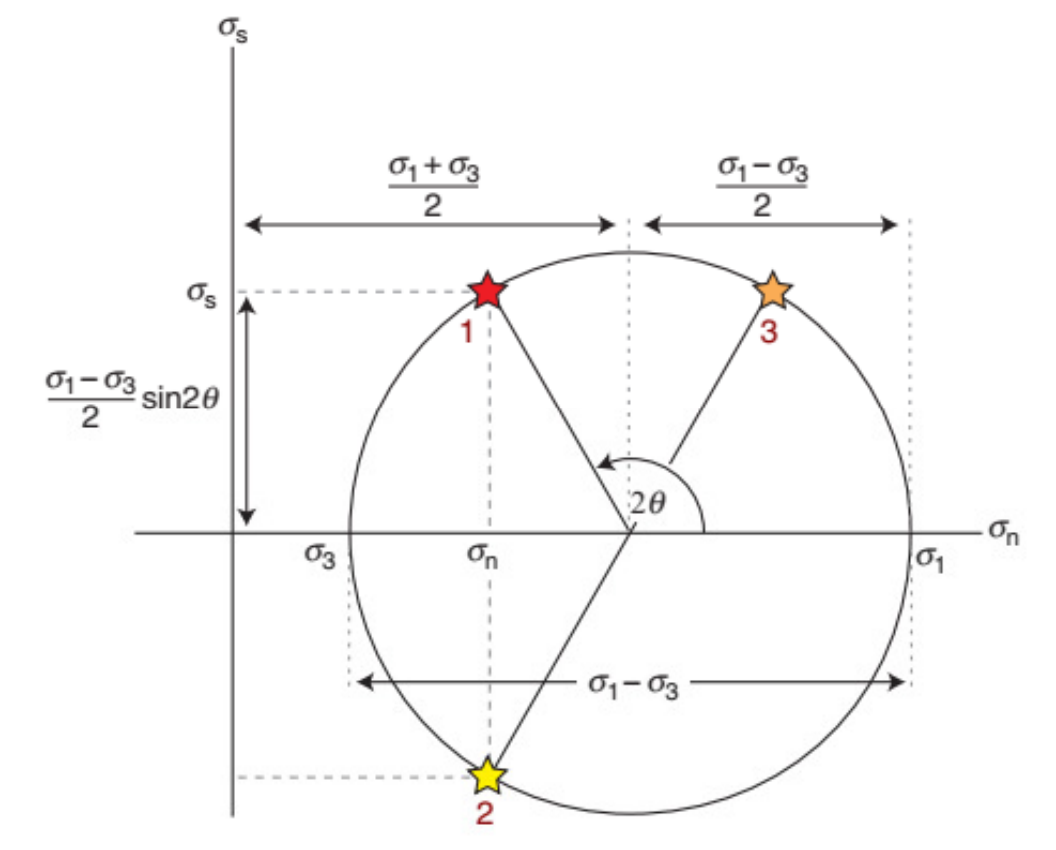
Structural Geology Part II

Fractures (Faults and Joints)

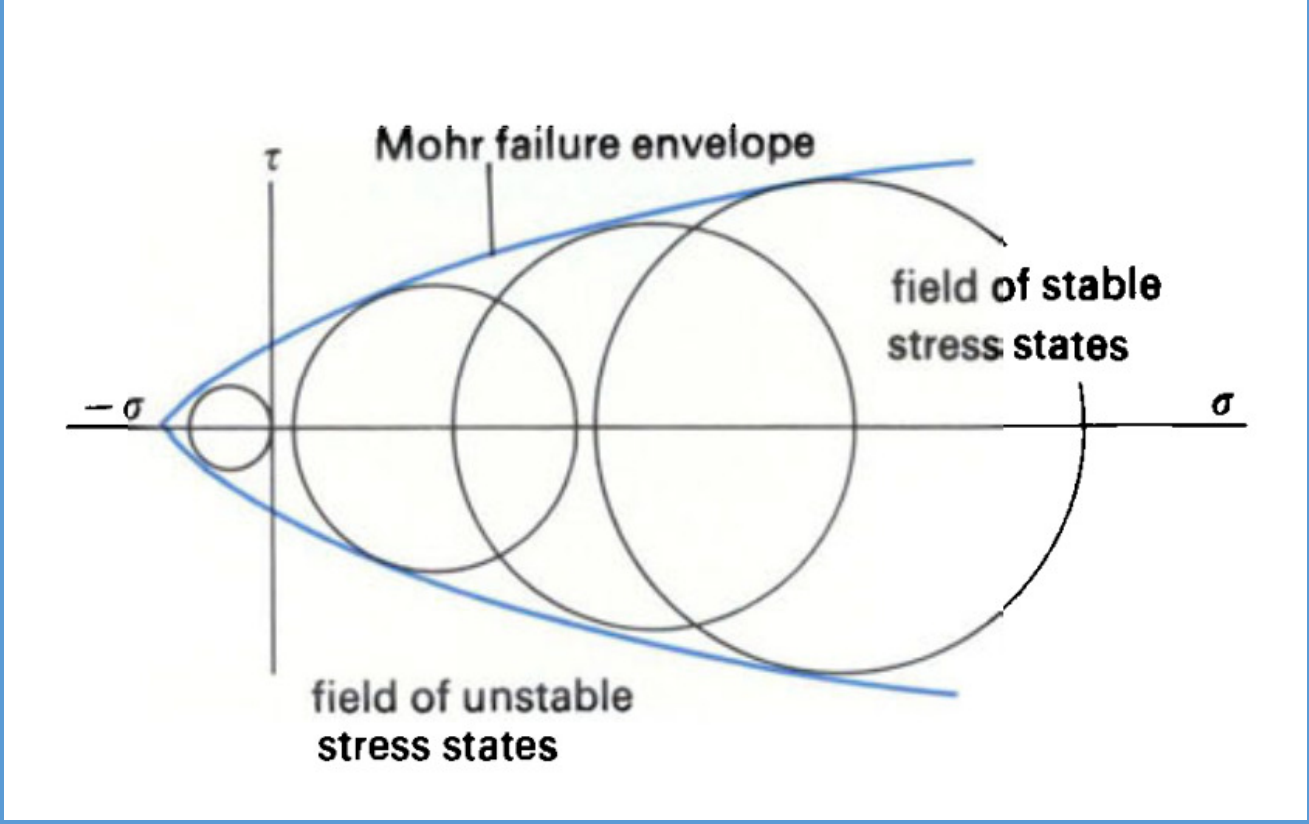
Mohr circle and diagram

The Mohr circle describes the normal and shear stress acting on planes of all possible orientations through a point in the rock.



