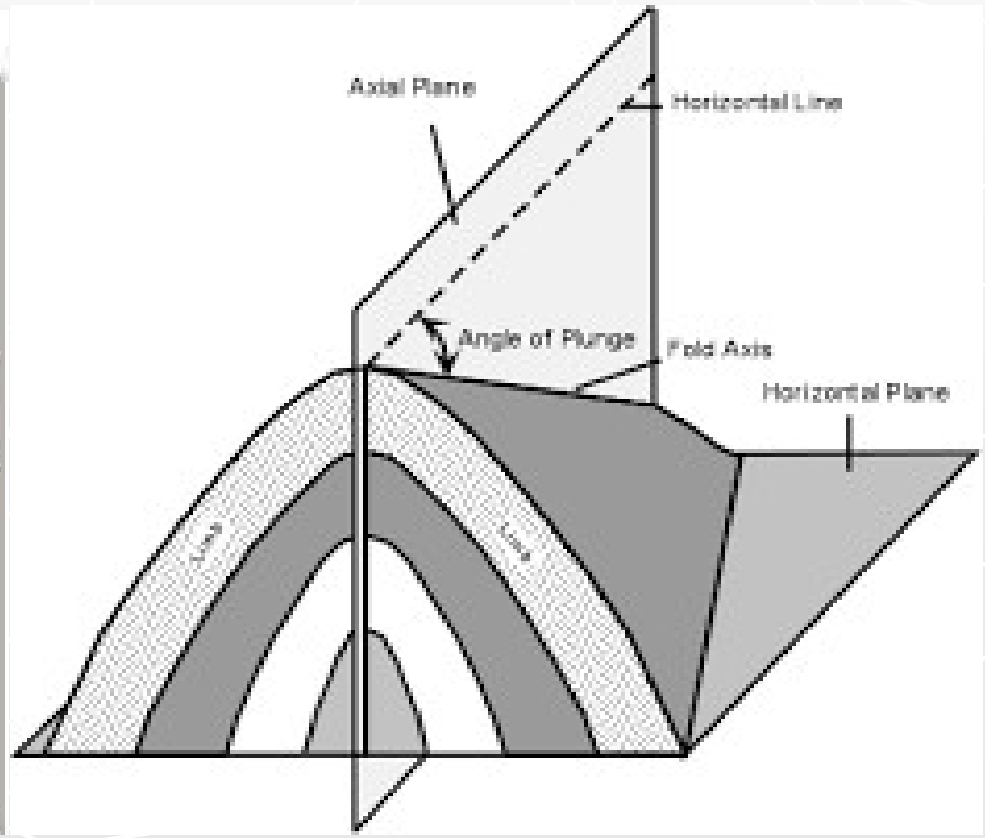
- These are planar or linear features that **result from flowage of magma** with or without contained crystals.
- **Occurs** in rocks when **they are in plastic state**.
- **Involves internal movement** that they may take any direction.
- **Occurs** in **weak rocks near the surface** and in **strong rocks at depth** due to confining pressure and high temperature.



