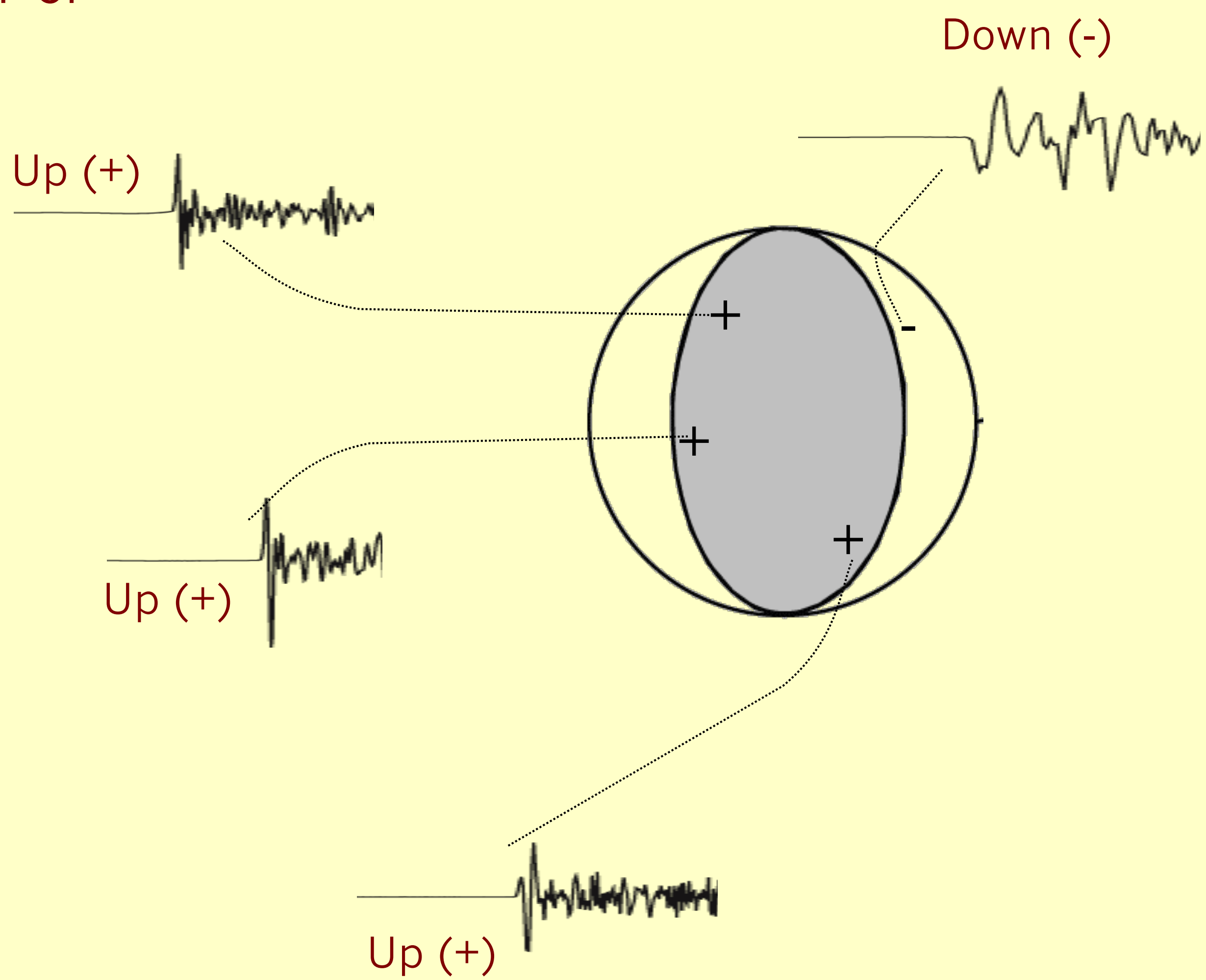
StereoNets

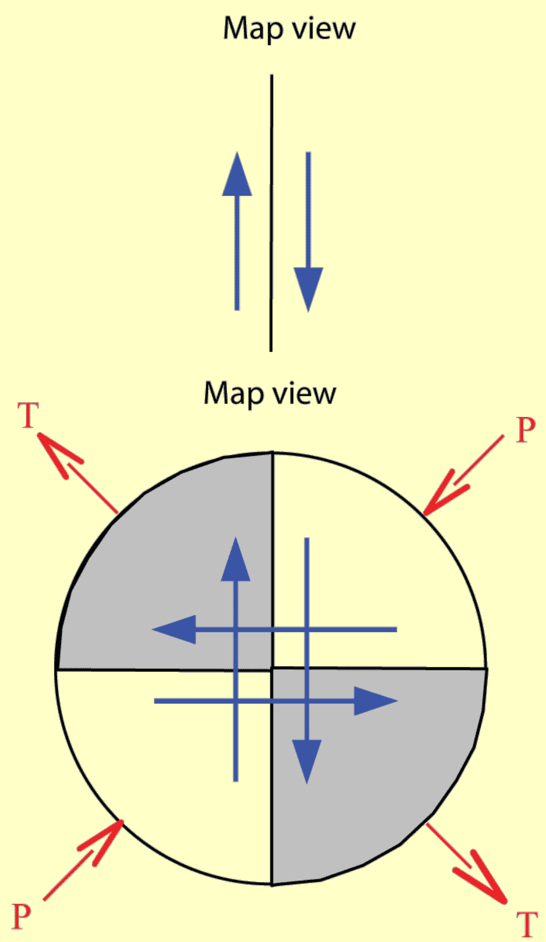
Mapping 3D features in 2D

- Useful for understanding orientation of planar or linear features
  - Planar features include:
    - Bedding Planes
    - Joints/Cleavage planes
    - Fault planes
    - Focal Mechanisms
  - Linear features
    - Grain alignment
    - Magnetic field orientation
    - Principle stress/strain directions
    - Slickenlines / fault rake
    - Poles of rotation

