SPHERICAL PROJECTIONS (I)

Schedule Updates and Reminders: Bring tracing paper &needles for Lab 5

I Main Topics
- A What is a spherical projection?
- B Spherical projection of a line
- C Spherical projection of a plane

II What is a spherical projection?
- A A 2-D projection for describing the orientation of 3-D features. A spherical projection shows where lines or planes that intersect the surface of a (hemi)sphere, provided that the lines/planes also pass through the center of the (hemi)sphere.
- B Uses in geology and geophysics
  1. Maps
  2. Representation of the orientation of planar features (e.g., bedding, fractures, crystal faces)
  3. Representation of the orientation of linear features (e.g., fold axes)
  4. Representation of first motion data from earthquakes
- C Great circle: intersection of the surface of a sphere with a plane that passes through the center of the sphere (e.g., lines of longitude)
- D Small circle: intersection of the surface of a sphere with a plane that does not pass through the center of the sphere (e.g., lines of latitude). A line rotated about an axis traces a small circle too.

III Spherical projection of a line
- A Technique (see handout):
  1. A line is at the intersection of two planes: 1) a vertical plane coinciding with the trend of the line and (2) an inclined plane coinciding with the plunge of the line.
  2. Trend and plunge: The point representing a line plots away from the center of the spherical plot in the direction of the trend of the line. **The trend of a line is measured along a horizontal great circle**. **The plunge of the line is measured along a vertical great circle by counting down from the horizontal plane**.
  3. Rake: If the strike and dip of a plane is specified, the rake (pitch) of a line in the plane can be measured along the cyclographic trace of the

great circle representing that plane. Rake is measured from the direction of strike.

B Plane containing two lines: Two intersecting lines uniquely define a plane. The cyclographic trace of the great circle representing that plane will pass through the points representing the lines.

IV Spherical projection of a plane

A A plane plots as the cyclographic trace of a great circle

B Strike and dip: **The strike is measured around the perimeter of the primitive circle. The dip of the line is measured along a vertical great circle perpendicular to the line of strike**.

