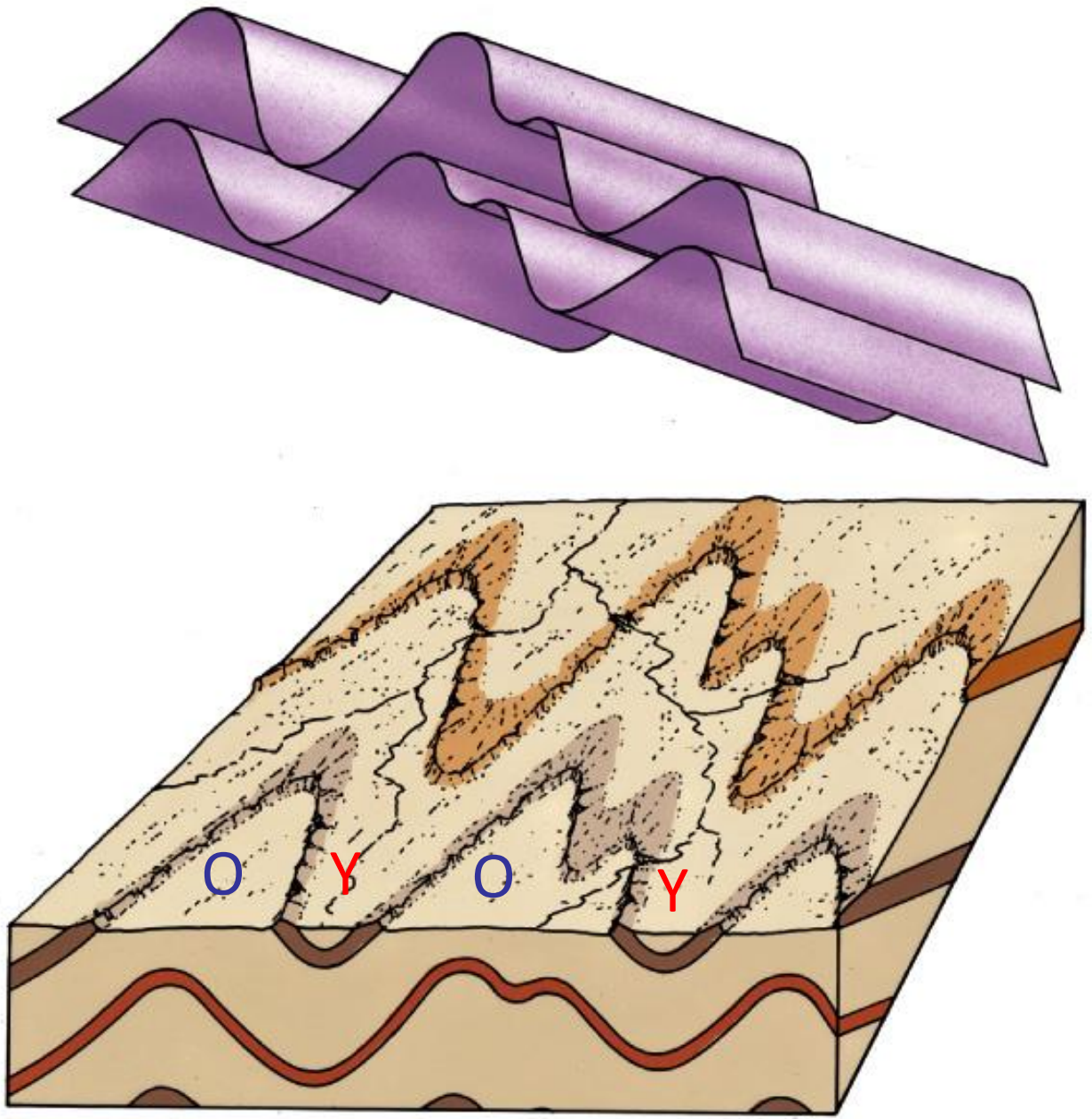
ES2105: Earth Science Lab 1

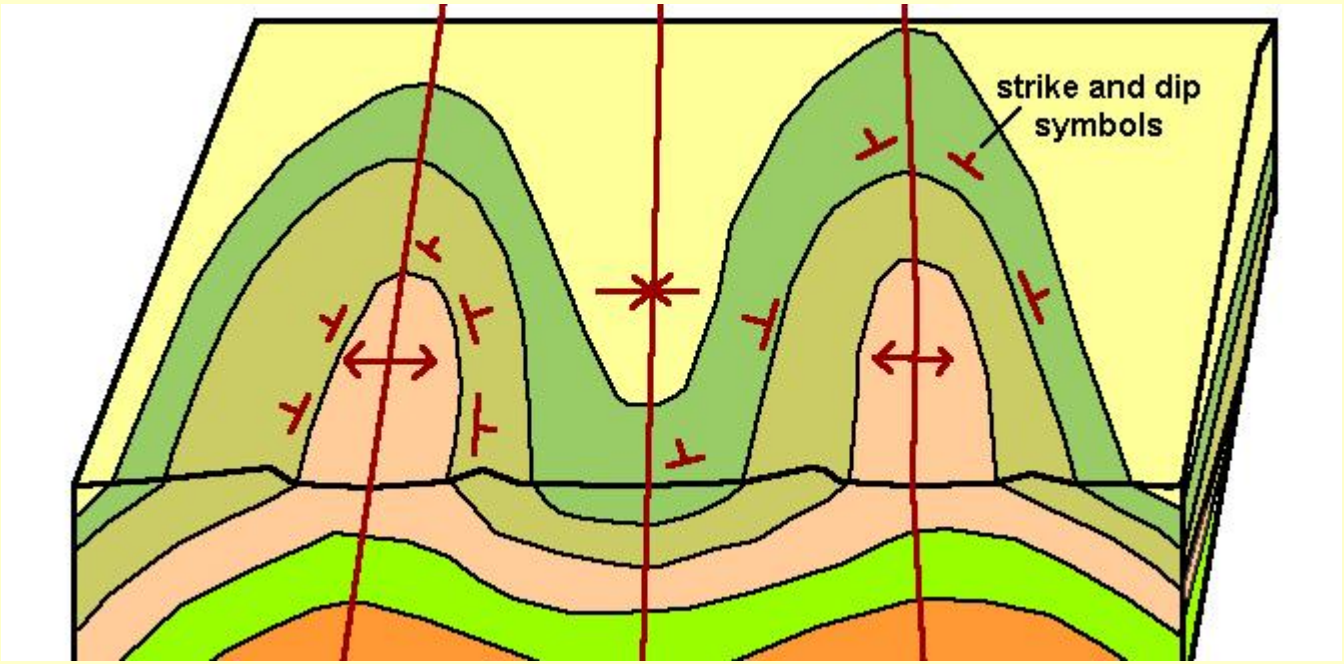
Deformation?