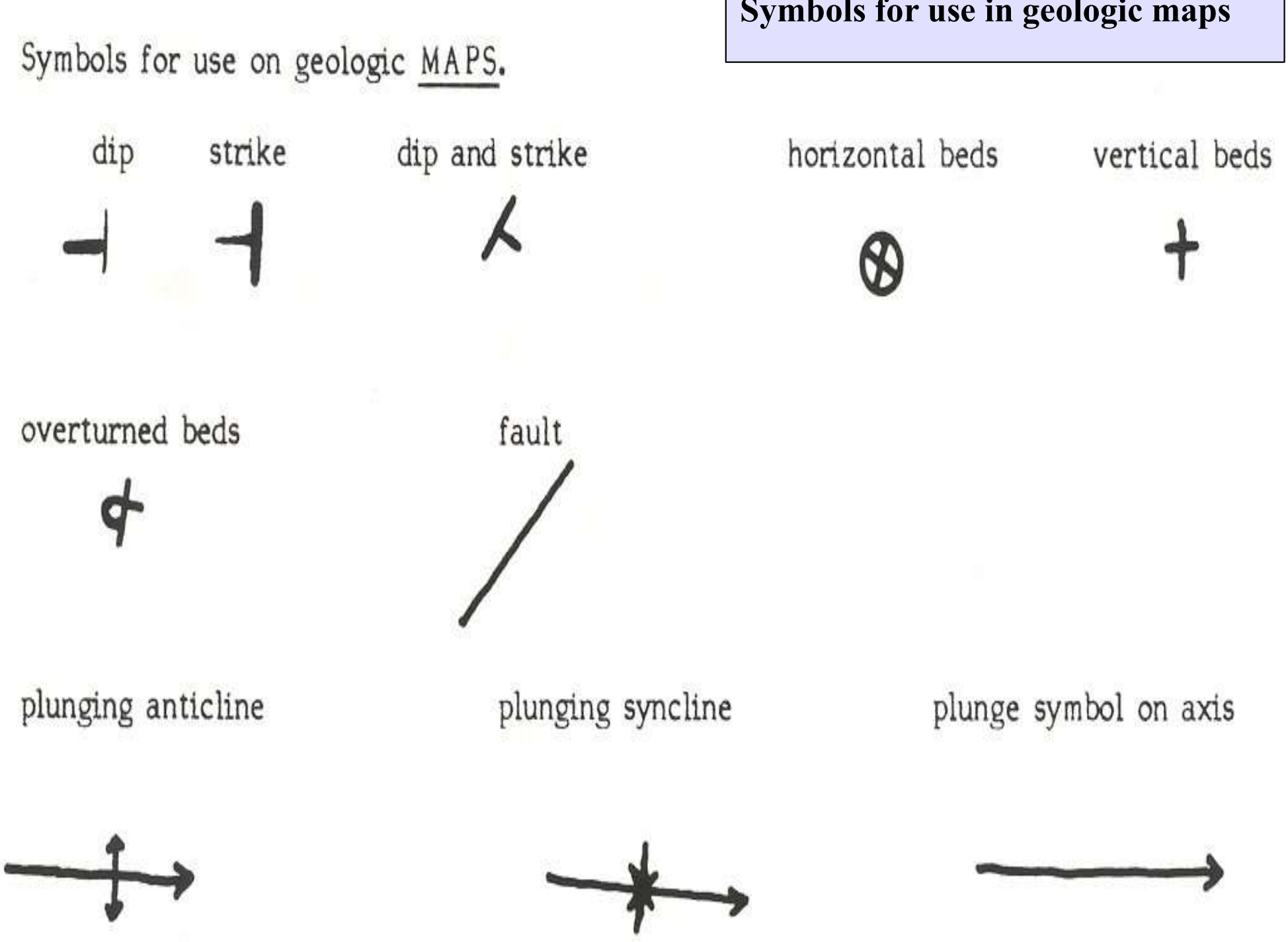
Parts of a Fold

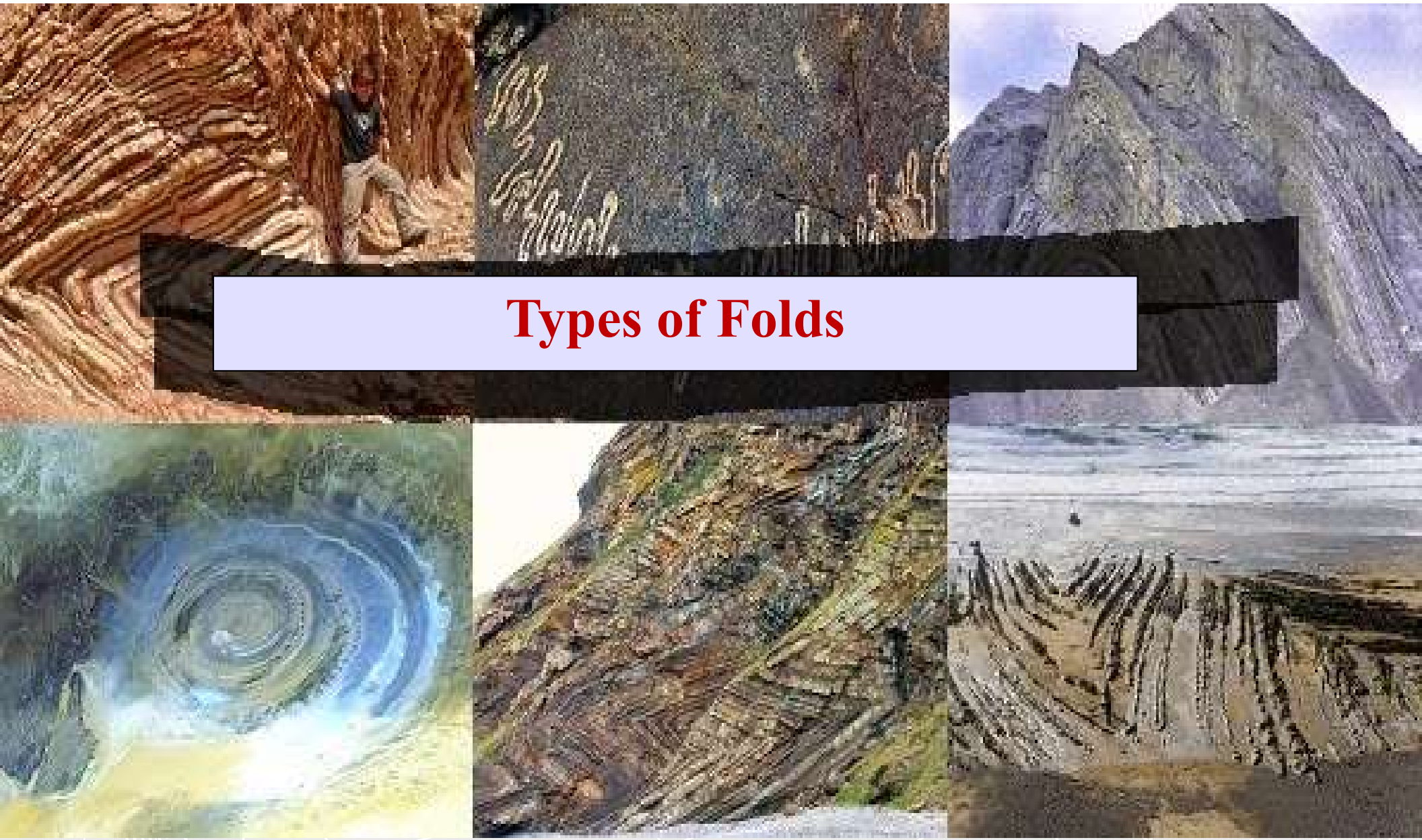
- **Axis** – the lines joining the places of the sharpest points of the folding.
- **Axial Plane** – includes the axis and that divides the fold as symmetrical as possible.
- **Angle of plunge** – Angle between the axis and the horizontal.
- **Limbs** – the sides of a fold.





Symbols for use in geologic maps





Types of Folds

Anticline:

- Anticline is a fold that **is convex up**.
- Most **common form** of geologic structure.
- **Limbs dip away** from each other.
- **Oldest rocks are at the core** and the youngest on the outer flanks.