C Pole to a plane

1 Pole can be plotted directly using its trend and plunge

2 Pole also can be plotted 90° along the cyclographic trace of a great circle that is perpendicular to the plane.

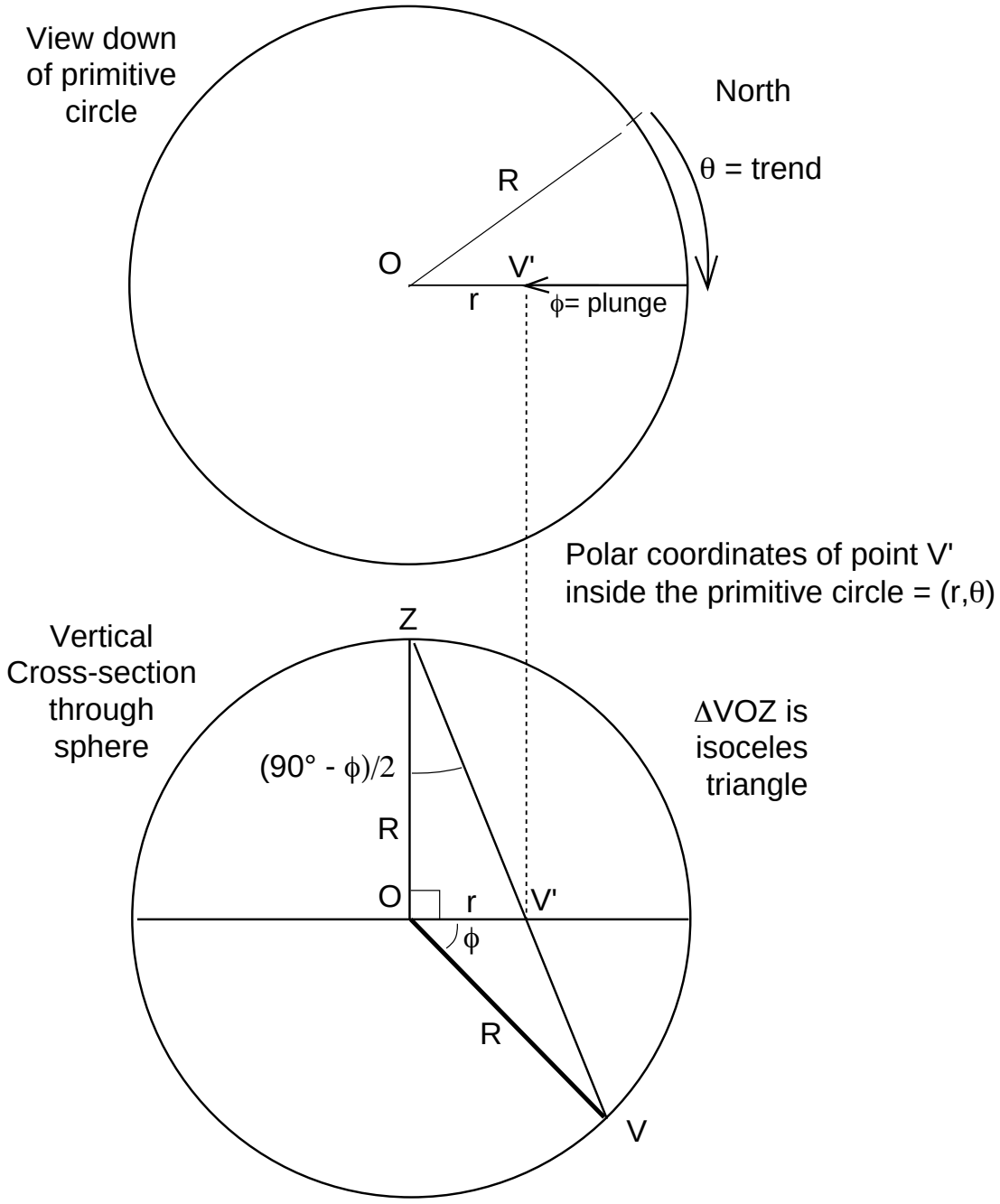
D Intersection of two planes

1 Two planes intersect in a line, which projects as a point in a spherical projection. This point is at the intersection of the cyclographic traces of the two planes.

2 The intersection is also 90° from the plane (great circle) containing the poles to the two planes; these 90° angles are measured along the great circles representing the planes containing the poles. This procedure is analogous to finding the cross product between poles.

Equal-Angle (Sterographic) Projection of a Line

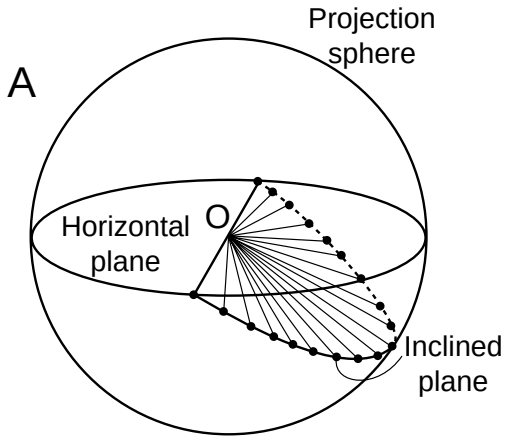
Fig. 8.1



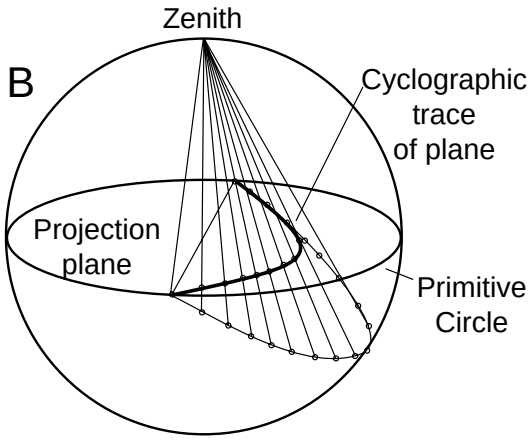
$$\frac{r}{R} = \tan[\,(90° - \phi)/2\,] \qquad r = R(\,\tan\,[\,(90° - \phi)/2\,]\,) \qquad \phi = 90° - 2(\,\tan^{-1}\,[\,r / R\,]\,)$$