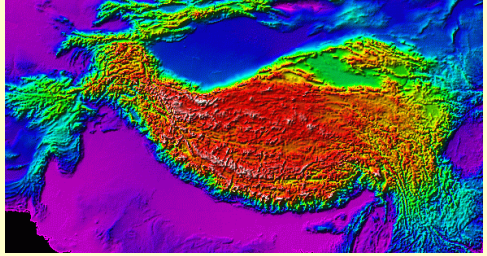
Reference: Bedding Plane

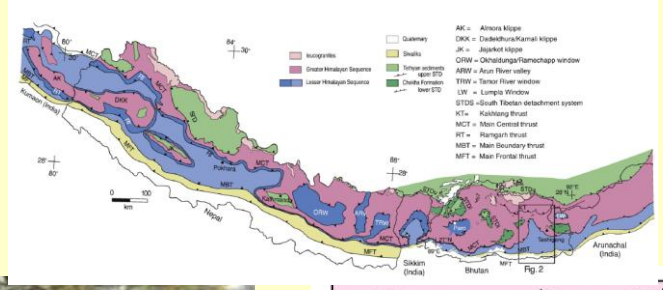

O
Y
O
Y

Folds

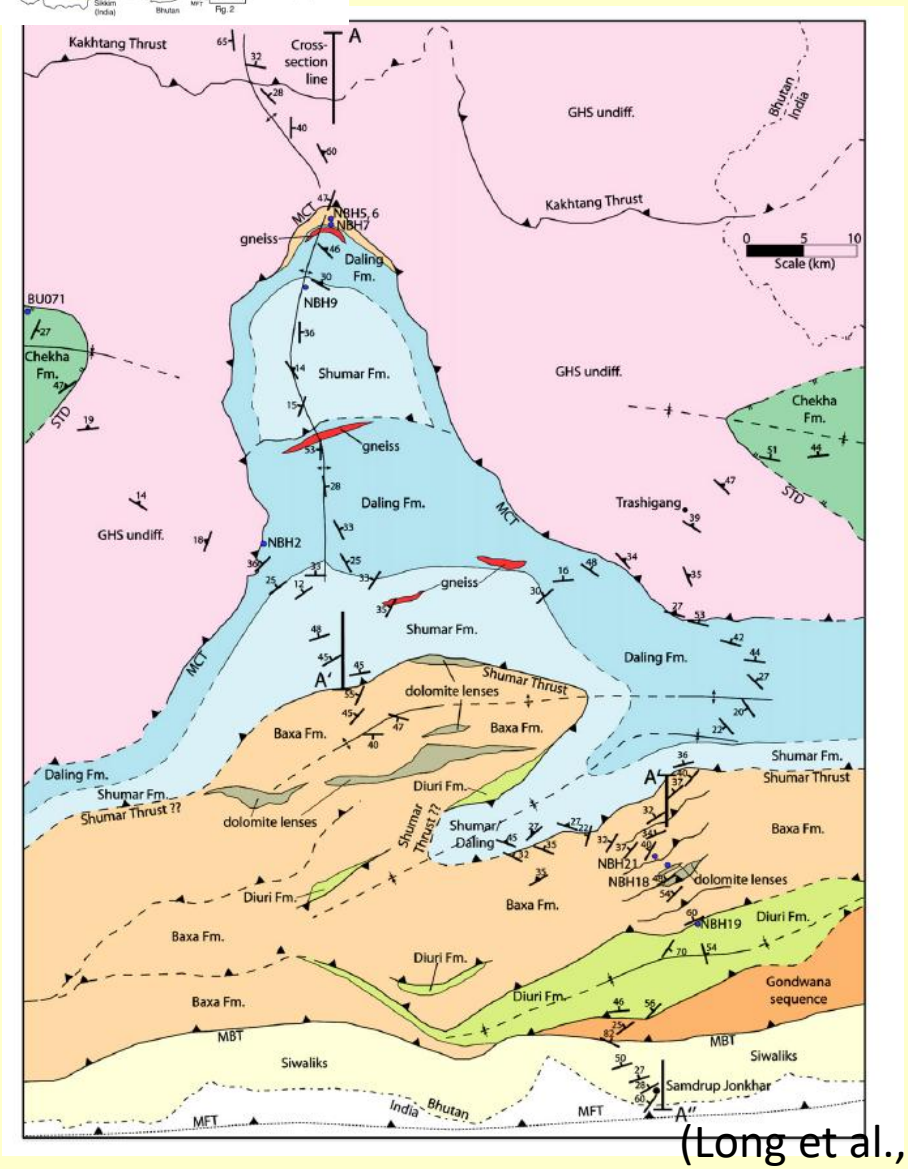
3D<------>2D



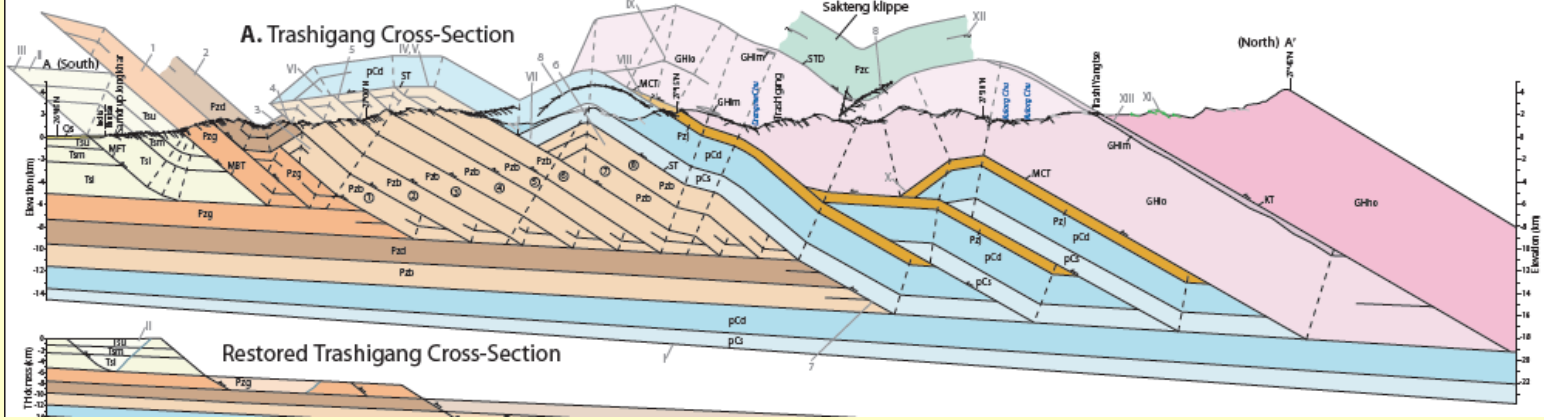




(Robinson and Pearson, 2006)

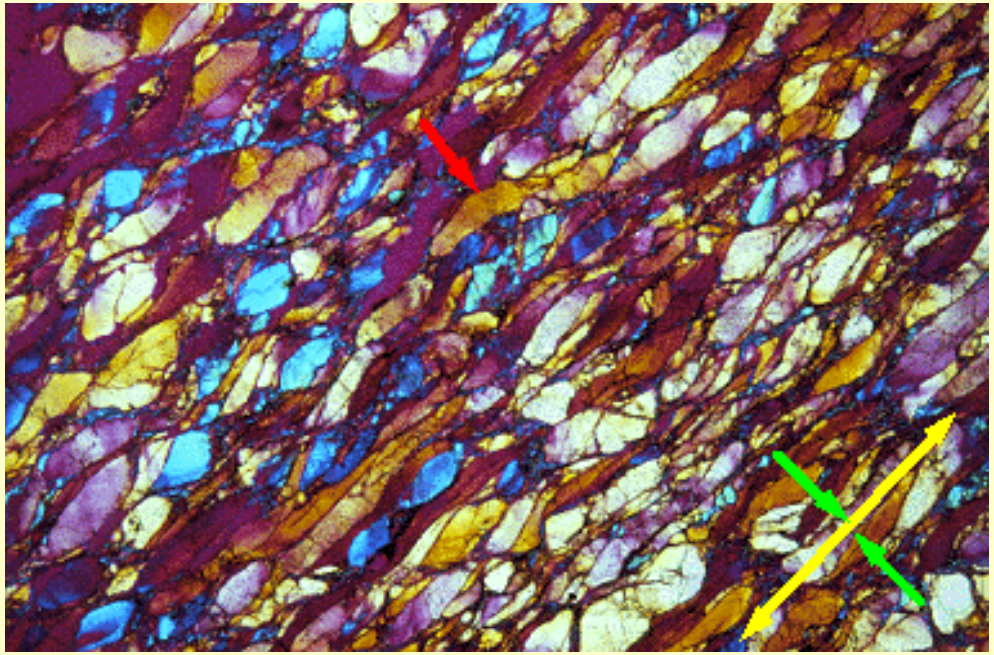


(Long et al., 2011)



(Long et al., 2011)

Strain Markers (Elliptical objects)



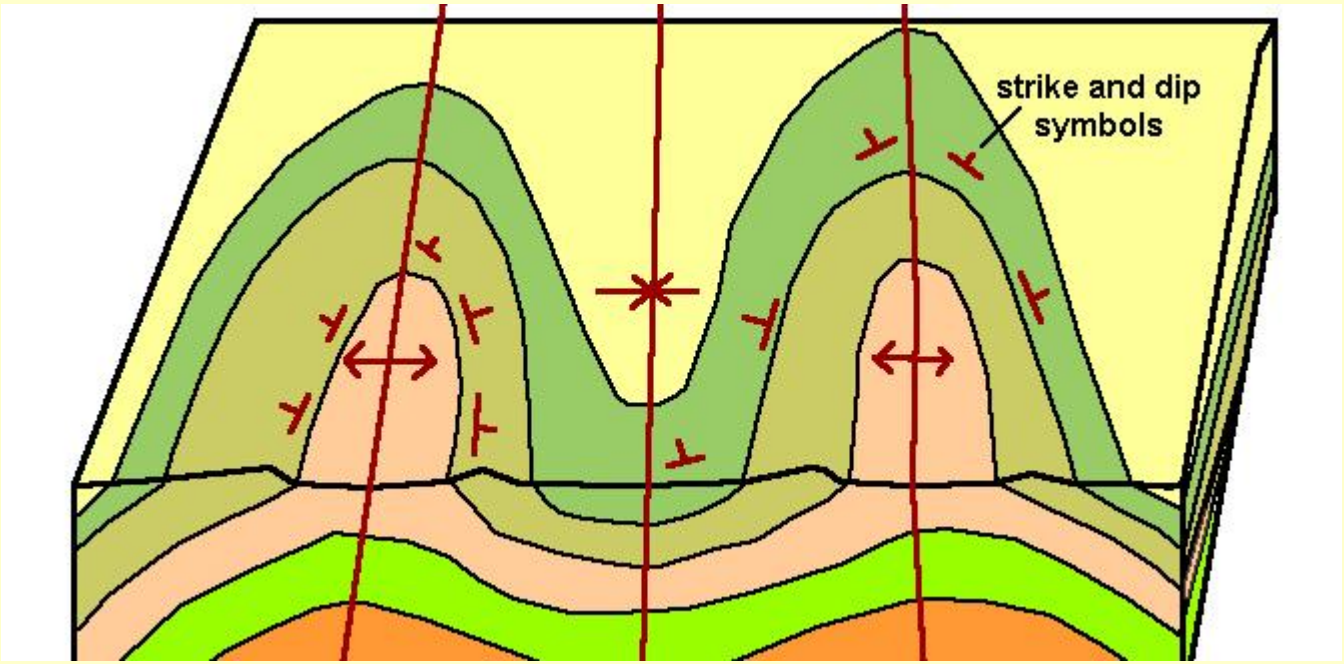
Attitudes of Planes (Angle it makes with 3 coordinate axes)

- Strike of a Plane
- Dip of a Plane

Strike line: A horizontal line on a plane.

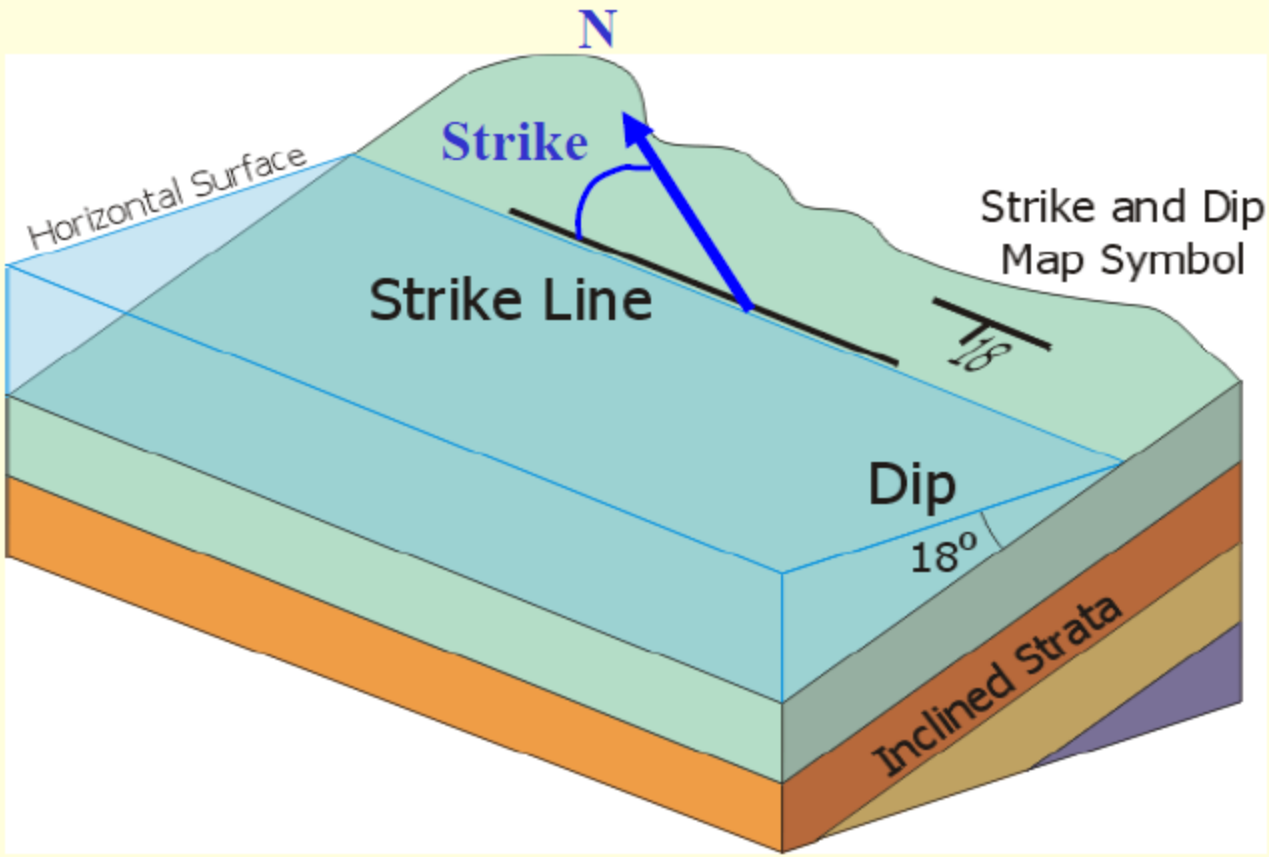
Line of intersection (trace) between a horizontal plane and the structure

3D<------>2D



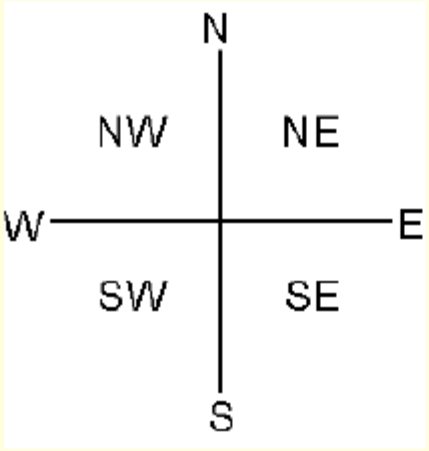
Attitudes of Planes

Strike: The angle between the strike line and true north.