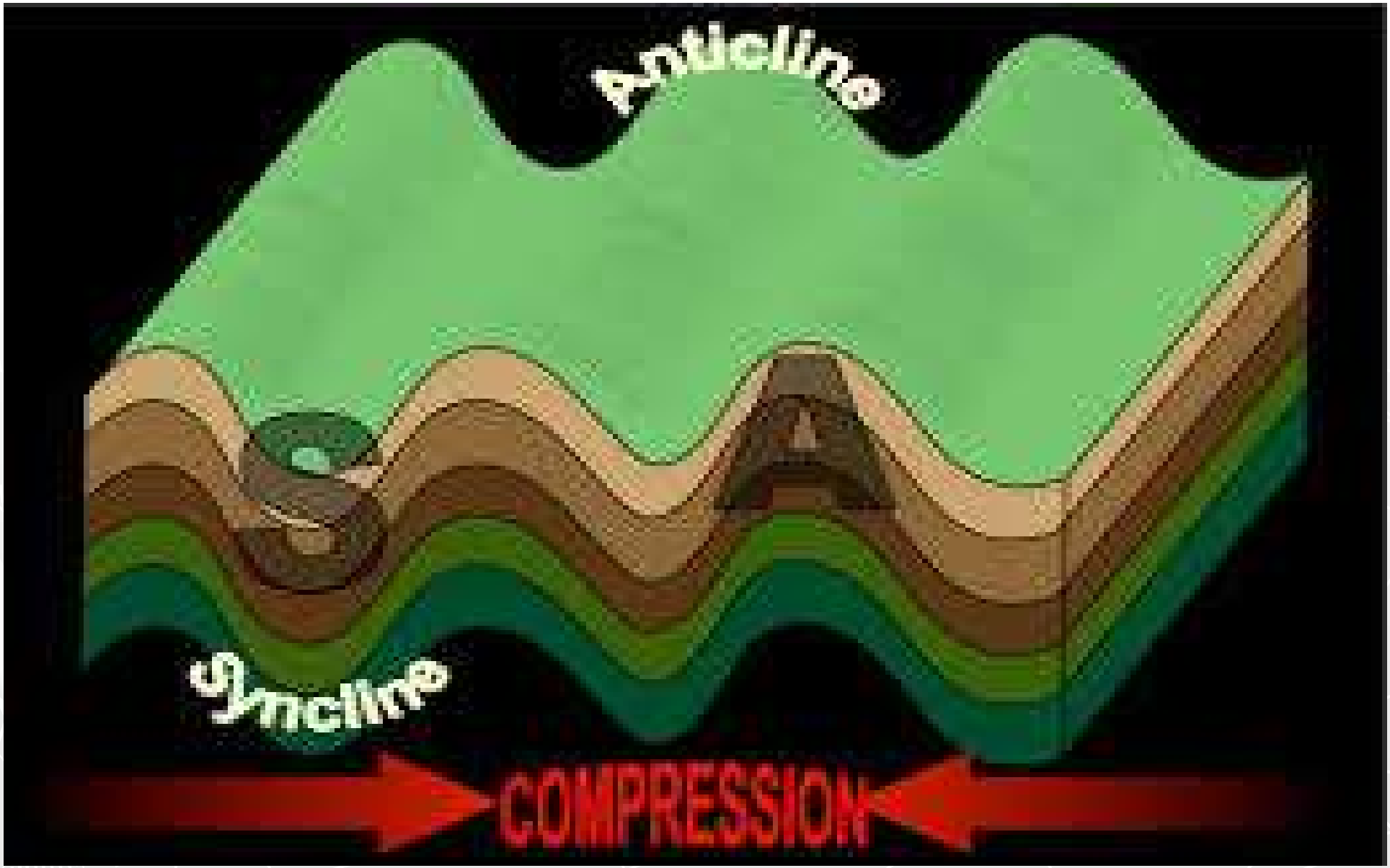
Anticline is in Alberta, Canada in Rocky Mountains

Syncline:

- Synclines are typically a **downward fold**, opposite of anticline.
- Limbs **dip towards** the central axis.
- With **younger layers closer to the center** of the structure with successively older rocks further out.