The Mohr circle θ is the angle between the largest stress and a given plane.

The difference between the maximum and minimum principal stresses is the diameter of the circle. This difference is called differential stress and is important in fracture mechanics. In general, great differential stress promotes rock fracturing.



The Mohr failure envelope joining points of failure for different stress states separates the field of stable stress states from the failure field. Note that the shape of the Mohr curve implies an increase in the values of the shear stress τ and fracture angle θ with an increase in the mean stress .

Extension fractures and tensile fractures

Extension fractures develop perpendicular to $\sigma 3$ and thus contain the intermediate and maximum principal stresses ($2\theta = 0$). Extension fractures are typical for deformation under low or no confining pressure, and form at low differential stress.

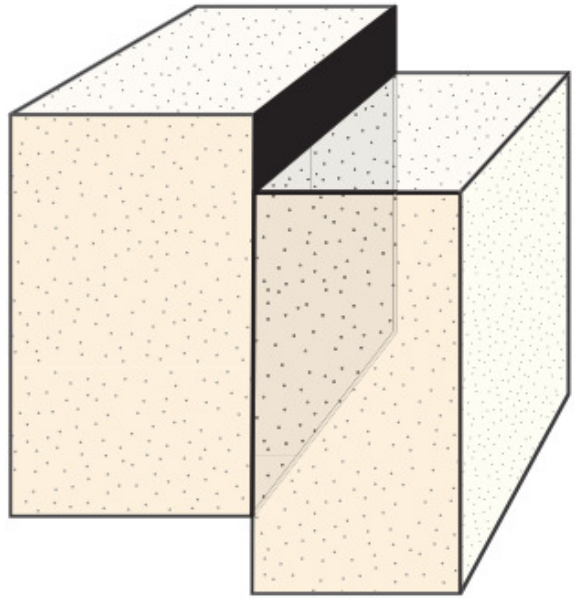
Joints are the most common type of extension fracture at or near the surface of the Earth and involve very small strains.

Shear fractures

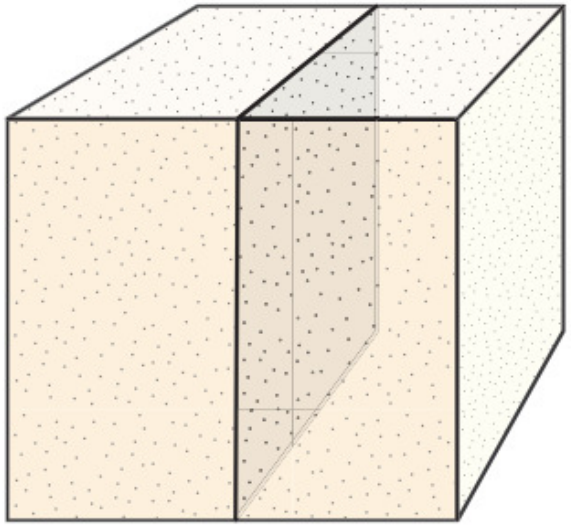
Shear fractures show fracture parallel slip and typically develop at 20–30 to $\sigma 1$,

A fracture is any planar or subplanar discontinuity that is very narrow in one dimension compared to the other two and forms as a result of external (e.g. tectonic) or internal (thermal or residual) stress.

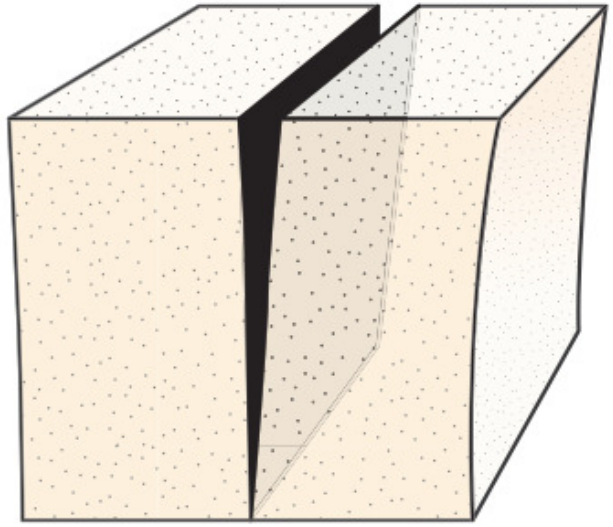
Fractures are discontinuities in displacement and mechanical properties where rocks or minerals are broken, and reduction or loss of cohesion characterizes fractures.



