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

View down of primitive circle

Vertical Cross-section through sphere

Polar coordinates of point V’ inside the primitive circle = (r,θ)

ΔVOZ is isosceles triangle

r = tan[ (90° - φ)/2 ]

r = R( tan [ (90° - φ)/2 ] )

φ = 90° - 2( tan⁻¹ [ r / R ] )
Stereographic (Equal-angle) Projections (I)

**Fig. 8.2**

A. **Projection sphere**
- Oblique view of plane intersecting a sphere

B. **Zenith**
- Stereographic projection of plane

C. **Projection sphere**
- Cross section view along strike of inclined plane
- \( OX = R \tan \left( \frac{\pi}{4} - \frac{\psi}{2} \right) \)

D. **Projection sphere**
- View down on projection plane (Lower hemisphere projection)
- \( OY = R \tan \left( \frac{\pi}{4} - \frac{\phi}{2} \right) \)

E. **Projection sphere**
- Orientation of a plane

F. **Projection sphere**
- Orientation of a line
Stereographic (Equal-angle) Projections (II)

**Fig. 8.3**

**F**
- Plane A
- Pole A
- Pole B
- Plane B
- Trend of line
- Line
- Plunge
- Line of intersection of two planes

**G**
- Plane containing two lines
- Basket
- Dip of plane
- Pole A
- Pole B
- Common plane

**H**
- Angle $\delta$ between two planes
- Plane A
- Pole A
- Pole B

**I**
- Angle $\eta$ between two lines
- Line A
- Line B
- Common plane

**J**
- Cylindrical fold axis
- Plane C
- Plane B
- Plane A
- Trend of fold axis
- Plunge
- Fold Axis
- by intersecting bedding planes
- $\beta$ diagram

**K**
- Cylindrical fold axis
- Fold Axis
- Pole A
- Pole B
- Pole C
- Trend of fold axis
- Plunge
- $\pi$ diagram
- $90^\circ$