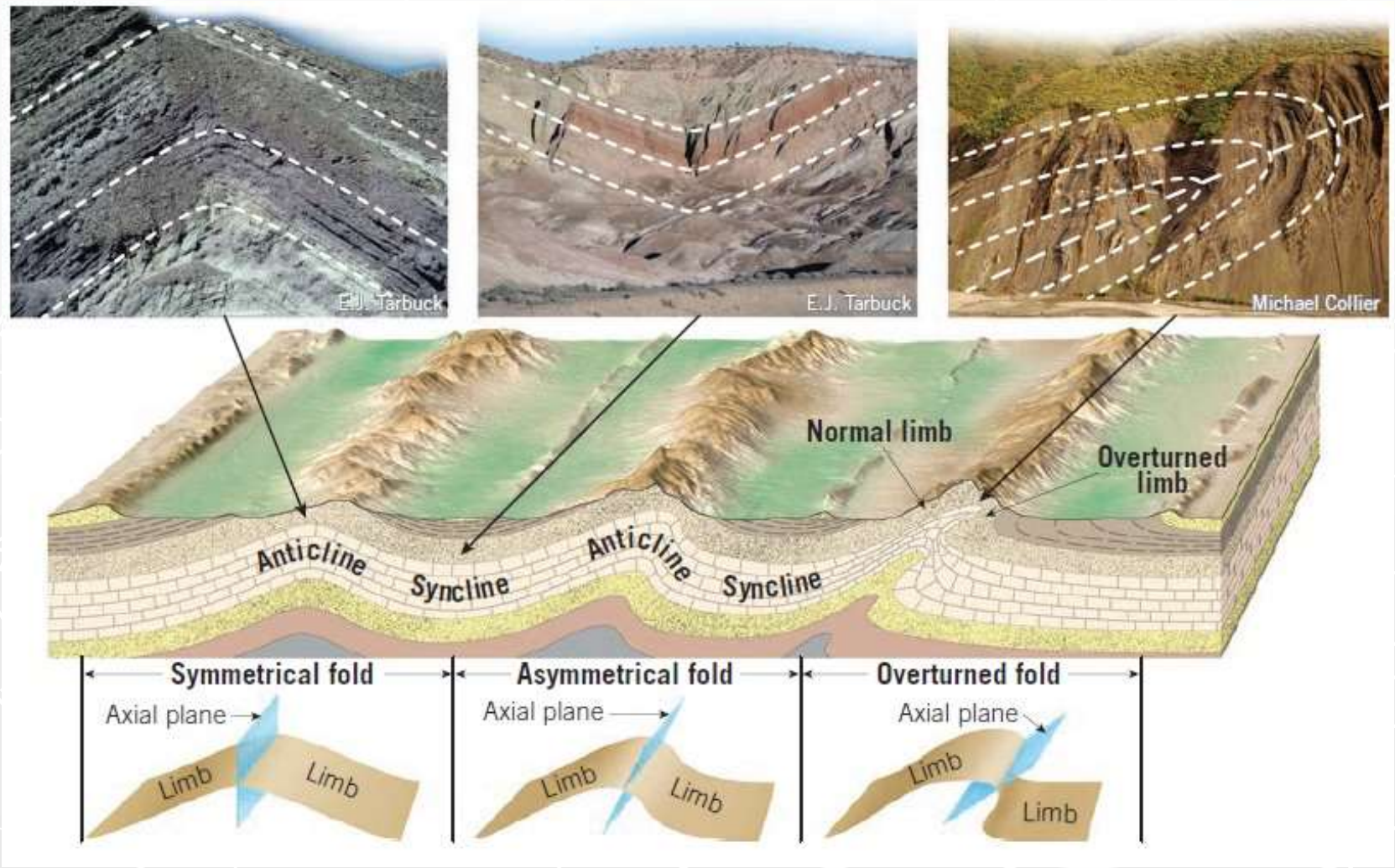


Syncline sidling hill


Anticline
Syncline
COMPRESSION

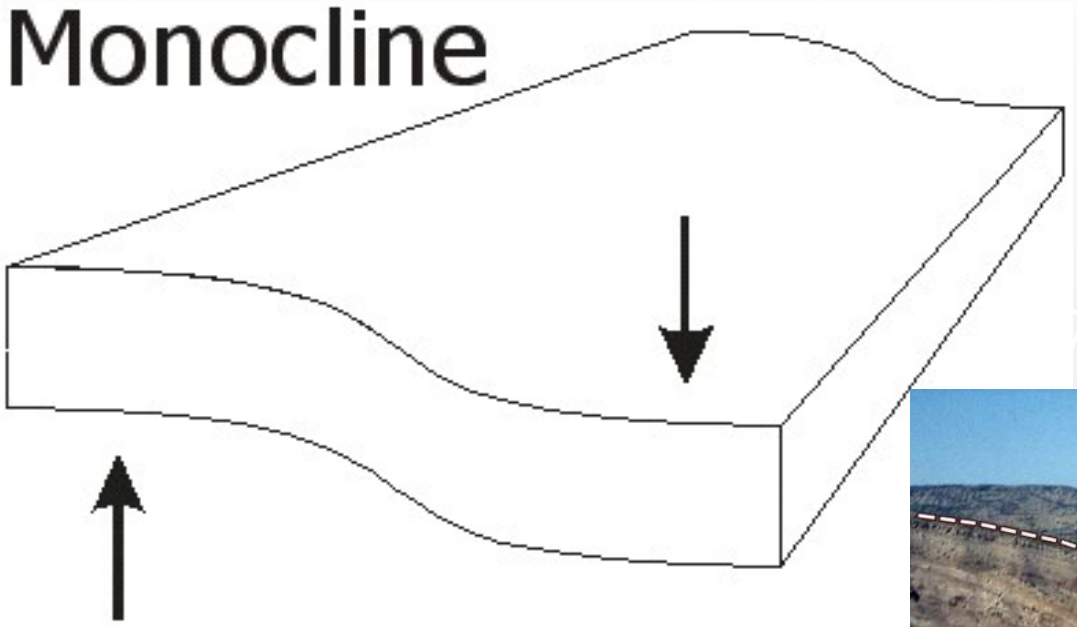
Both anticline and monocline may be <u>symmetrical</u> and <u>asymmetrical</u>:

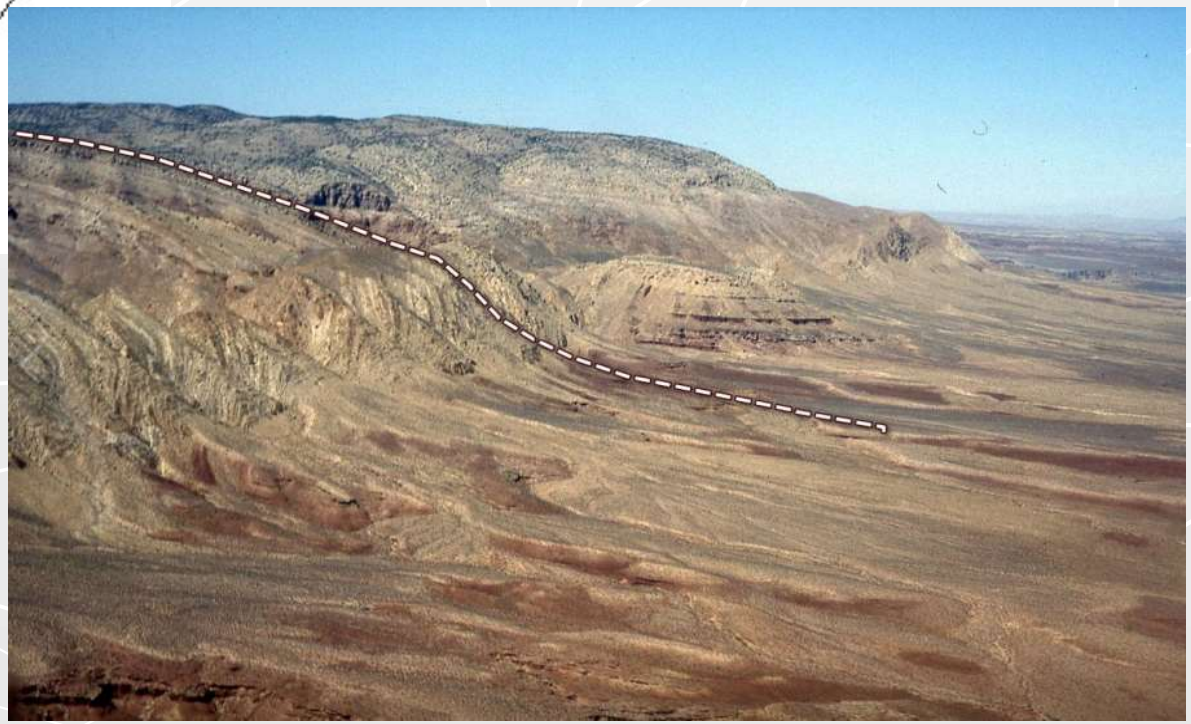
- **Symmetrical**: Both limbs have an equal but opposite angle of dip.
- **Asymmetrical**: One limb dips at different amount of angle than the other.



Monocline:

- Local steepening of an otherwise uniform dip.
- **Form by vertical movement** of rock strata.





Overturned Fold:

- Limbs **tilted beyond vertical**.
- Both limbs **dip in the same direction**, may not be in the same amount.



Recumbent fold

- **Axial plane** of which **approaches horizontality**.
- Axial plane is **essentially horizontal**, with the limit of variation of **axial-planar dip**, and the resulting limit of plunge, **being 10°.**