Shear fracture

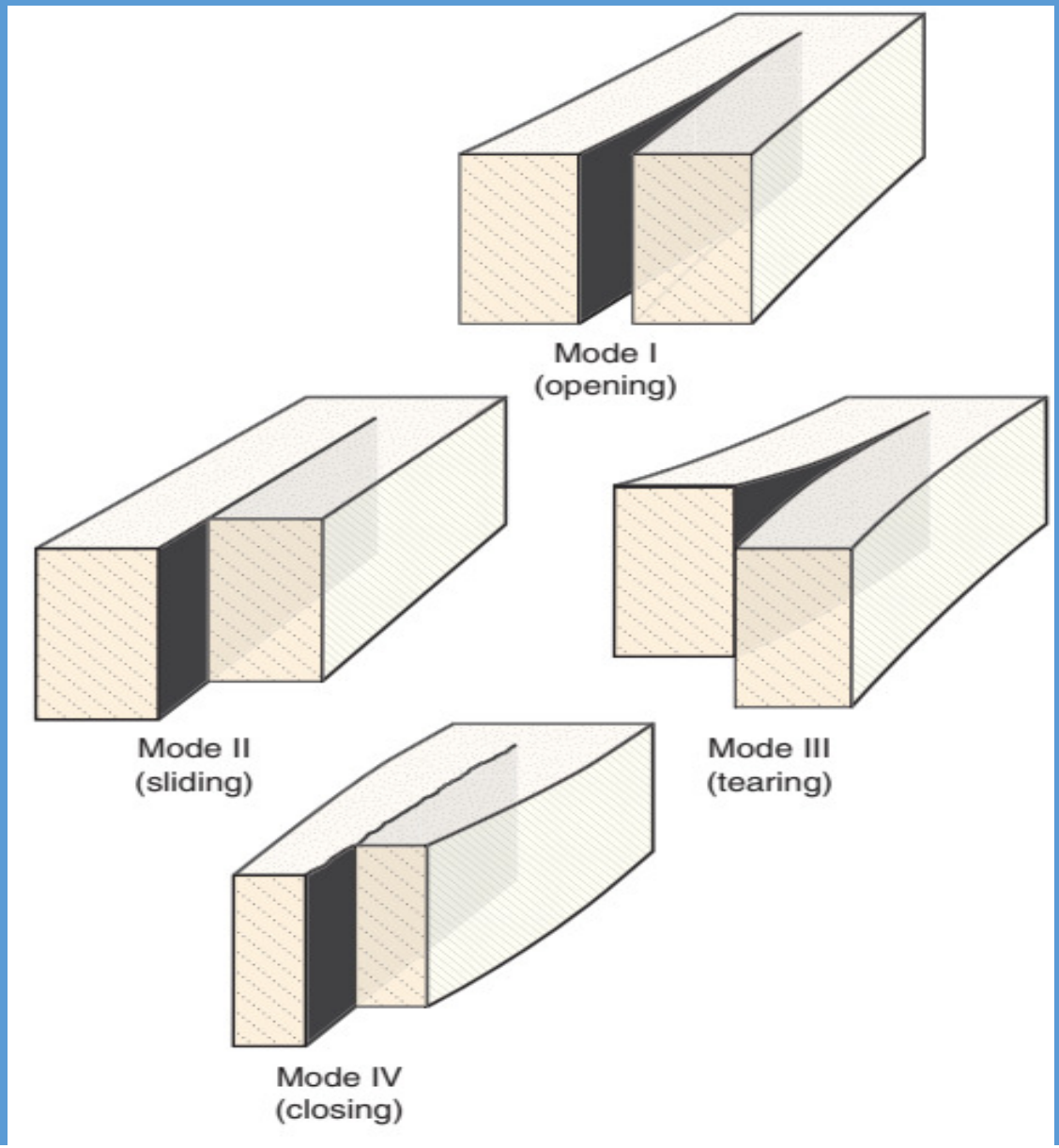


Extension fracture:
Joint



Extension fracture:
Fissure

In the field of fracture mechanics it is common to classify the displacement field of fractures or cracks into IV different modes.



Mode I is the opening (extension) mode where displacement is perpendicular to the walls of the crack.

Mode II (sliding mode) represents slip (shear) perpendicular to the edge

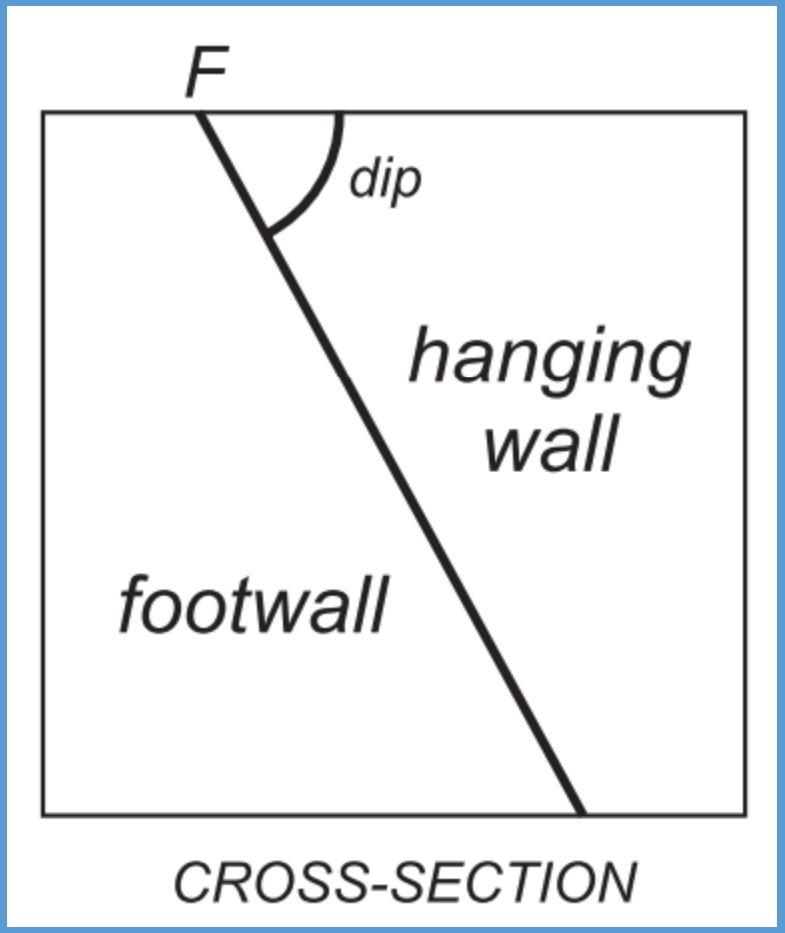
Mode III (tearing mode) involves slip parallel to the edge of the crack.
Mode IV (closing mode) is sometimes used for contractional features such as stylolites.