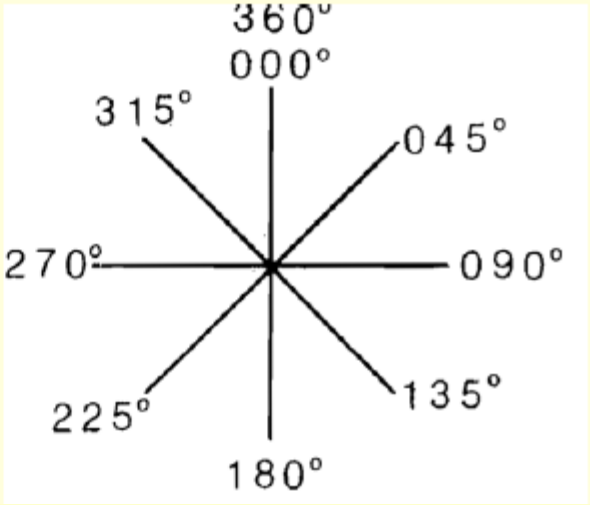


Two conventions for representing Strike of a plane:

(a) Quadrant Convention



(b) Azimuth Convention



Quadrant convention: All possible directions for a strike are divided into four quadrants of 90°each.

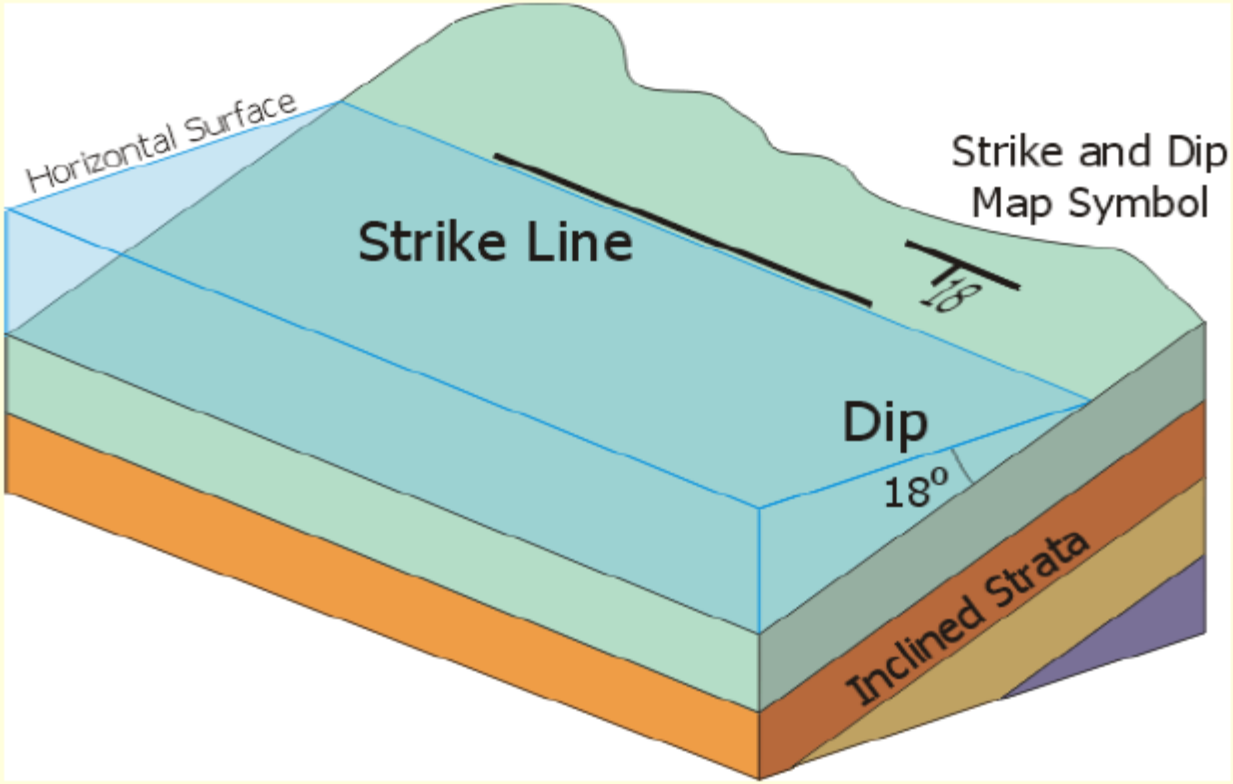
- Strike represented in terms of "given number of degrees" E/W from N.
- General convention, strike expressed in terms of N.

Azimuth convention: Range of possible direction on a horizontal plane divided in 360°; direction of due N assigned 000°/360°.

- All strike directions must have three digit numbers.

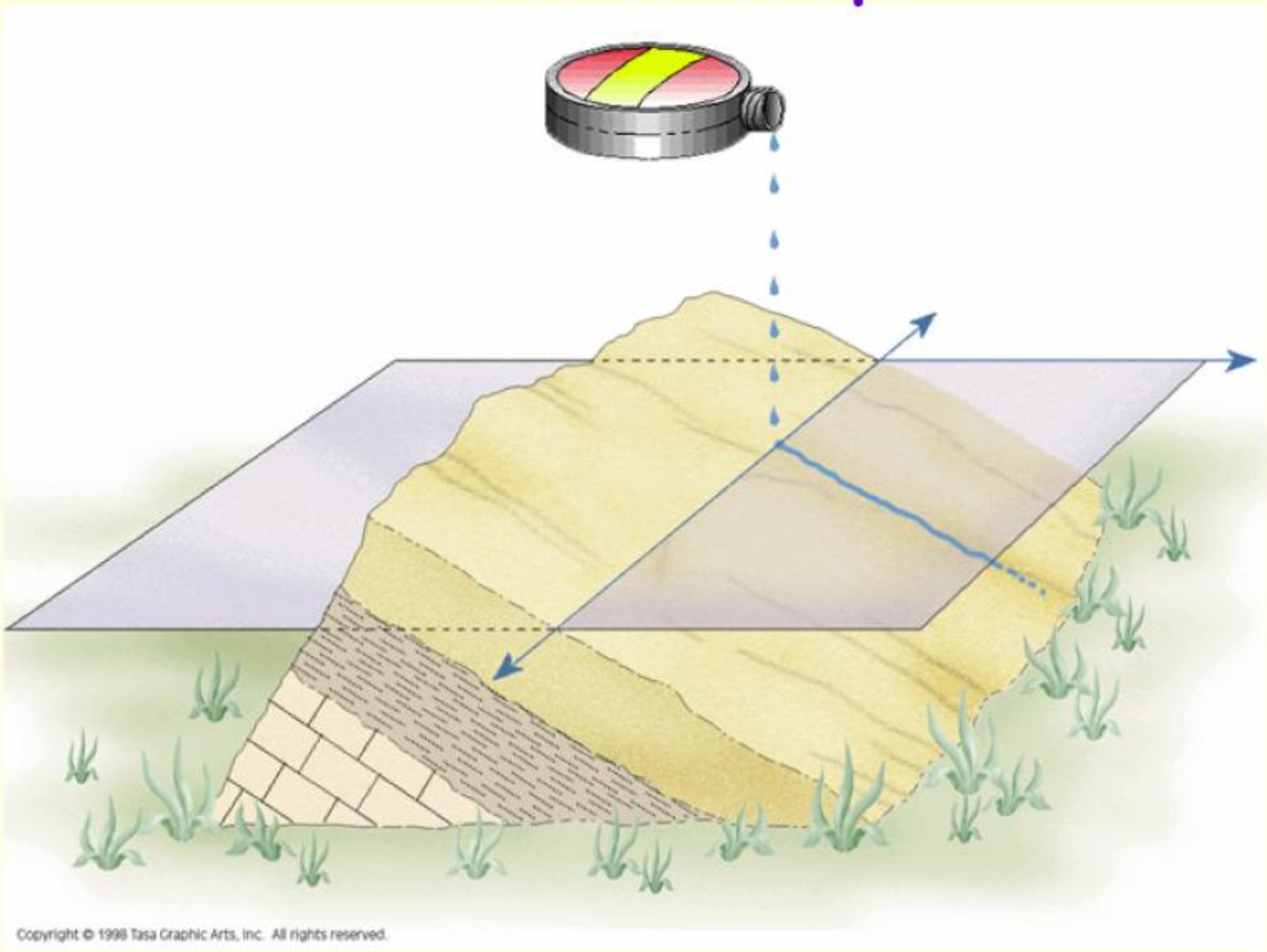
Dip of a plane:

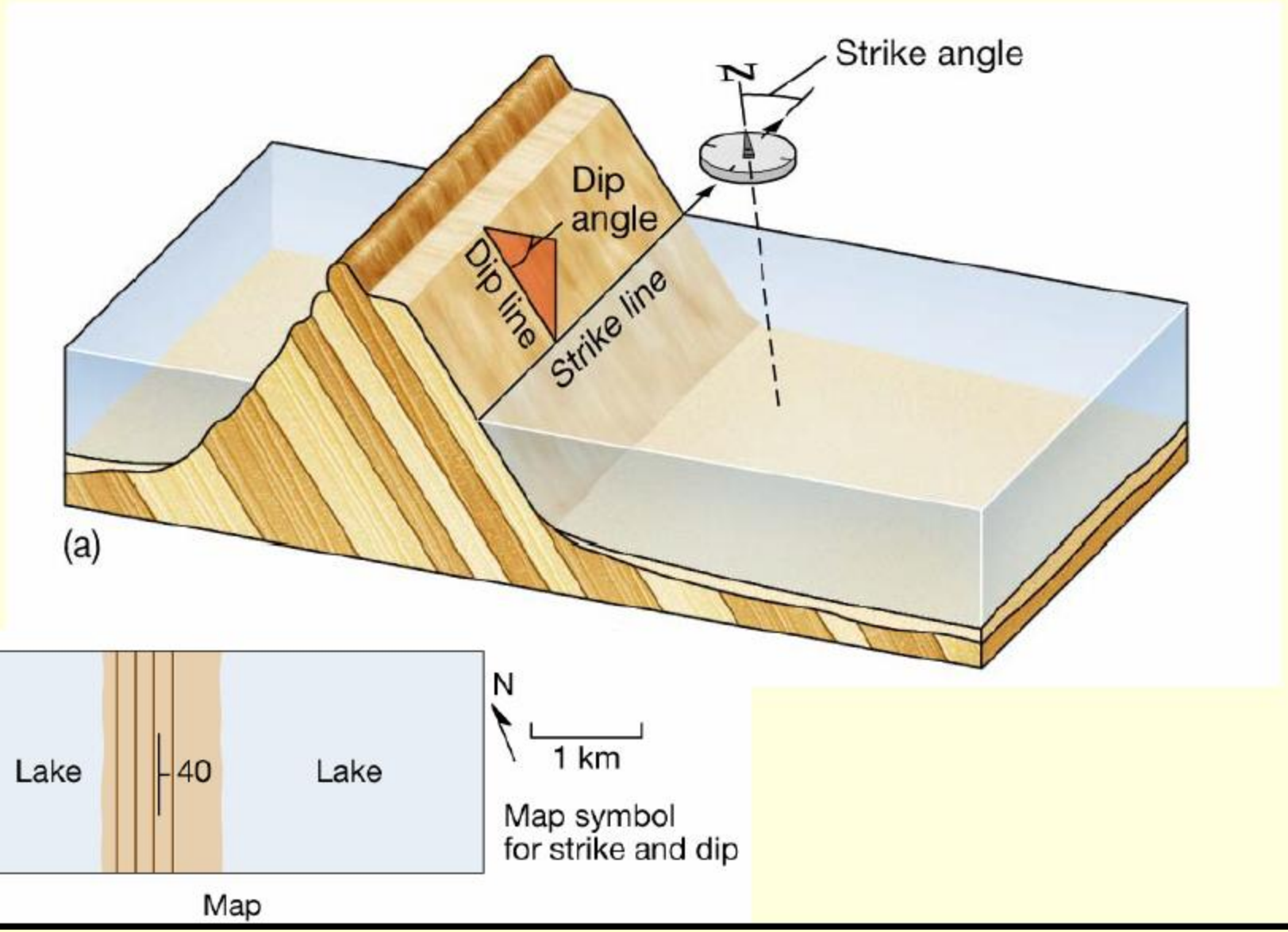
• True Dip of a plane: Angle between the plane and a horizontal plane as measured in a unique vertical plane that lies perpendicular to the strike line.



• True dip is the steepest possible slope on a given plane.
• True dip direction is the azimuth perpendicular to the strike

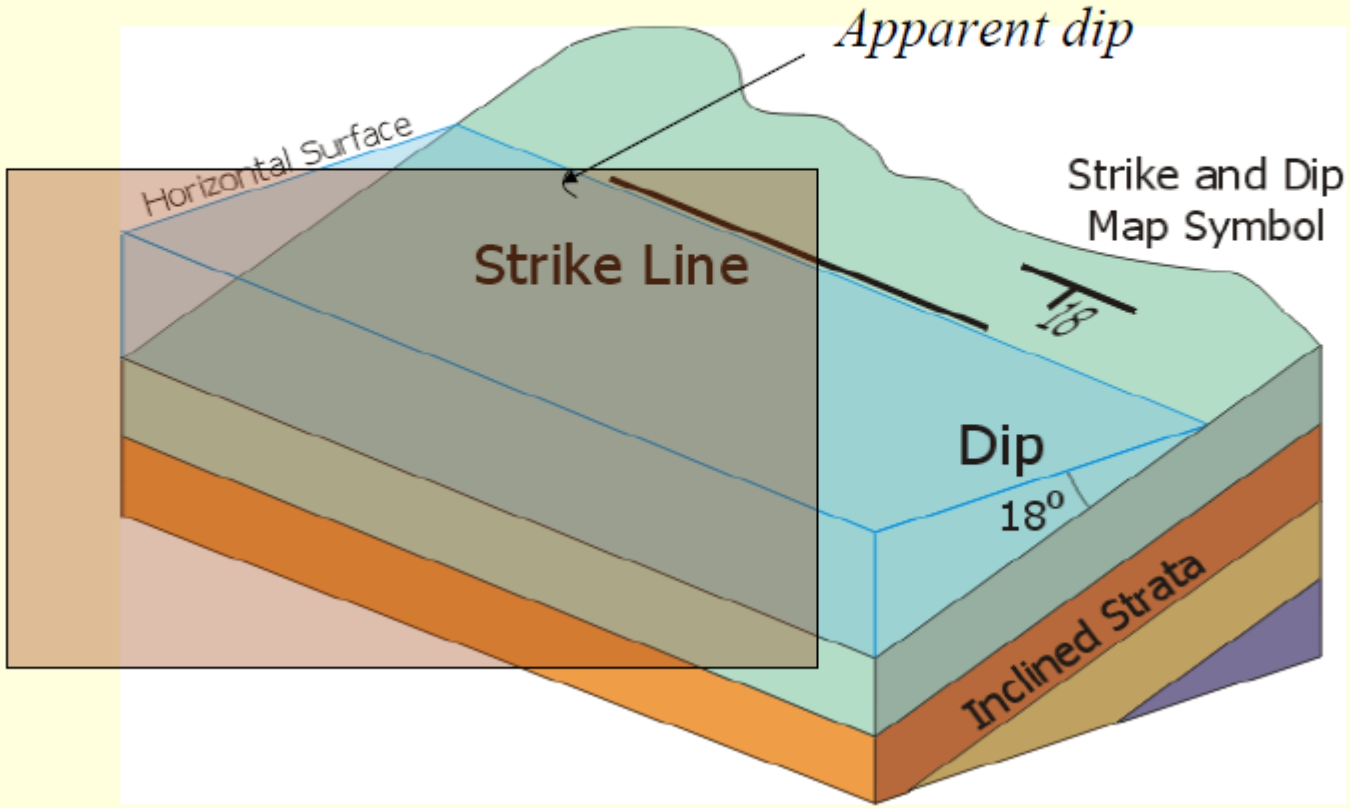
Strike and Dip




N
Strike angle
Dip angle
Dip line
Strike line
(a)
Lake
40
Lake
N
1 km
Map symbol for strike and dip
Map

What is apparent dip?

- Dip angle measured in any vertical plane that is not perpendicular to the strike of the plane



Representation of planar attitudes

- Strike
- Dip

Anything Missing?!

Representation of planar attitudes

- Strike
- Dip
- Dip Direction

Anything missing?

Representation of planar attitudes

N05°E, 35°W or 005°, 35°W

Note: Specify the quadrant toward which the plane is dipping, except if the strike is within 10° of N/S/E/W.

Representation of planar attitudes

Any other format possible?

Yes…

Dip & Dip direction

35°→285 ° Or, 35°, 285°

If moving along the dip direction?


Siccar Point, Scotlan
Hutton's Uniformata

https://www3.nd.edu/~cneal/PlanetEarth/Lab-Structural/Overturned.html

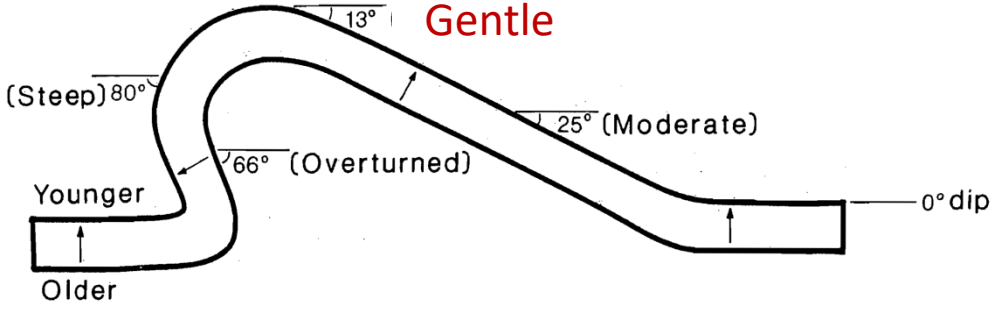
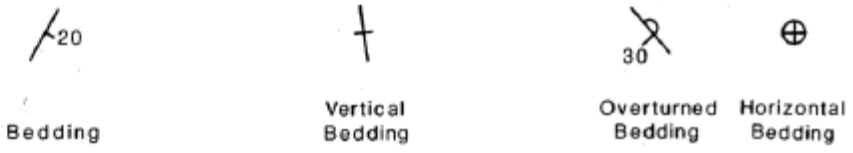


Figure 1-7. Adjectives used to describe dip of a layer. The example shows an overturned fold. The arrows indicate stratigraphic younging direction.