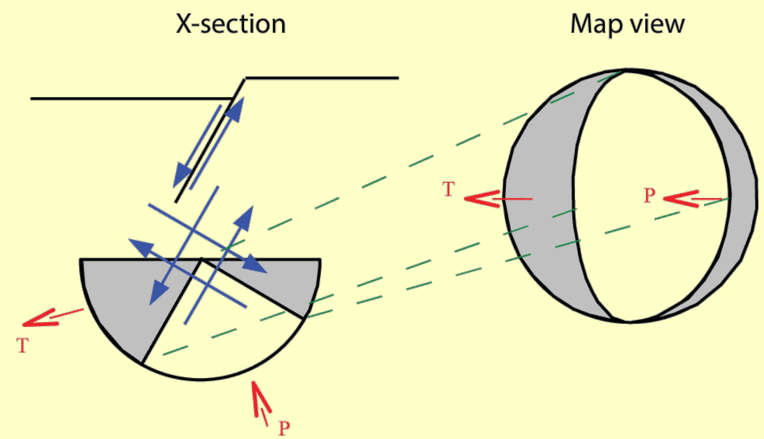


Focal Mechanisms: Fault Orientations

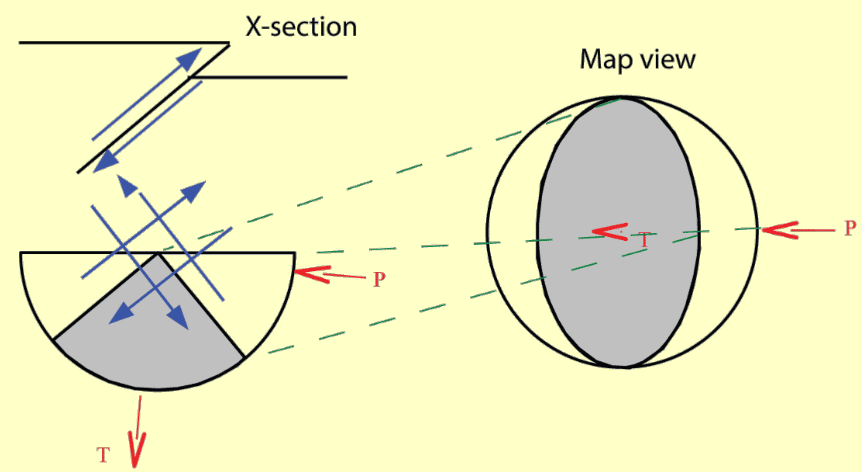
Strike slip Fault



Normal Fault



Reverse (Thrust) Fault