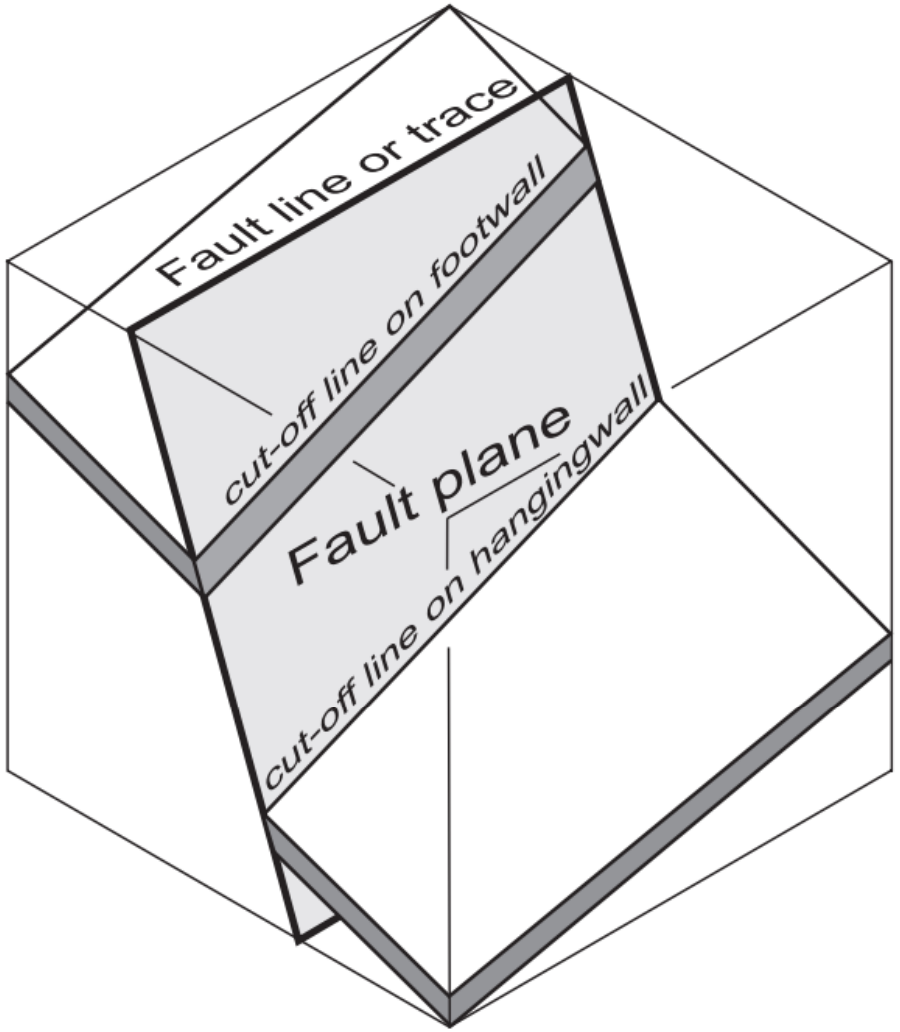
Fault: a surface along which appreciable displacement has taken place; this surface may be planar or curviplanar.
Fault zone: a zone containing a number of parallel or anastomosing faults.
Echelon faults: relatively short, parallel faults of a zone which display an overlapping pattern.
Shear zone: a zone across which two blocks have been displaced in fault-like manner, but without development of visible fractures.

Footwall: the surface bounding the body of rock immediately below a non-vertical fault. The body of rock itself is called the footwall block.

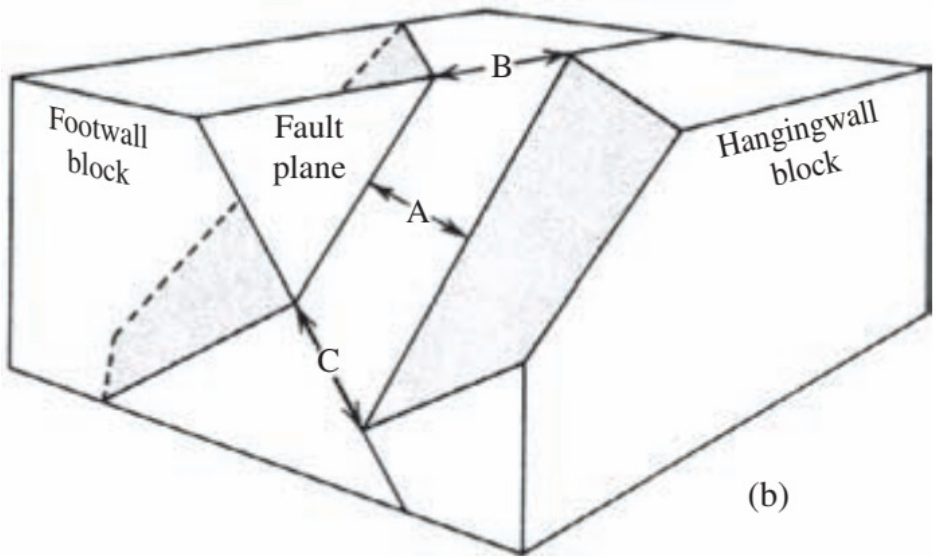
Hanging wall: the surface bounding the body of rock immediately above a non-vertical fault. The body of rock itself is called the hanging wall block.

Cut-off line: the trace of a displaced plane on the fault surface; these lines occur in pairs, one on the footwall and one on the hanging wall.