Stereographic (Equal-angle) Projections (I)

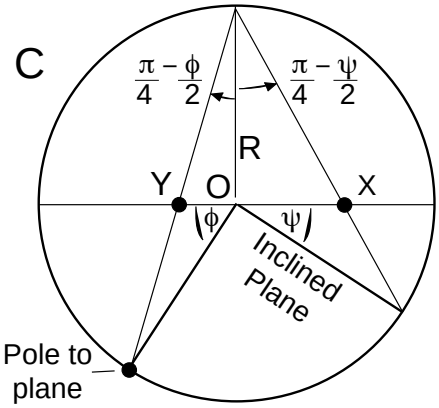
Flg. 8.2



Oblique view of plane intersecting a sphere

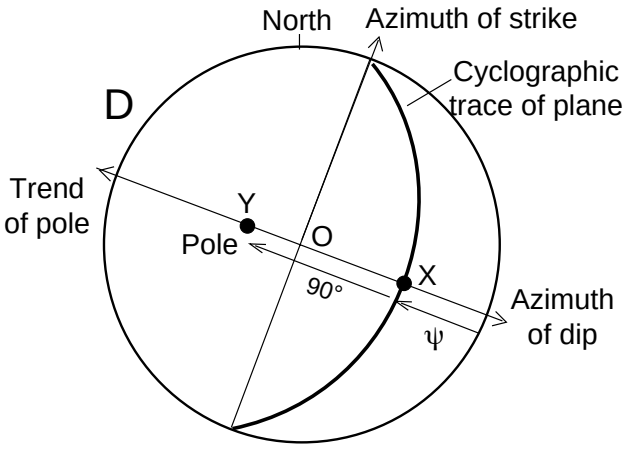


Stereographic projection of plane



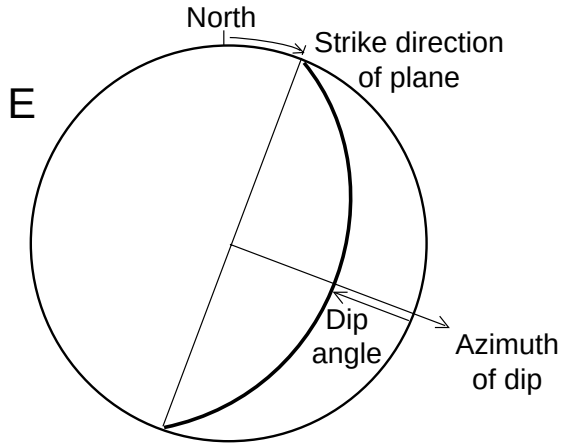
Cross section view along strike of inclined plane

$OX = R \tan(\pi/4 - \psi/2)$

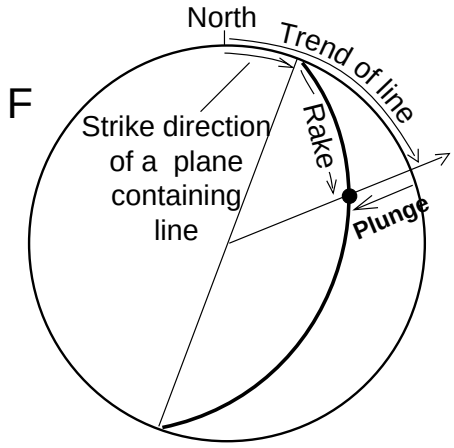


View down on projection plane (Lower hemisphere projection)