Focal Mechanisms are lower-hemisphere projections

Focal Mechanisms: Plate Boundaries

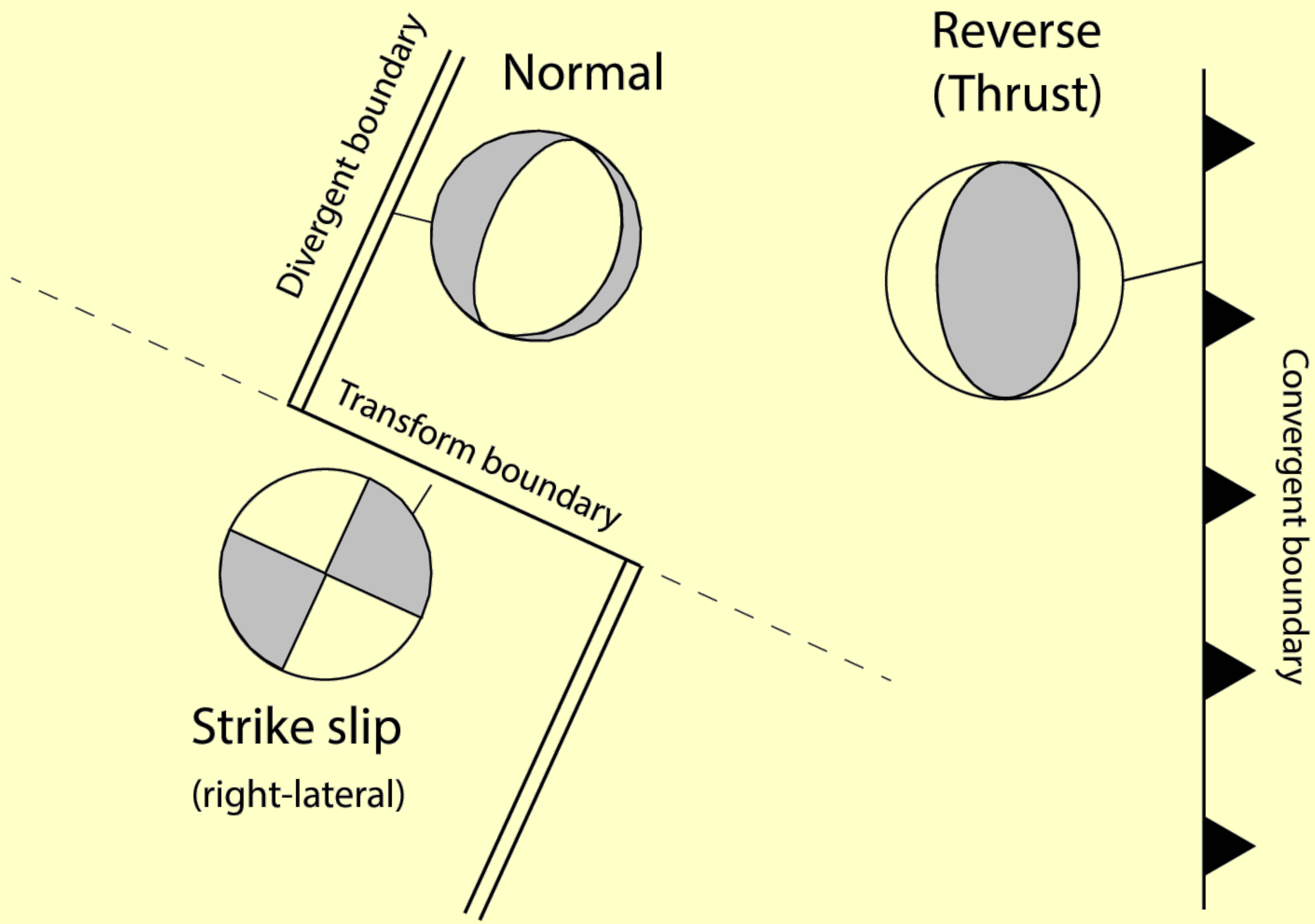
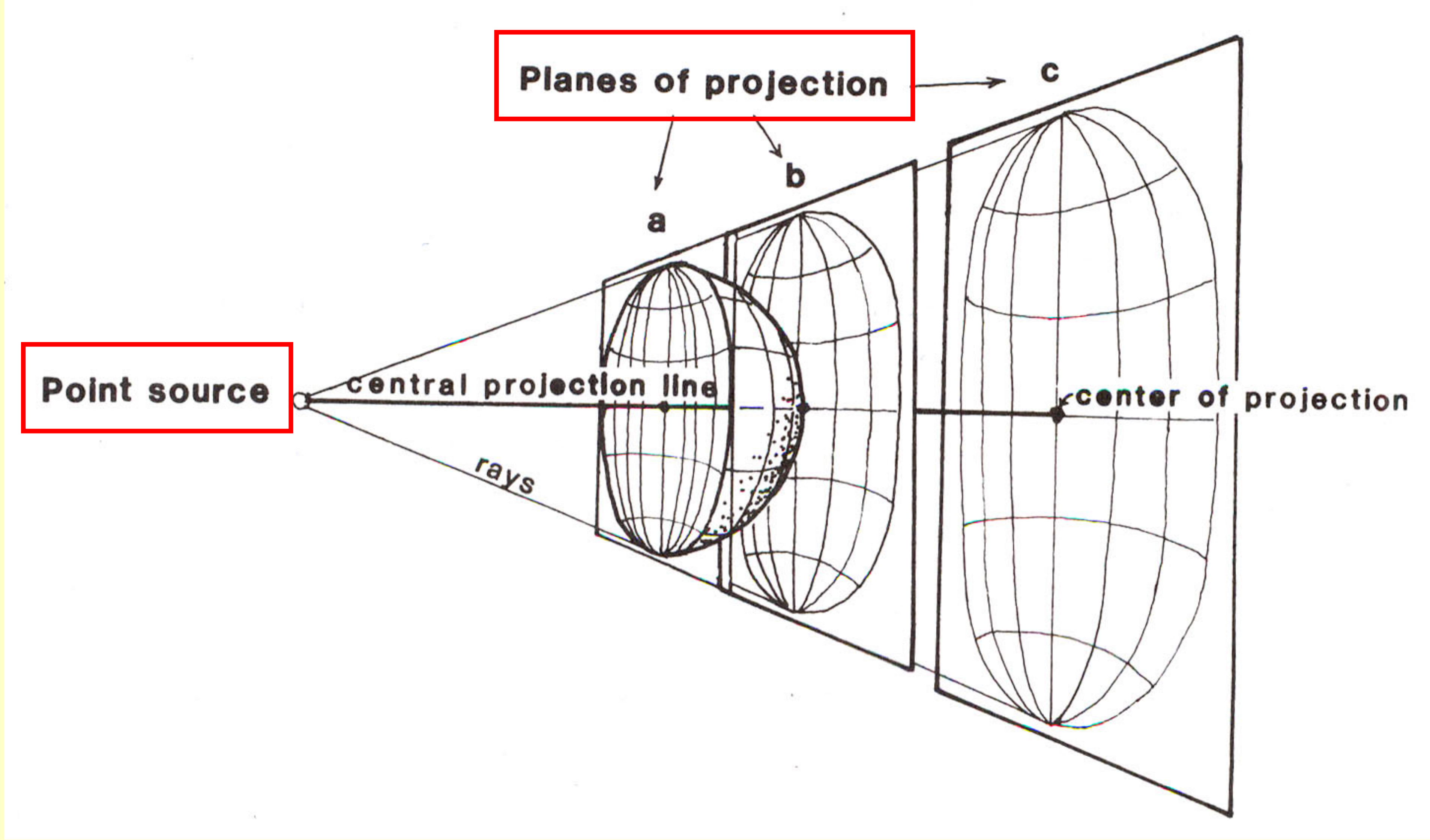