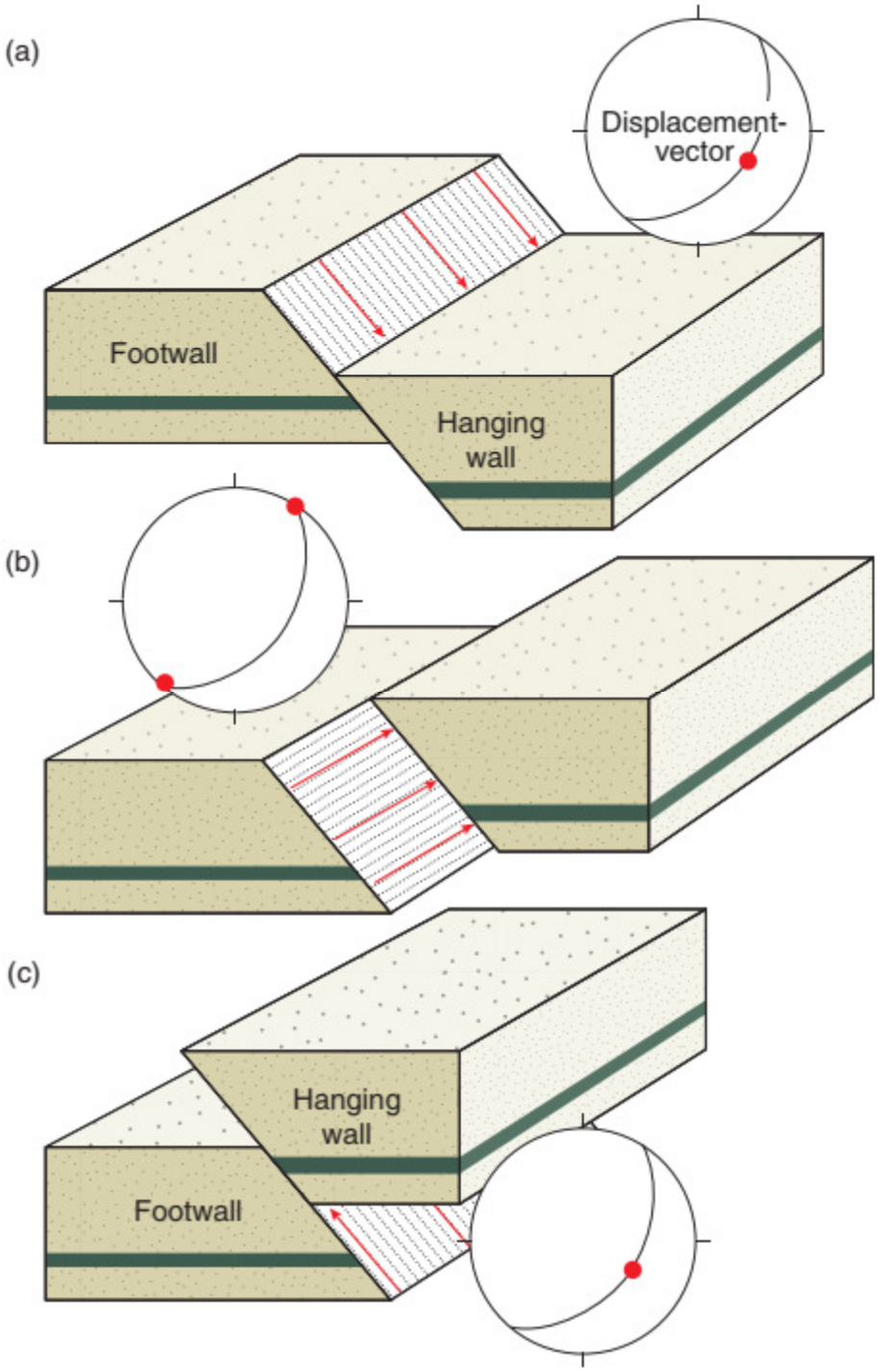

F
dip
hanging
wall
footwall
CROSS-SECTION


Fault line or trace
cut-off line on footwall
Fault plane
cut-off line on hangingwall

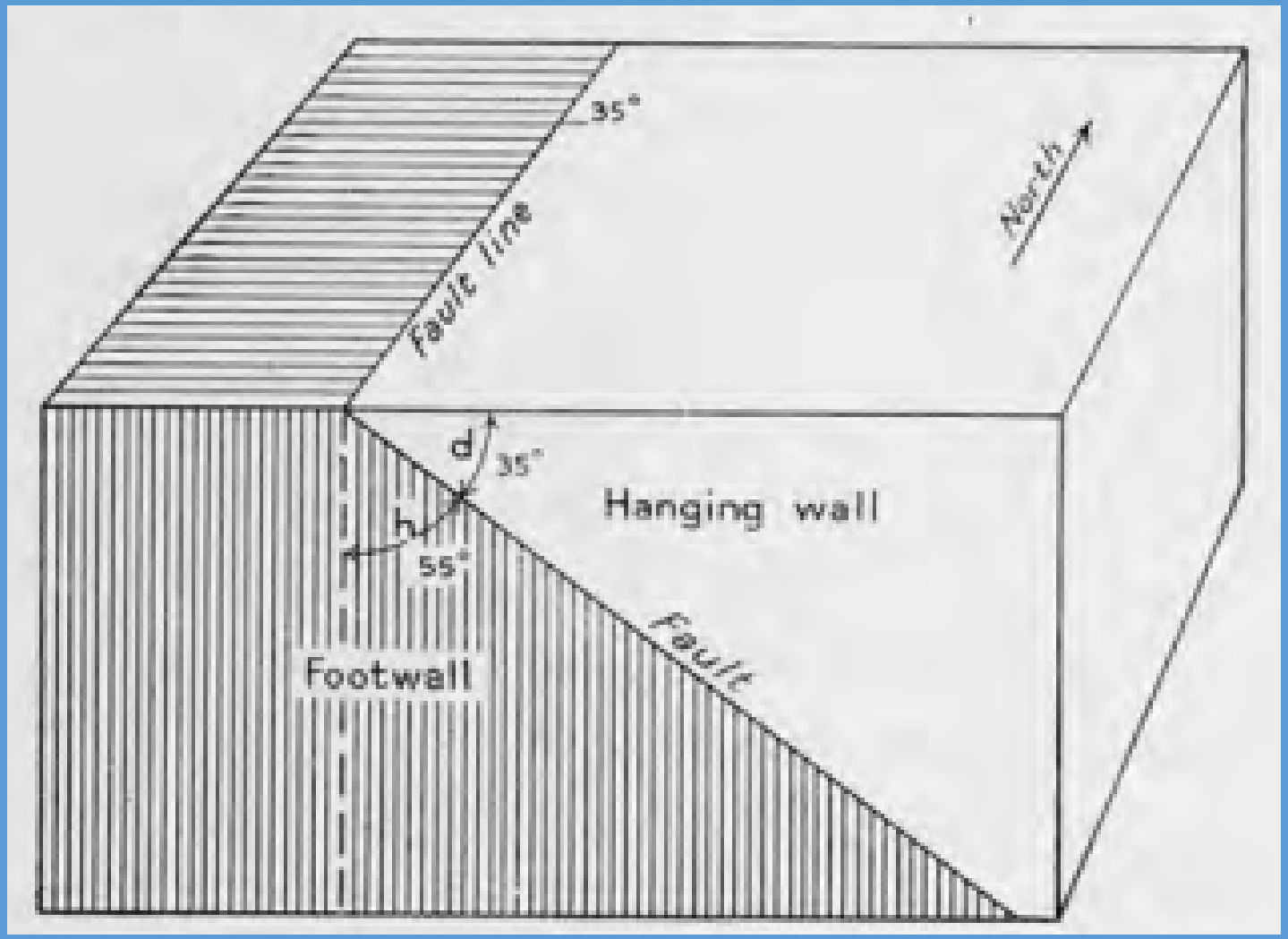
Separation: the distance between two displaced planes. It may be measured on the fault perpendicular to the cut-off lines, but more commonly in the strike or dip directions. On the other hand, *stratigraphic separation* is measured perpendicular to the displaced strata, not in the plane of the fault.