Map Symbols

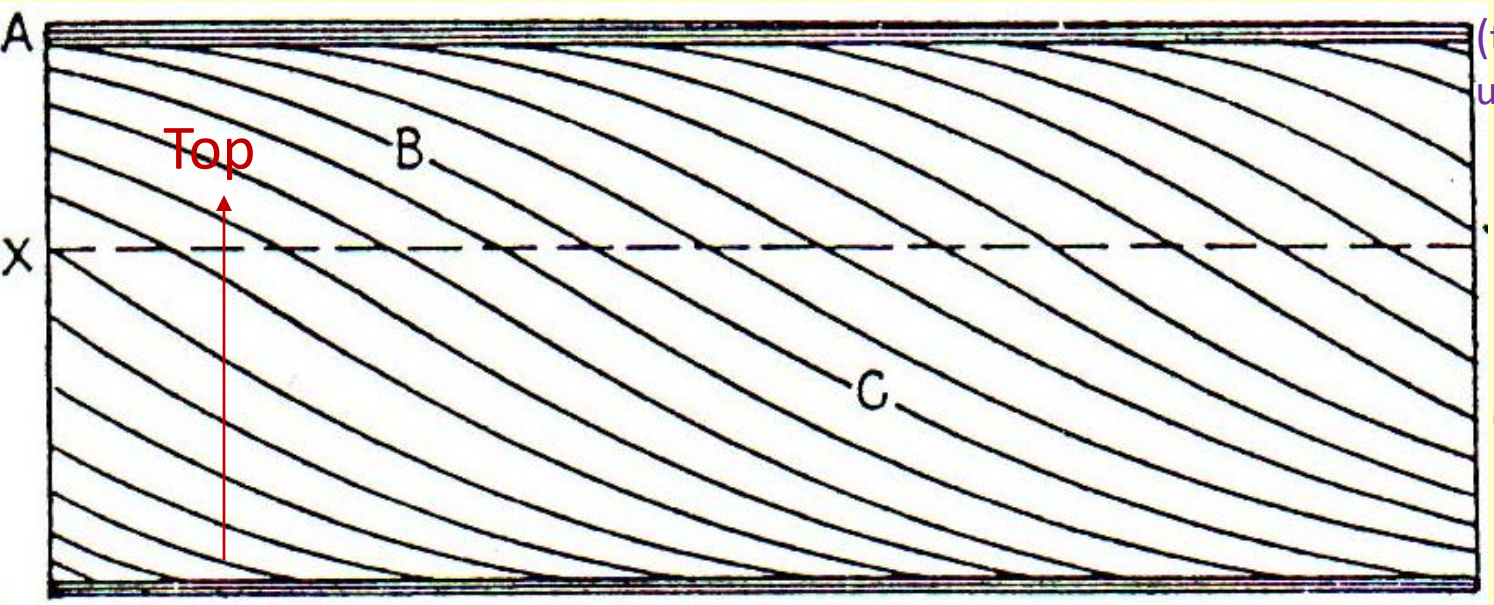
Figure 1-9. Basic symbols commonly used for specification of strike and dip of a planar structure on a map. Note that the numbers are always written in the same orientation.



Some primary structures that can help us identify the stratigraphic top/younging direction of a bed

Cross-bedding: Internal layers within one bedded unit that are oblique to the overall bounding surfaces of the master bed.

• Sediment movement from upstream /windward direction to downstream/ leeward direction (lower current velocity)



Topset
(thin beds parallel to upper bounding surface)

Penecontemporaneous erosion

Foreset
(Inclined layers)

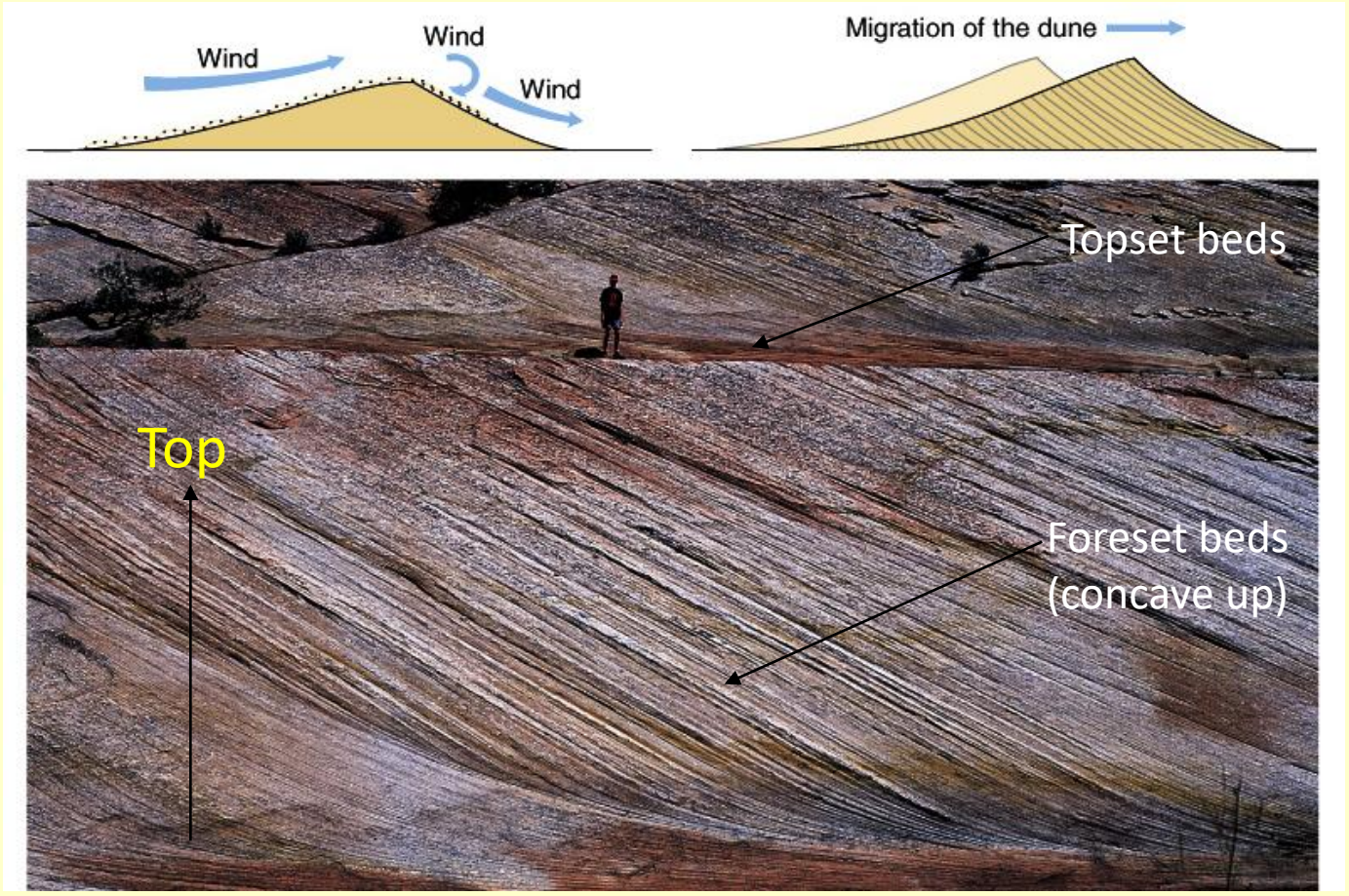
Bottom set

Direction of top: Truncate at top and asymptotic at bottom

1. Internal Structure of sedimentary rocks

Cross-bedding: Internal layers within one bedded unit that are oblique to the overall bounding surfaces of the master bed.

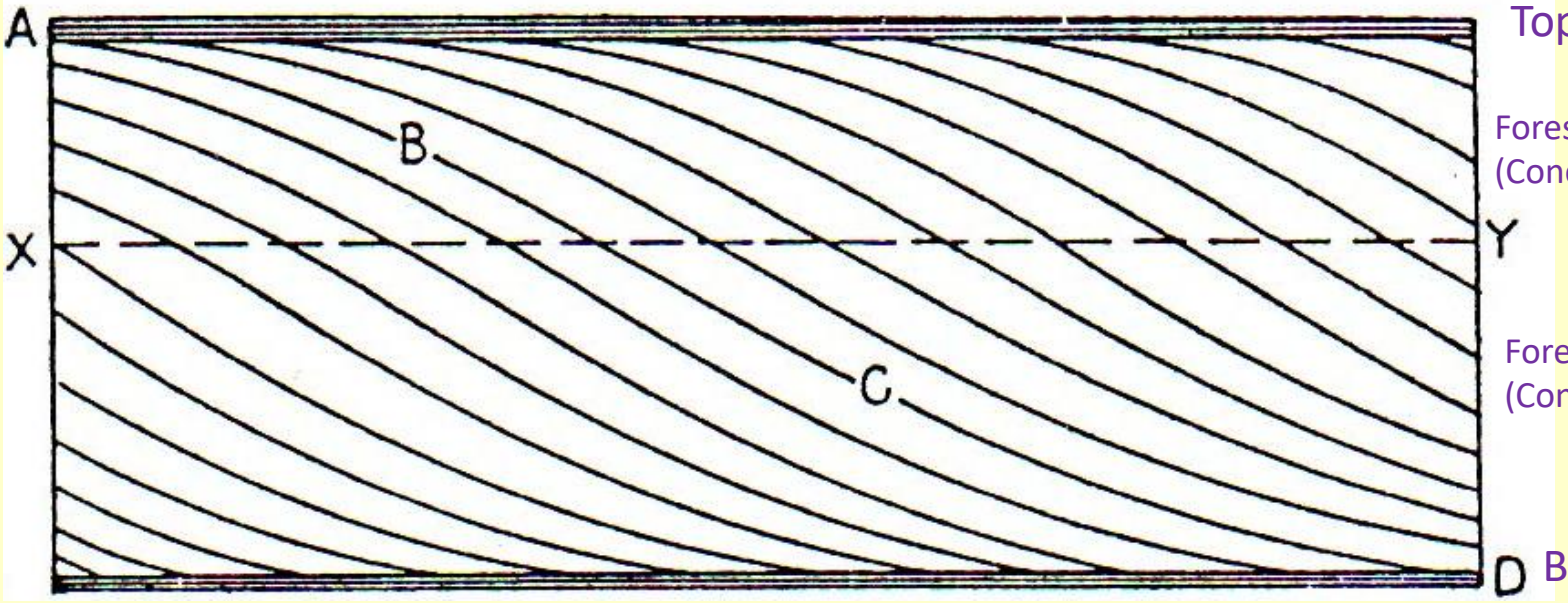
• Sediment movement from upstream /windward direction to downstream/ leeward direction (lower current velocity)



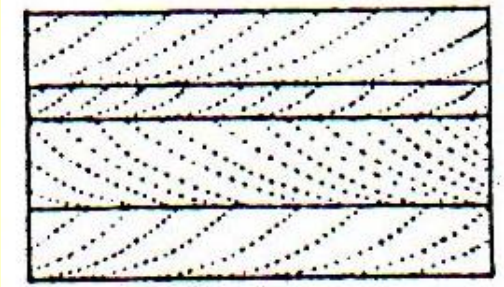
Direction of top: Truncate at top and asymptotic at bottom

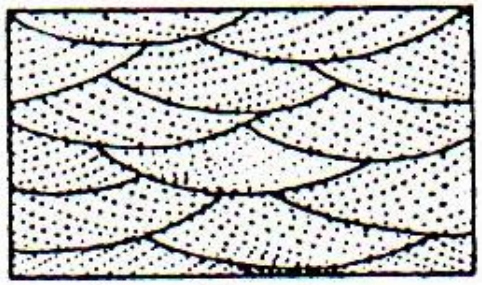
Cross Bedding

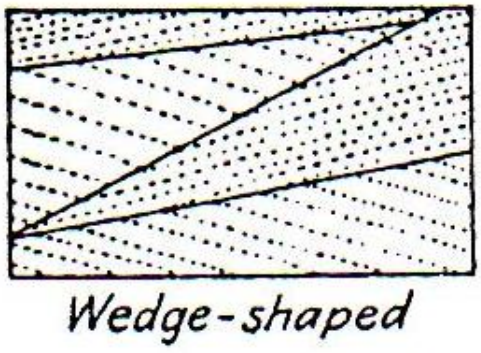
Truncate at top and asymptotic at bottom