Recumbent fold, Bahrain

Isoclinal fold

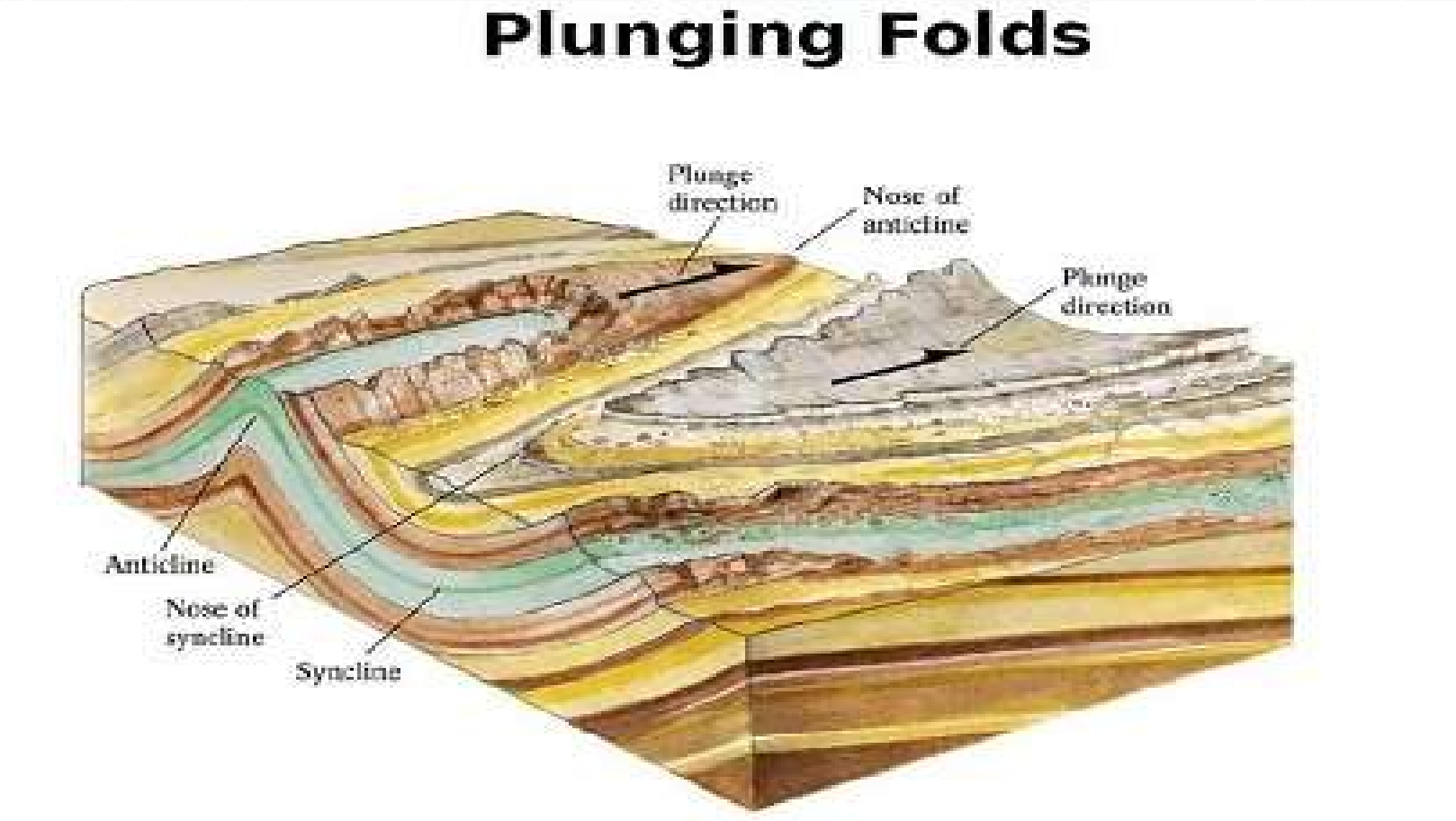
- **Similar to symmetrical folds**, but these folds **both limbs have the same angle** and **are parallel to each other**.
- '**Iso**' means 'the same' (symmetrical), and '**cline**' means 'angle,' so this name literally means 'same angle.'
- So isoclinal folds are **both symmetrical** and aligned in a parallel fashion.





Plunging fold

- **Axis plane is not horizontal**.
- Direction of plunge - the **direction in which the axis is inclined as nose** - indicate the direction of plunge.
- In **anticline**, plunge is directed **towards nose** and in **syncline** it is **directed away from nose.**



Dome and Basin

Domes:

- Like **anticlines** but instead of an arch, the **fold is in a dome shape**, like an **inverted bowl**.
- Nonlinear **strata dip away from center** in all directions,
- **Oldest** strata in center.
- Results when a **broad area of uplift occurs.**

Basins:

- Like **synclines** but again, instead of a sinking arch, the fold is in a shape of a **bowl sinking down** into the ground.
- Nonlinear strata **dip toward center** in all directions,
- **Youngest** strata in center.
- When **subsidence occurs**



Dome



Basin

Thank you