A = separation, B = strike separation; C = dip separation

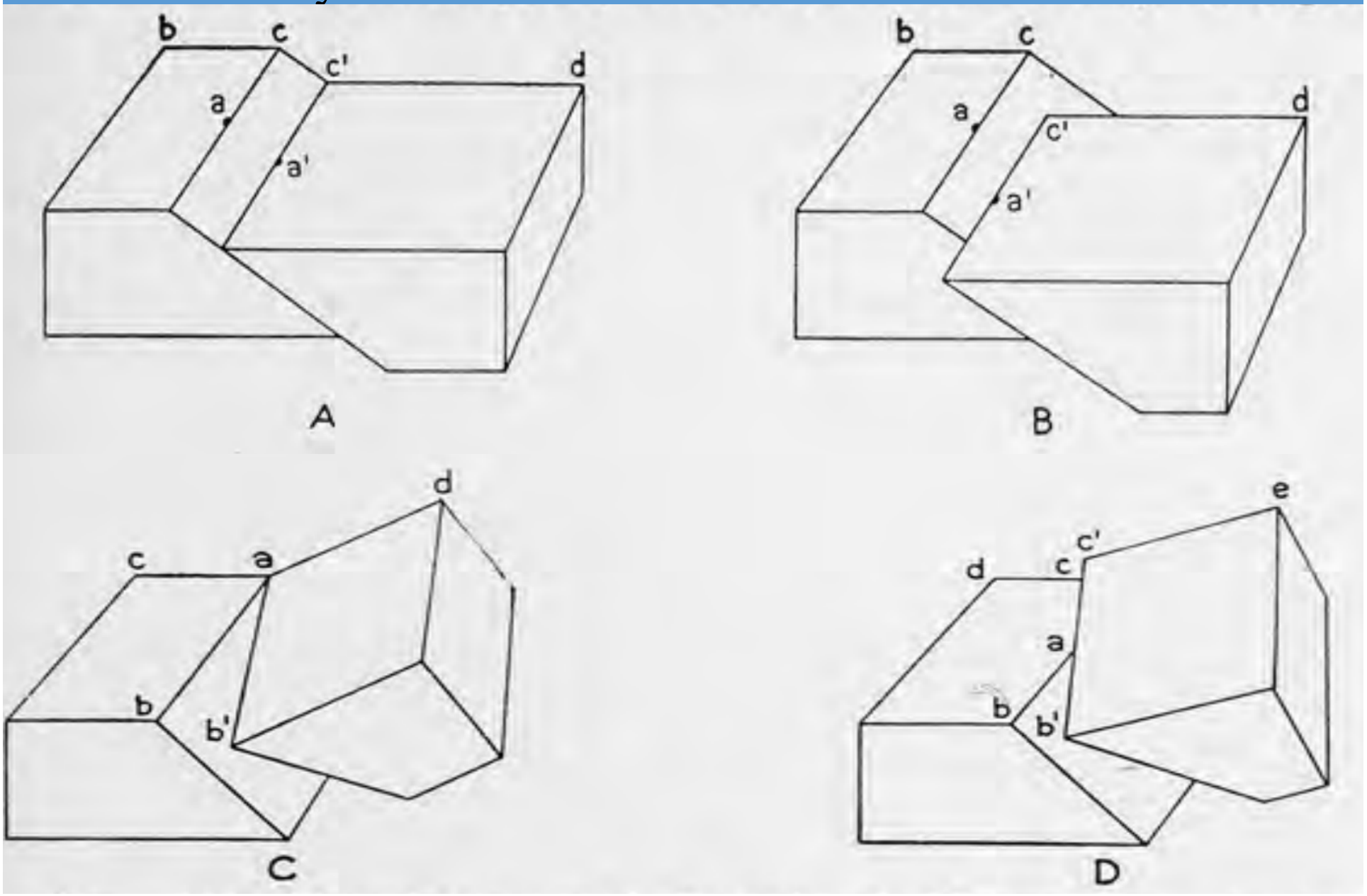


The intersection of the fault with the surface of earth is known as the *fault line, fault trace or fault outcrop.*