Plate boundaries are dominated by specific mechanisms

Spherical Projections

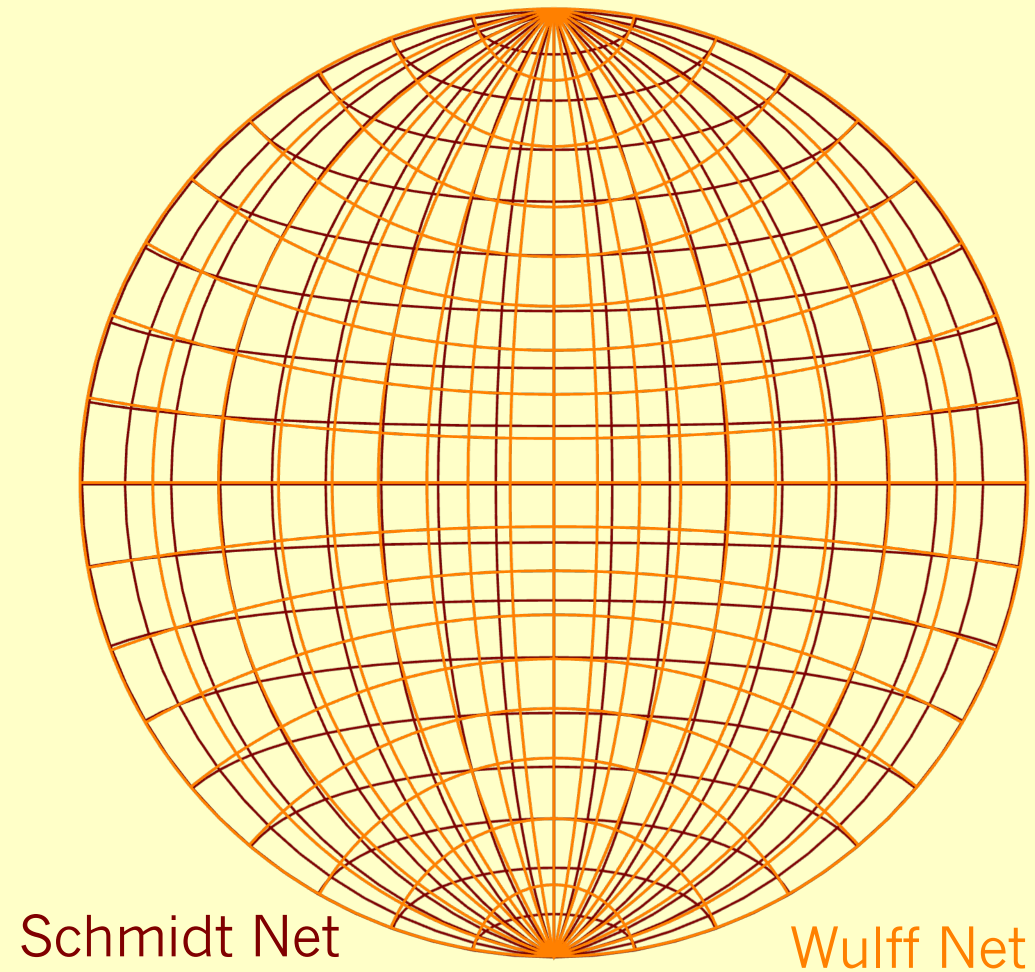


stereonets project a 3-D sphere onto a flat piece of paper

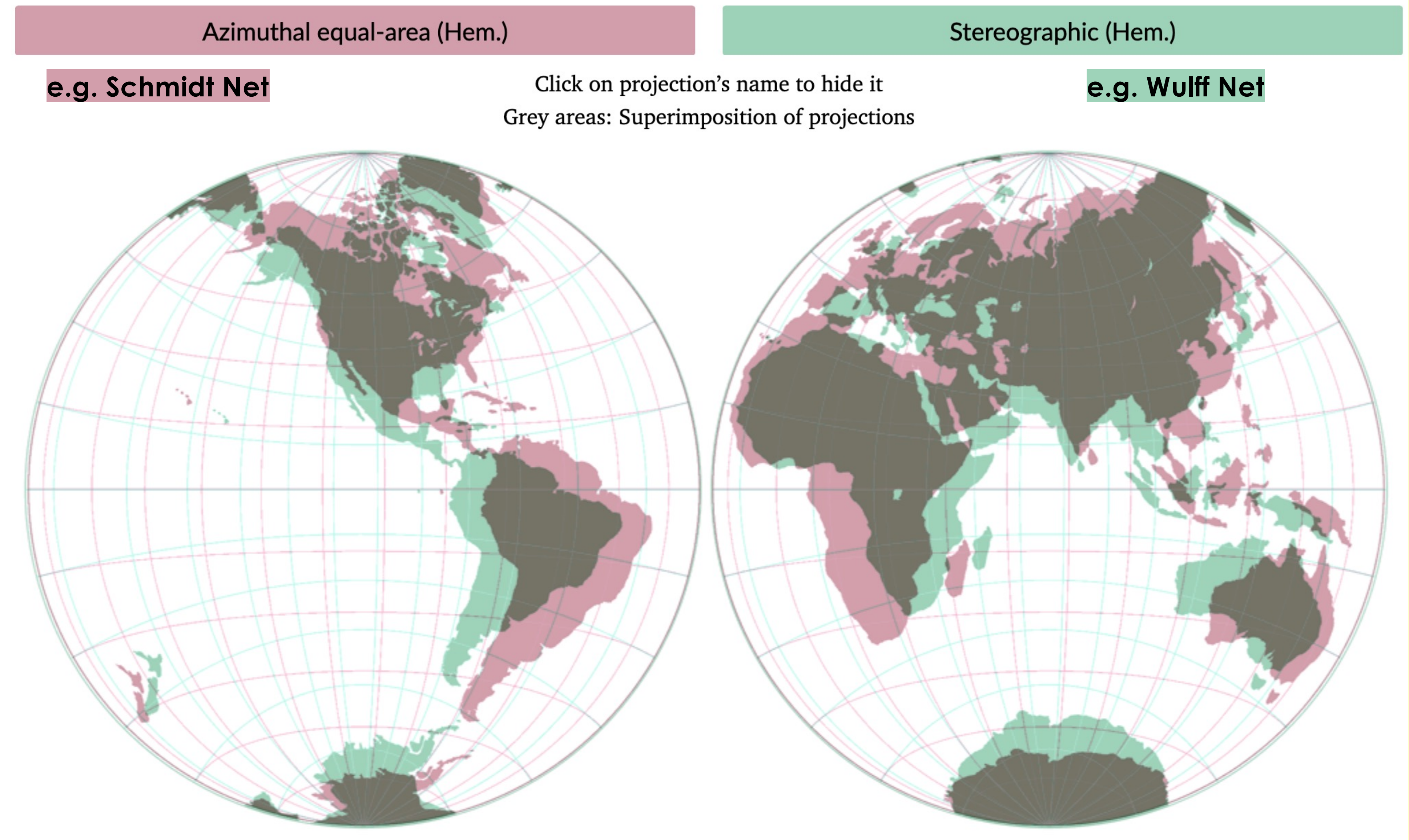
Stereonets

- Lambert Equal Area Projection
  - Preserves area
  - Distorts angles
  - Uses a **Schmidt Net**
  - Most commonly used in US by geophysicists and geologists

- General Stereographic Projection
  - Preserves angles
  - Distorts areas
  - Uses a **Wulff Net**
  - Common in Canada and UK
  - Used extensively in crystallography