$OY = R \tan(\pi/4 - \phi/2)$



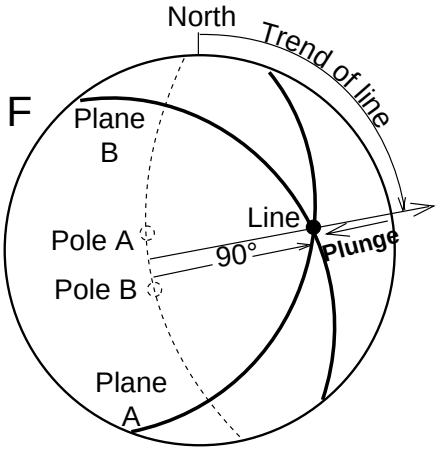
Orientation of a plane



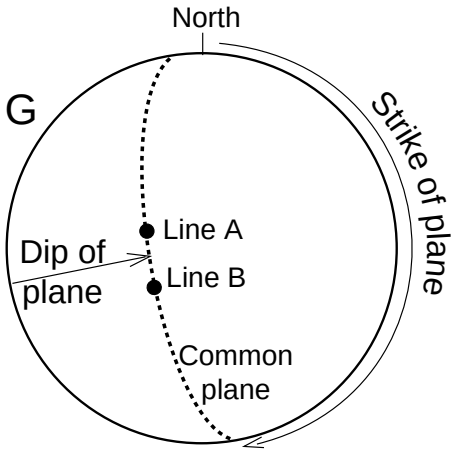
Orientation of a line

Stereographic (Equal-angle) Projections (II)

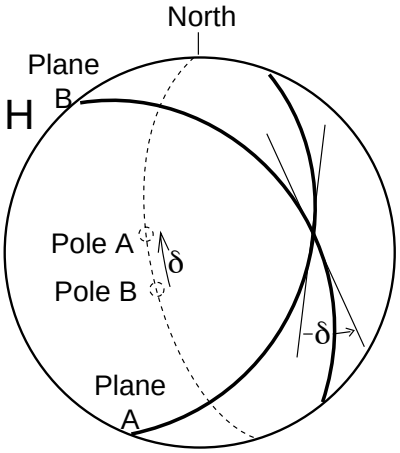
Fig. 8.3



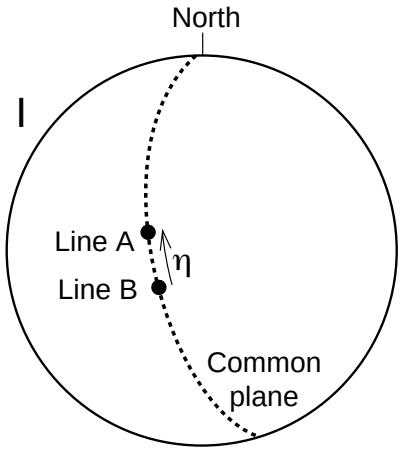
Line of intersection of two planes



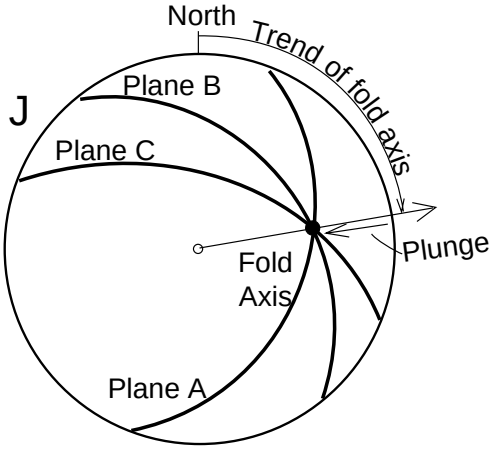
Plane containing two lines



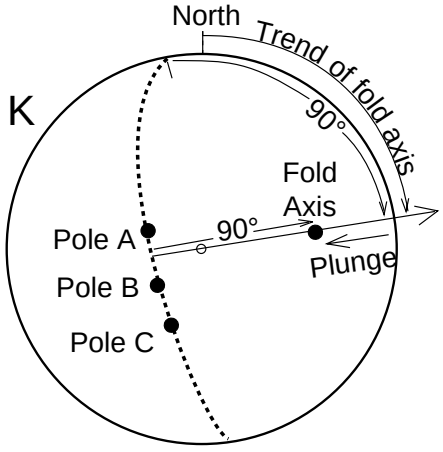
Angle δ between two planes



Angle η between two lines



Cylindrical fold axis
by intersecting bedding planes
β diagram



Cylindrical fold axis
by normal to poles
π diagram