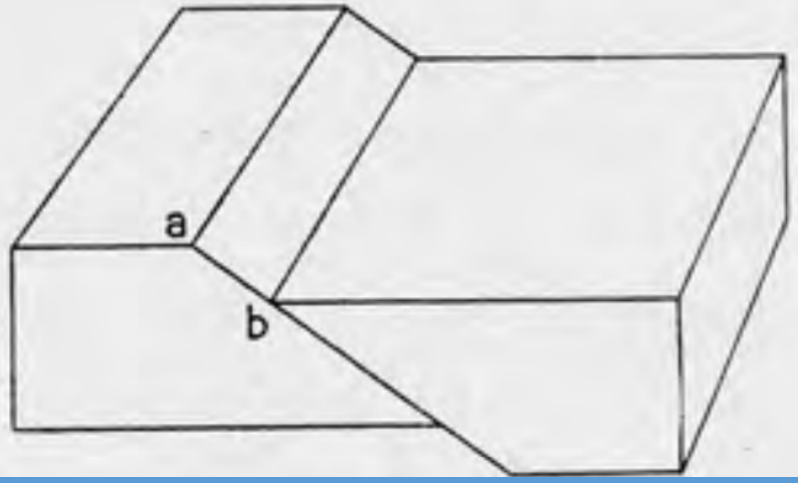


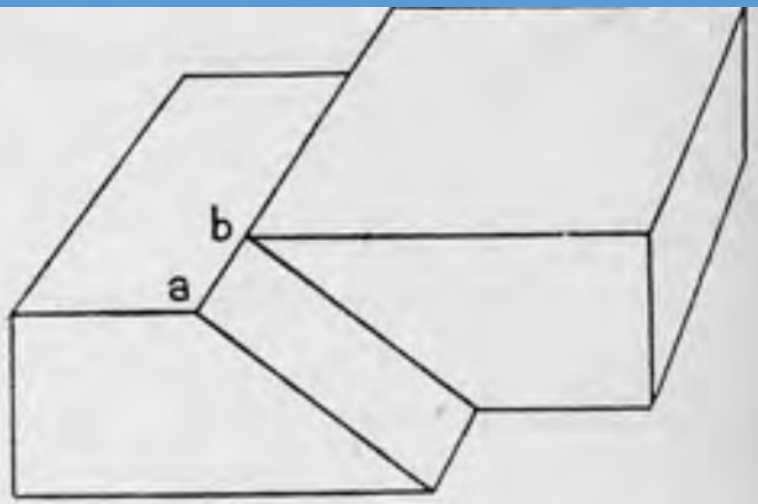
Nature of movement along fault plane

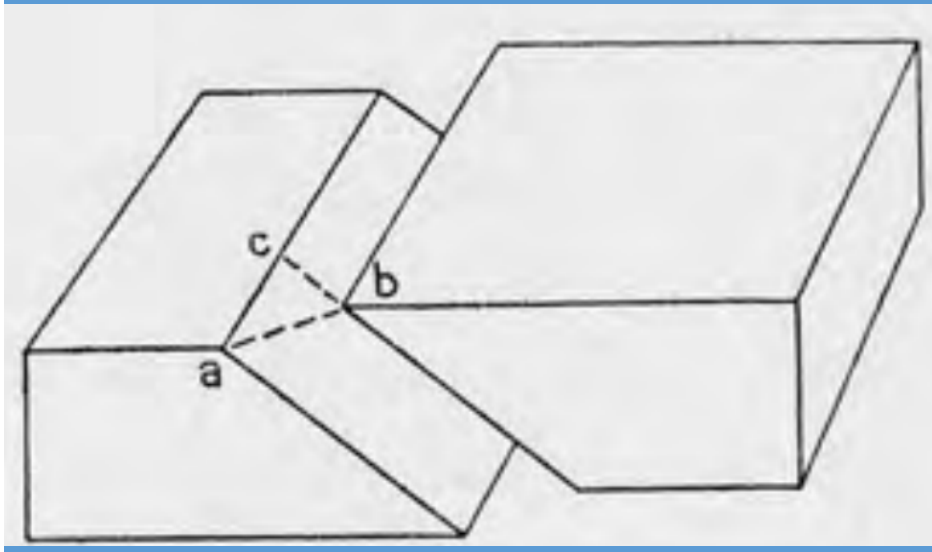
Translatory and Rotational movement

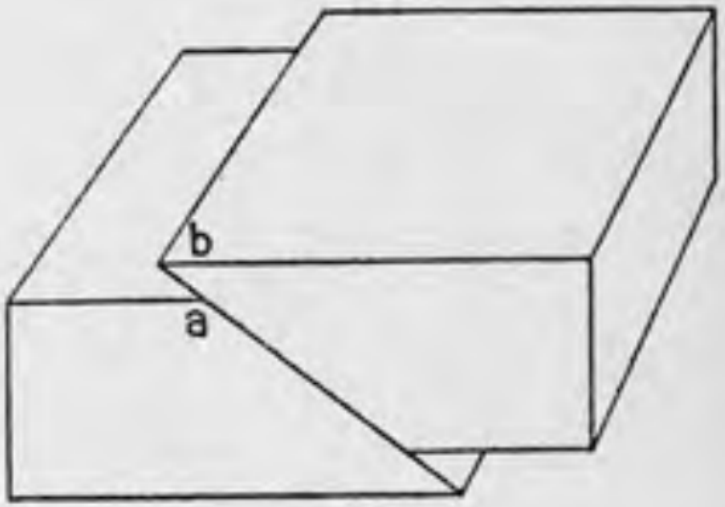


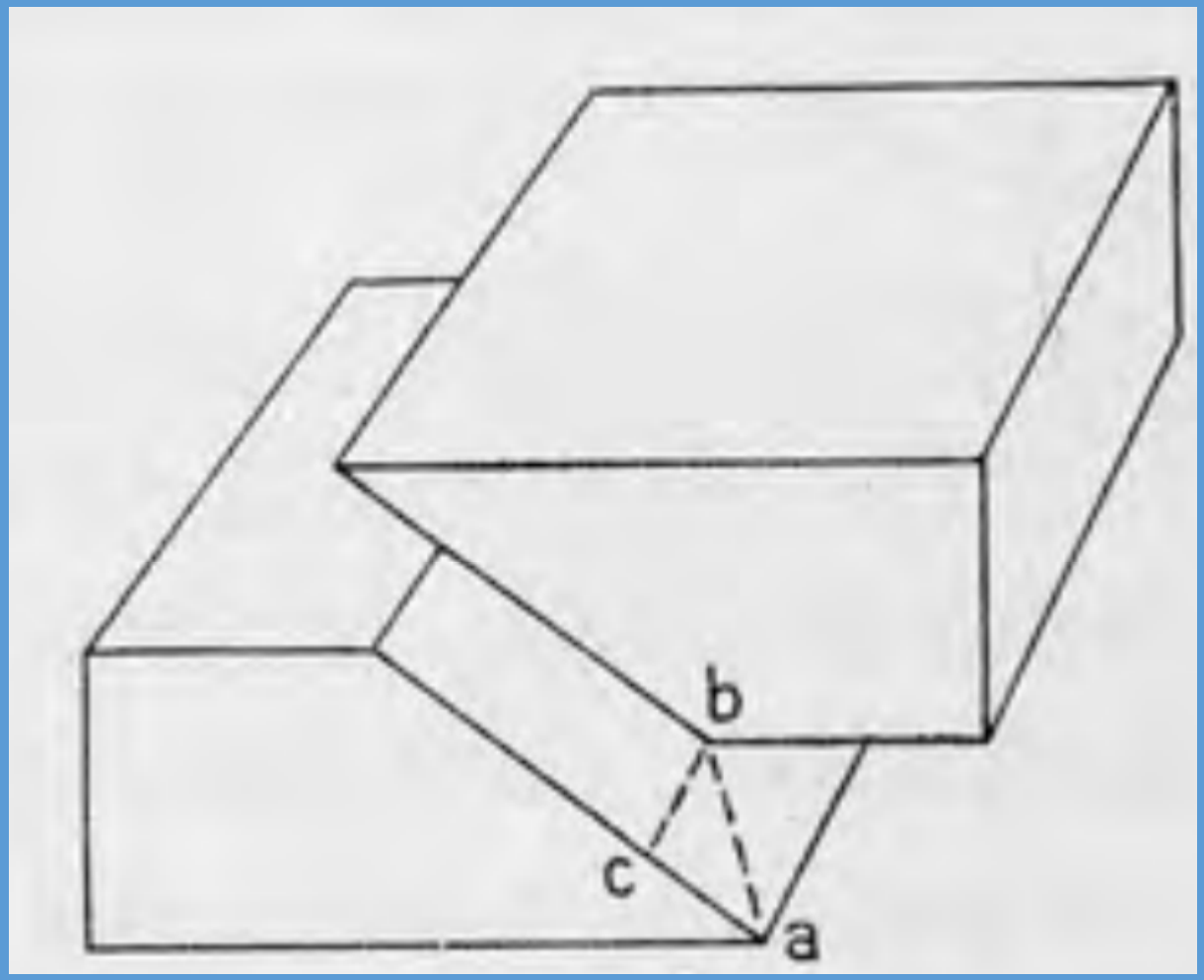
Slip: the relative displacement of formerly adjacent points on opposite side of the fault , and it is measured in fault plane .