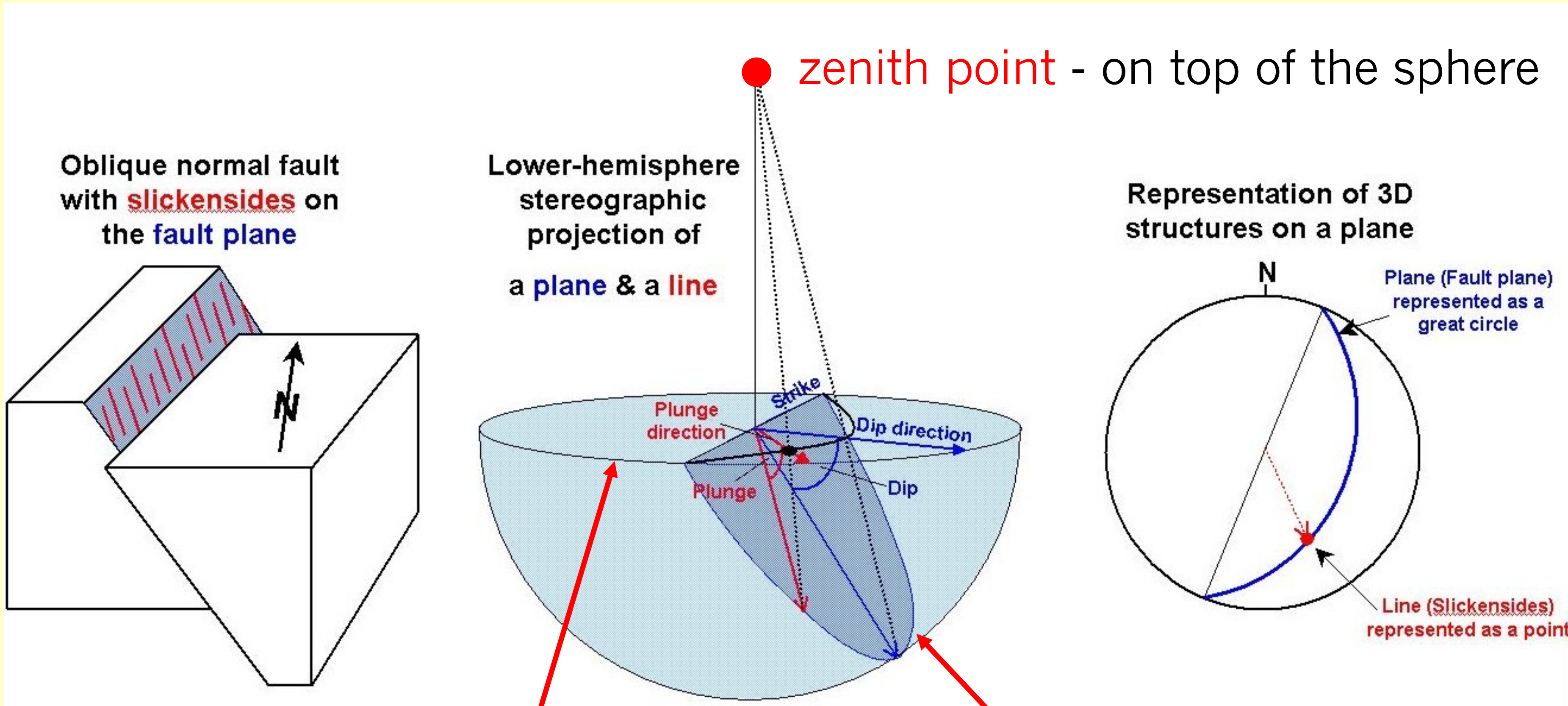


Comparison of projections



Map comparison from here

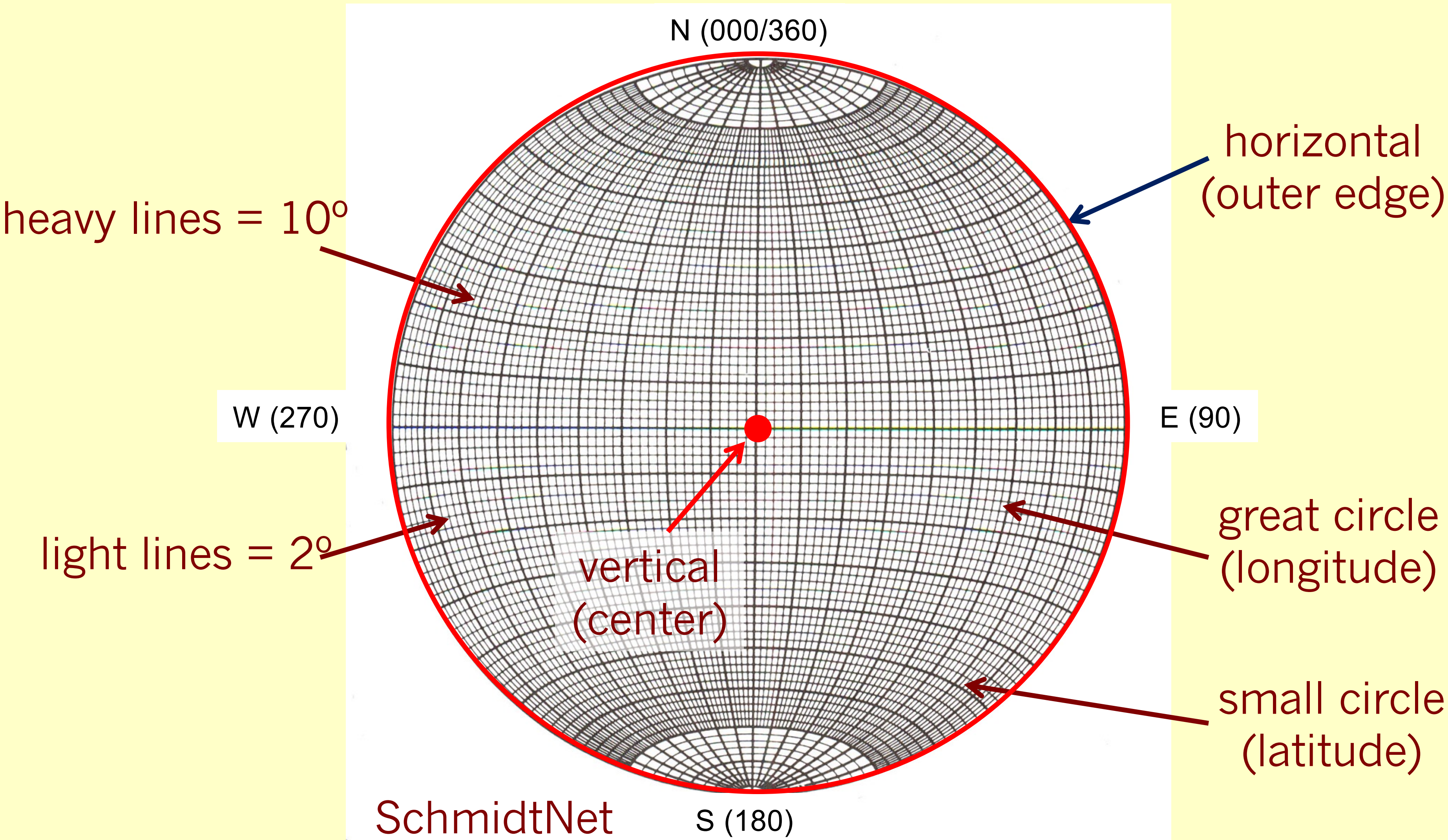