Trough



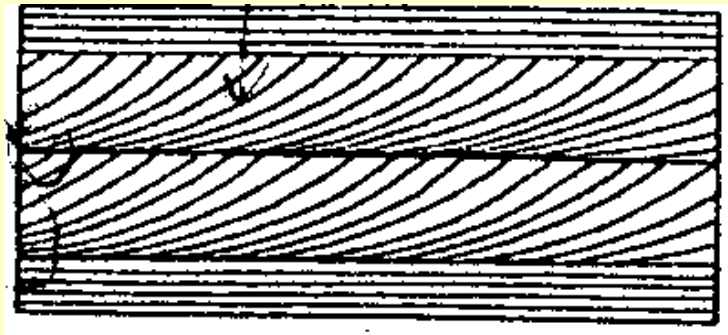




(Commonly by water-laid sediments)

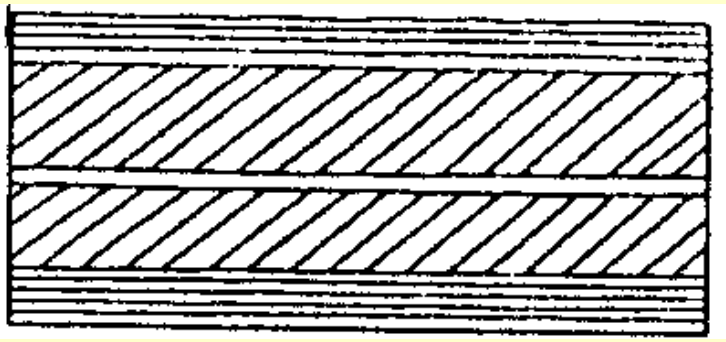
Commonly by wind deposit

Which one is more useful to structural geologists?



Normal cross-bedding

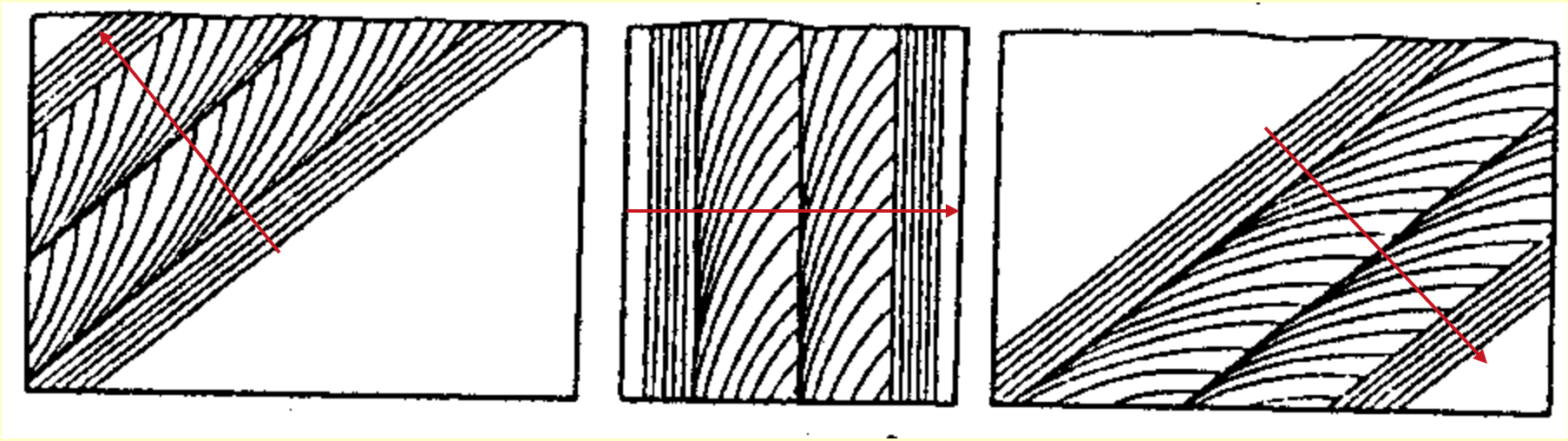
(can determine top)



Planar cross-bedding

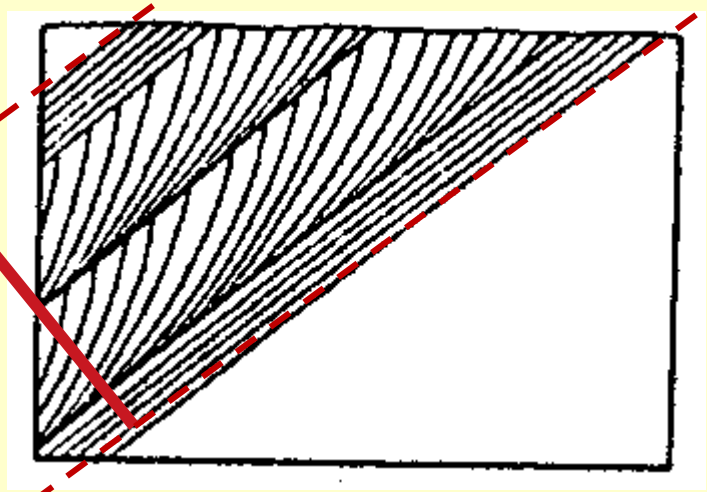
(Can't determine top)

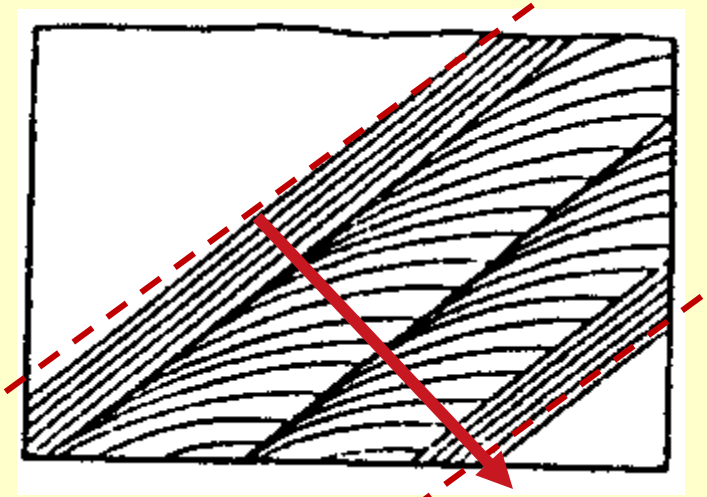
Use of normal cross-bedding to determine top of beds



Structural Facing

Right way up/normal bed





Overturned bed

Not sufficient

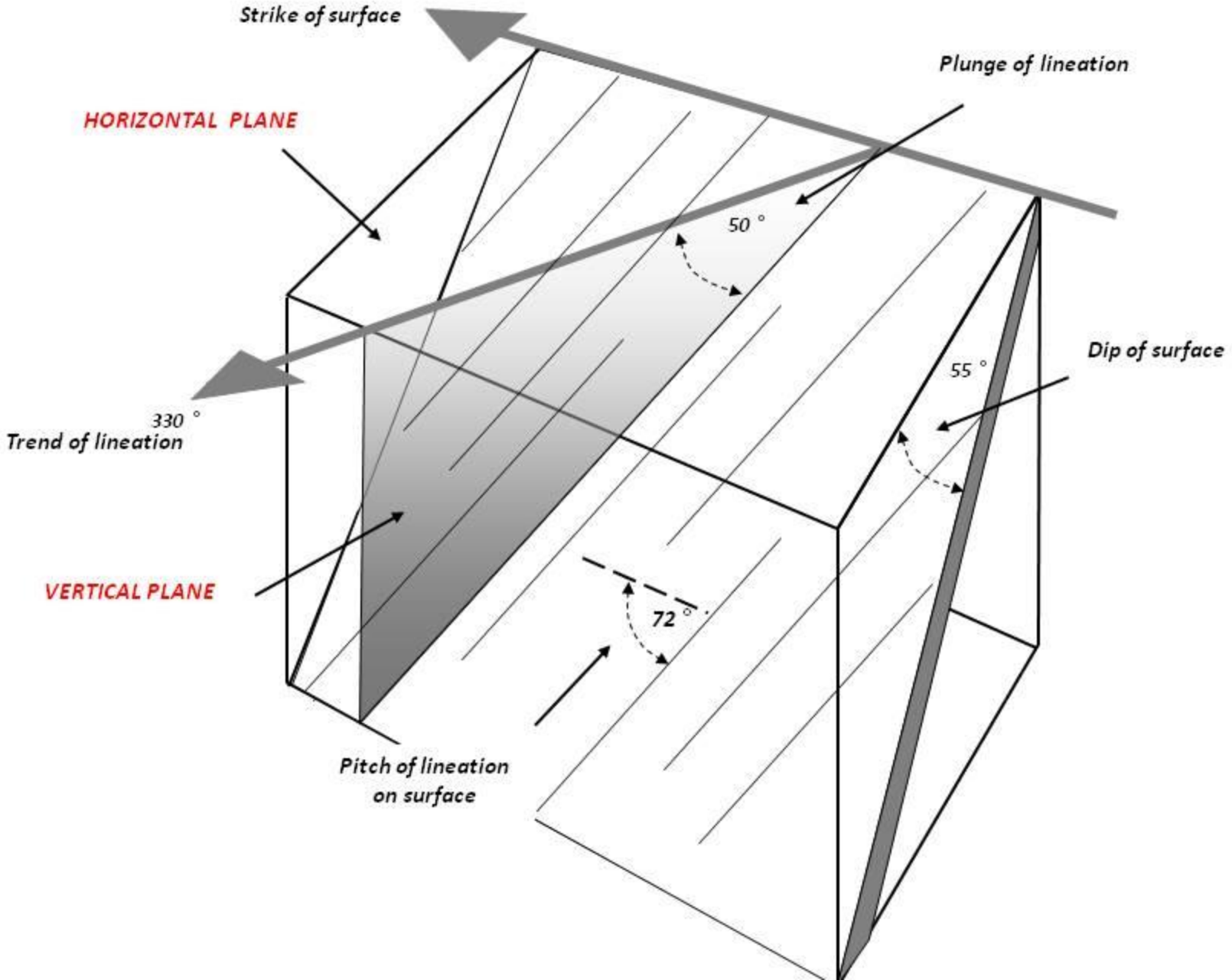
Attitude of lines (lineation)

Attitude of lines (lineation)

Attitude of lines (lineation)

- Plunge
- Bearing
- Rake/Pitch

Plunge of a line is the angle that the line makes with respect to a horizontal plane as measured in a vertical plane.containing the line



Plunge of a line is the angle that the line makes with respect to a horizontal plane as measured in a vertical plane.