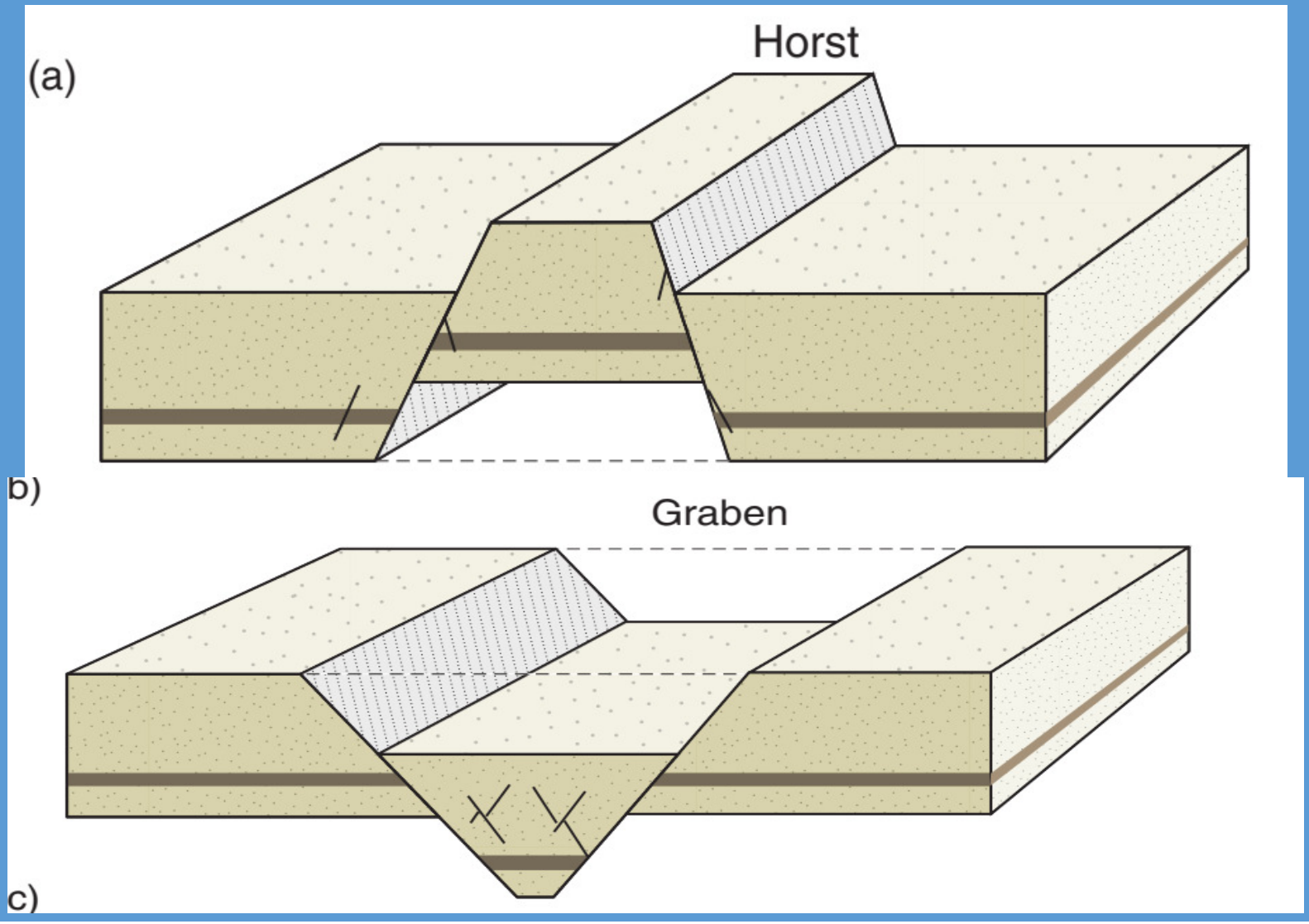







b
c
a

Two separate normal faults dipping toward each other create a down thrown block known as a graben .
Normal faults dipping away from each other create an up thrown block called a horst.



The two separations recorded in a vertical section are more commonly referred to as heave (horizontal component) and throw (vertical component)