Stereographic Projection



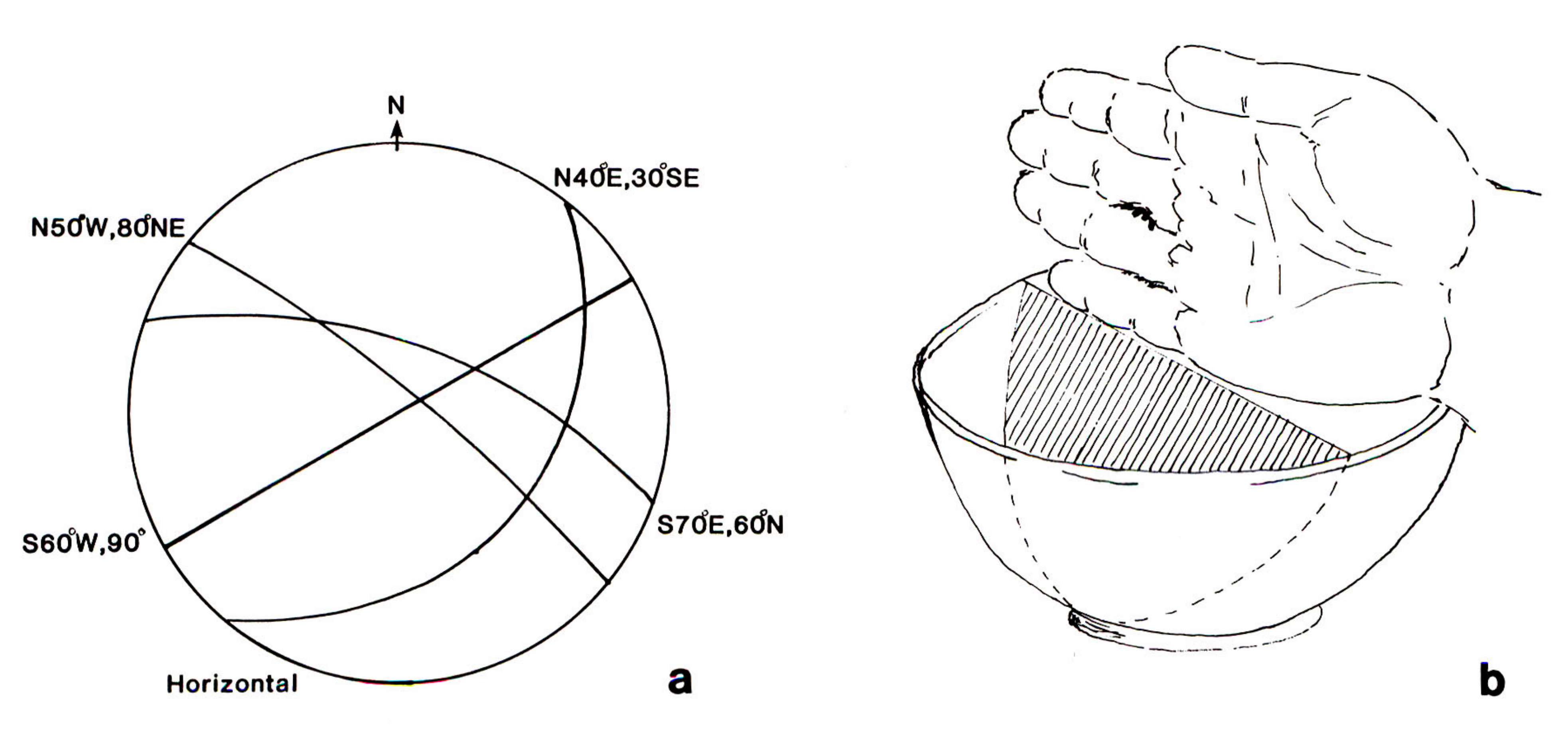
the projection plane is equatorial plane