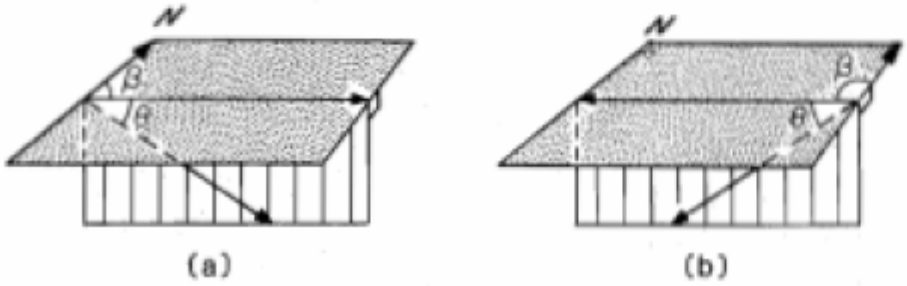
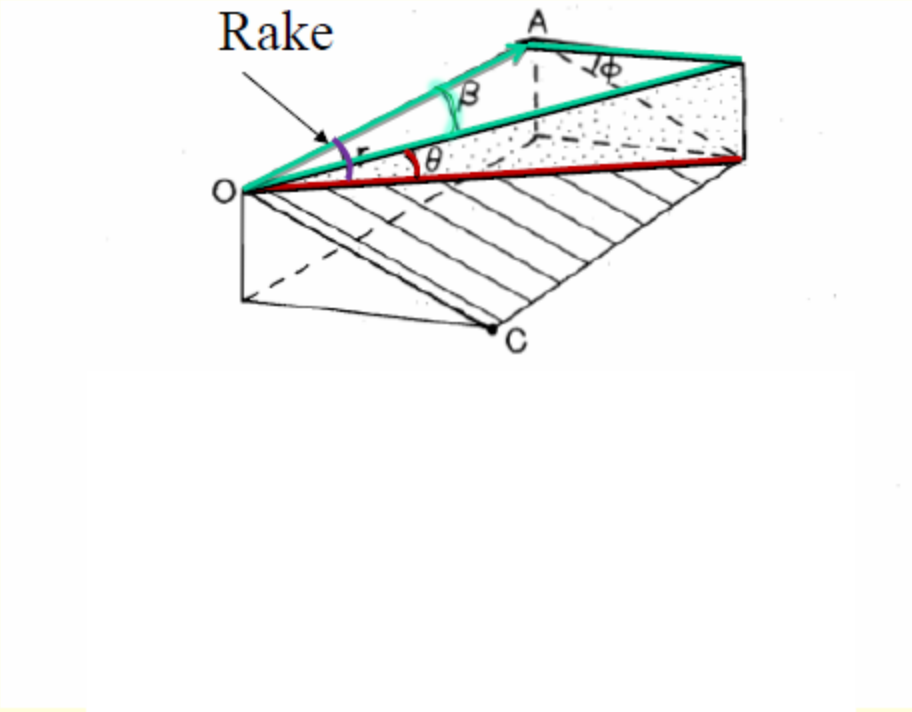


Figure 1-11. Definition of the plunge and bearing of a line. The horizontal plane is shaded and the vertical plane is ruled. ß is the angle of bearing. (a) Line plunging to the east; (b) line plunging to the west. Note that the bearing of the two lines is different even though the magnitude of the plunge (θ) is the same and both lines lie in the same plane.

Trend (or bearing) of a line is the azimuth of the projection of the line onto a horizontal coordinate plane. The line and its projection must both lie on the same vertical plane .

Rake of a line:

Angle between the line and the horizontal as measured in the plane on which the line occurs.



Representation of Lineation

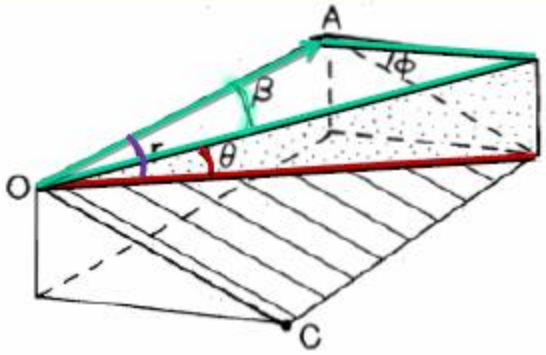
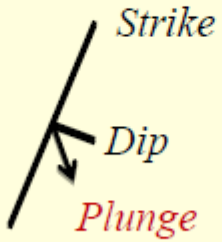
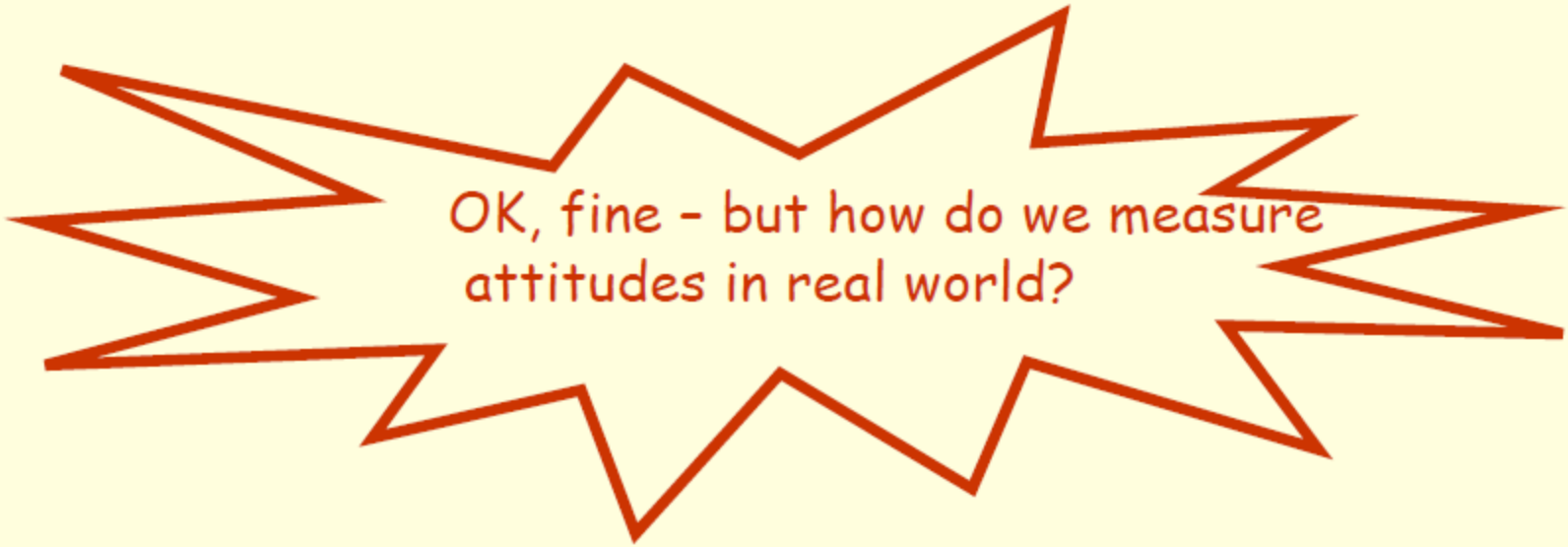


Figure 1-12. Block diagram illustrating the meaning of rake and the relation of rake to plunge and bearing. Ruled plane is inclined and the stippled plane is vertical. r = rake (measured in the inclined plane); ß = bearing (measured in the horizontal plane); ø = true dip of the plane, θ = plunge of the line.

- 25°, 030°
- 25°, N30°E

Map symbol for representing Lineation




OK, fine – but how do we measure attitudes in real world?

Brunton Compass

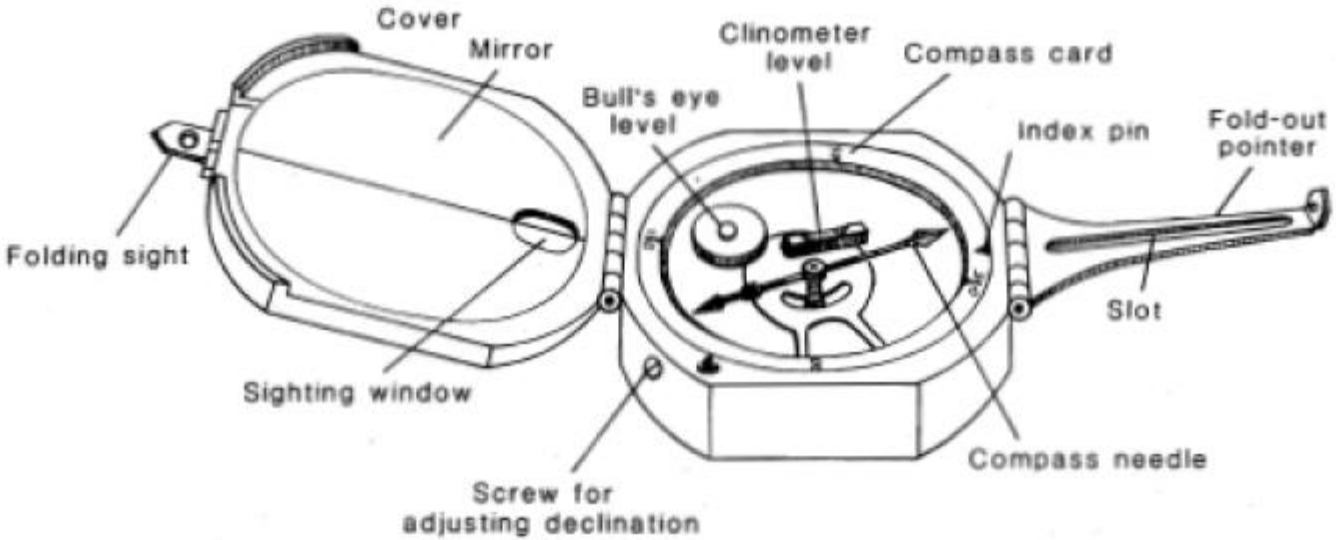


Figure 1-14. Sketch of a Brunton compass, with the key components labeled. Adapted from Compton, 1962.

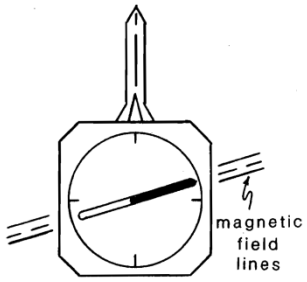


Figure 1-15. Sketch showing the orientation of a compass with respect to a magnetic field line.

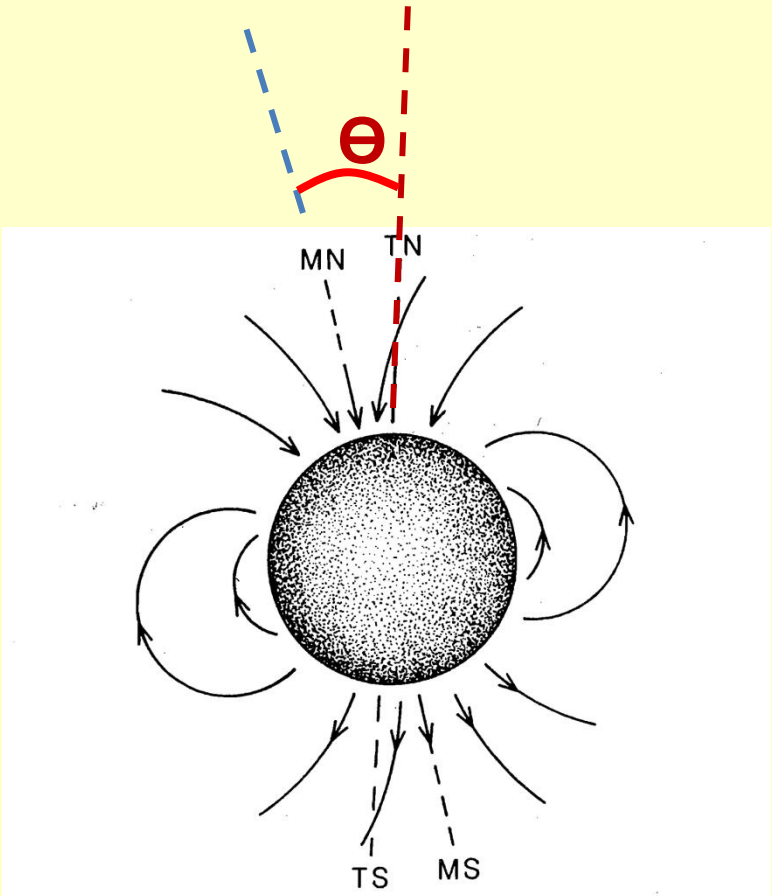
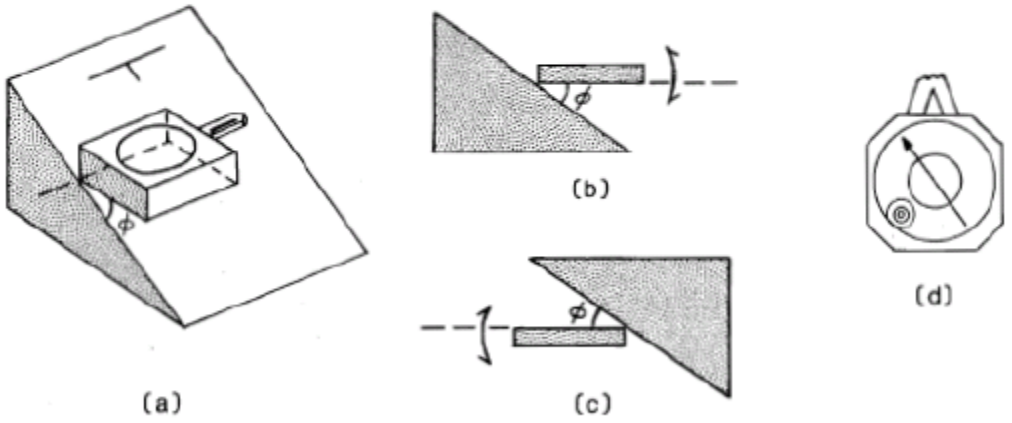


Figure 1-16. Earth's magnetic field lines. MN = magnetic north; TN = true north; MS = magnetic south; TS = true south. (Adapted from Judson, Kauffman, & Leet, 1987.)

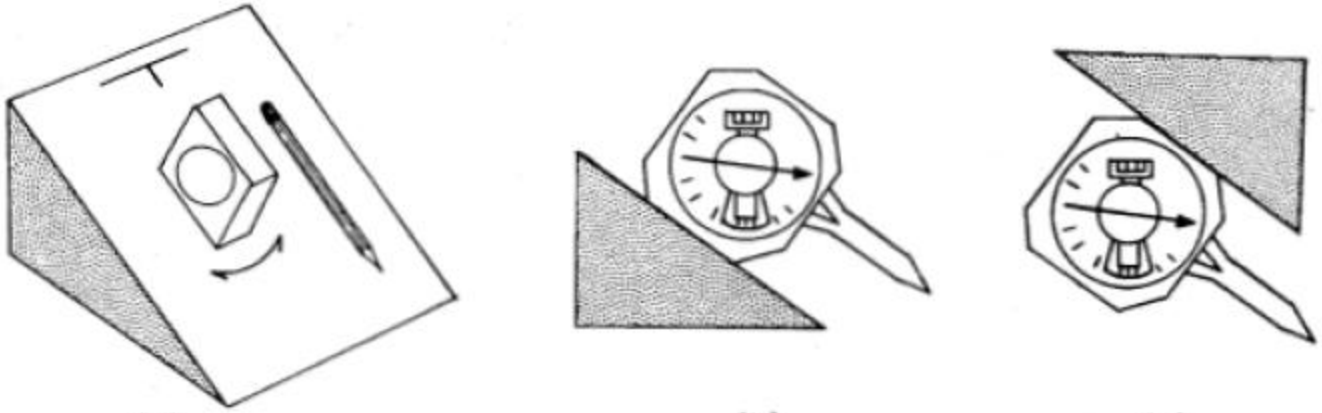
θ = Magnetic declination

Measurement of Strike

Figure 1-19. Sketch illustrating the position of a compass during measurement of strike. Note that the bottom side edge is flush with the dipping surface. (a) Block diagram. Stippled plane is vertical and is perpendicular to strike. (b) View of compass looking along strike for an upward-facing surface. True dip is ø. (c) View of compass looking along strike for a downward-facing surface. (d) Top view of compass showing bubble centered in bull's-eye.



Measurement of Dip



(a) (b) (c)

Figure 1-20. Sketch illustrating the position of a compass during measurement of true dip. (a) Block diagram. Stippled plane is perpendicular to strike. The arrows indicate movement of the compass during the operation to confirm that the dip measured is the steepest possible dip on the surface. The pencil points in the direction of true dip; (b) view looking down strike showing the proper position of the clinometer for an upward-facing surface; (c) view looking down strike showing the proper position of the clinometer for a downward-facing surface.

Measurement of Lineation

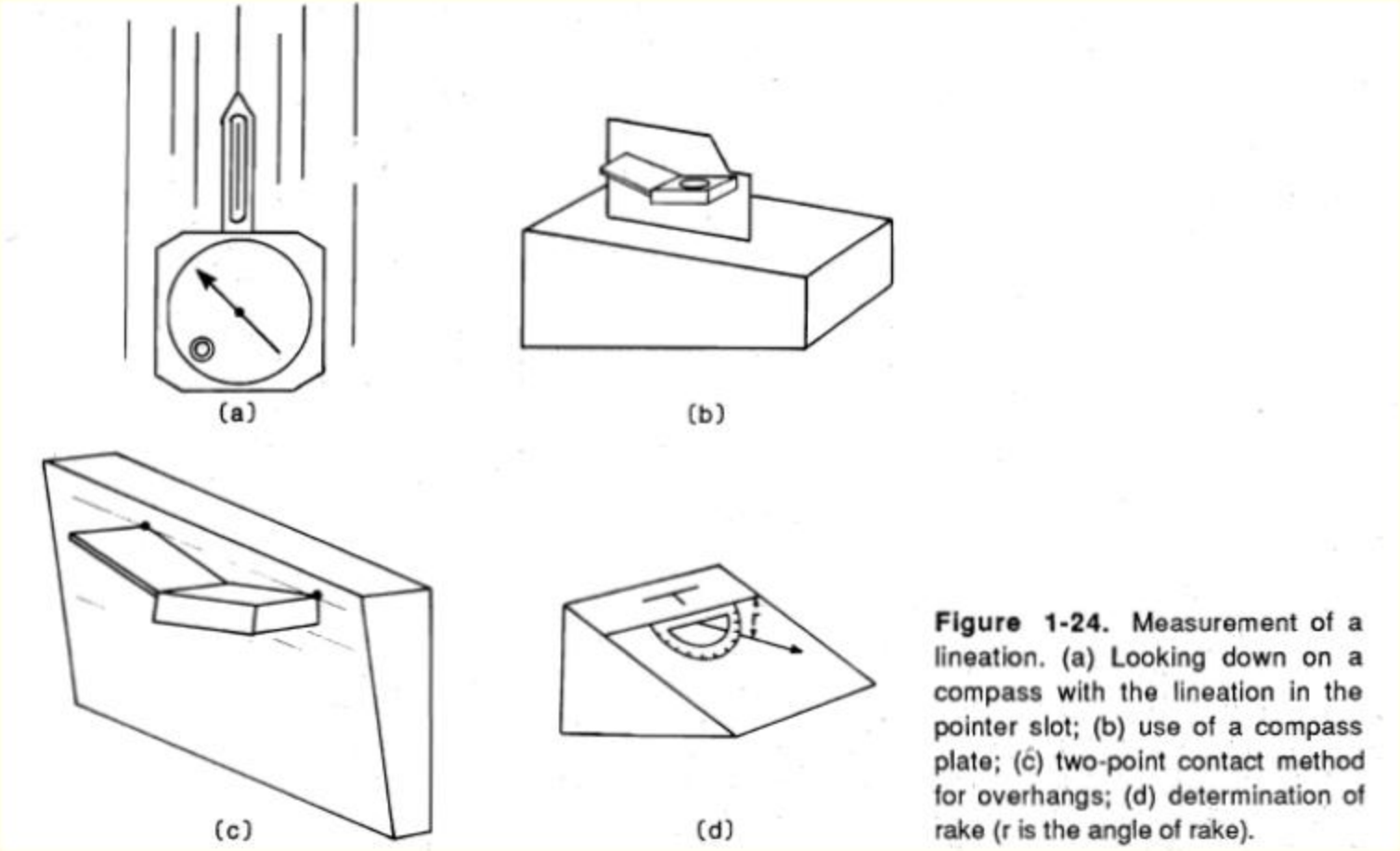


Figure 1-24. Measurement of a lineation. (a) Looking down on a compass with the lineation in the pointer slot; (b) use of a compass plate; (c) two-point contact method for overhangs; (d) determination of rake (r is the angle of rake).