lower hemisphere - projection is from the lower-half of the sphere

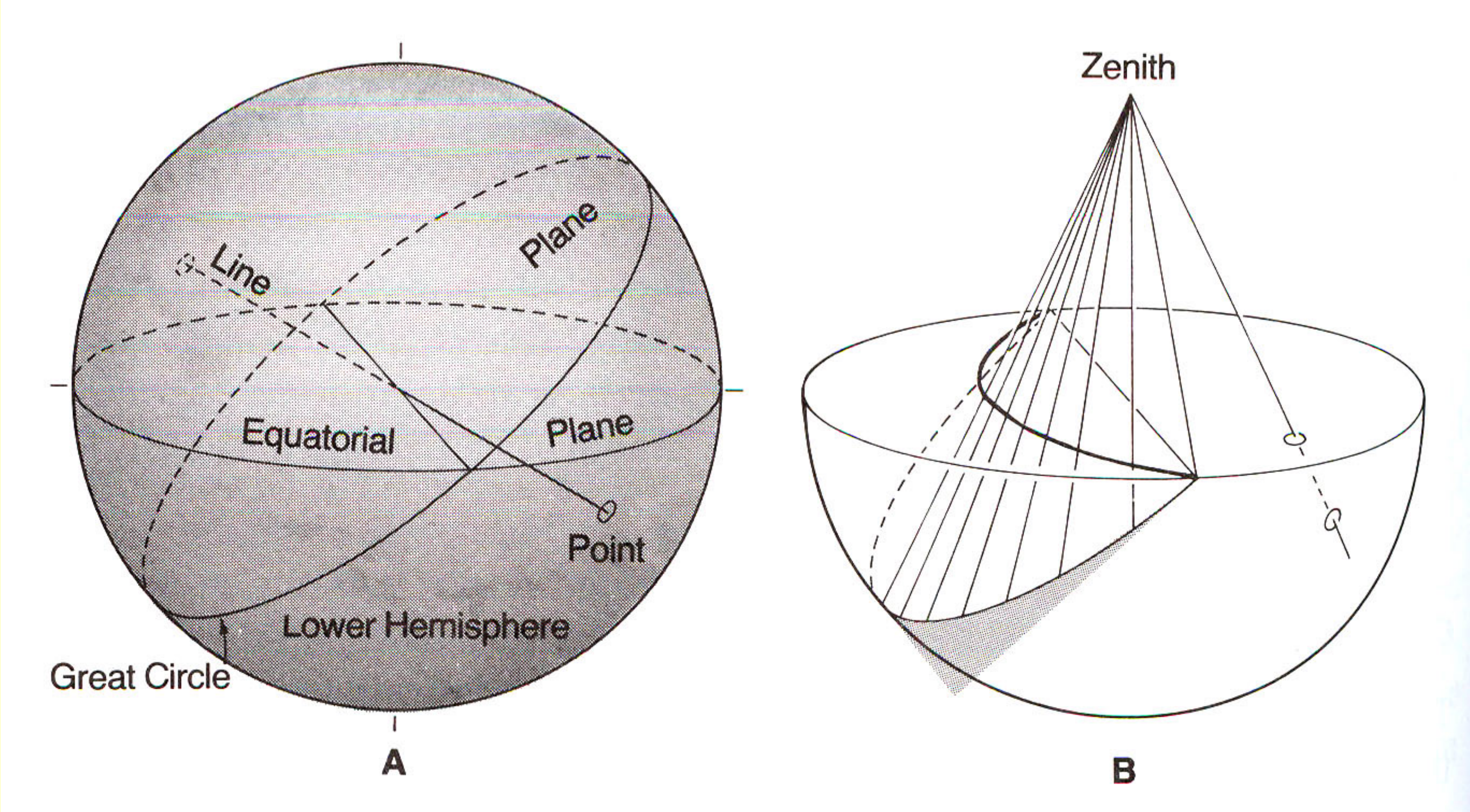
The Stereonet



Projecting Planes

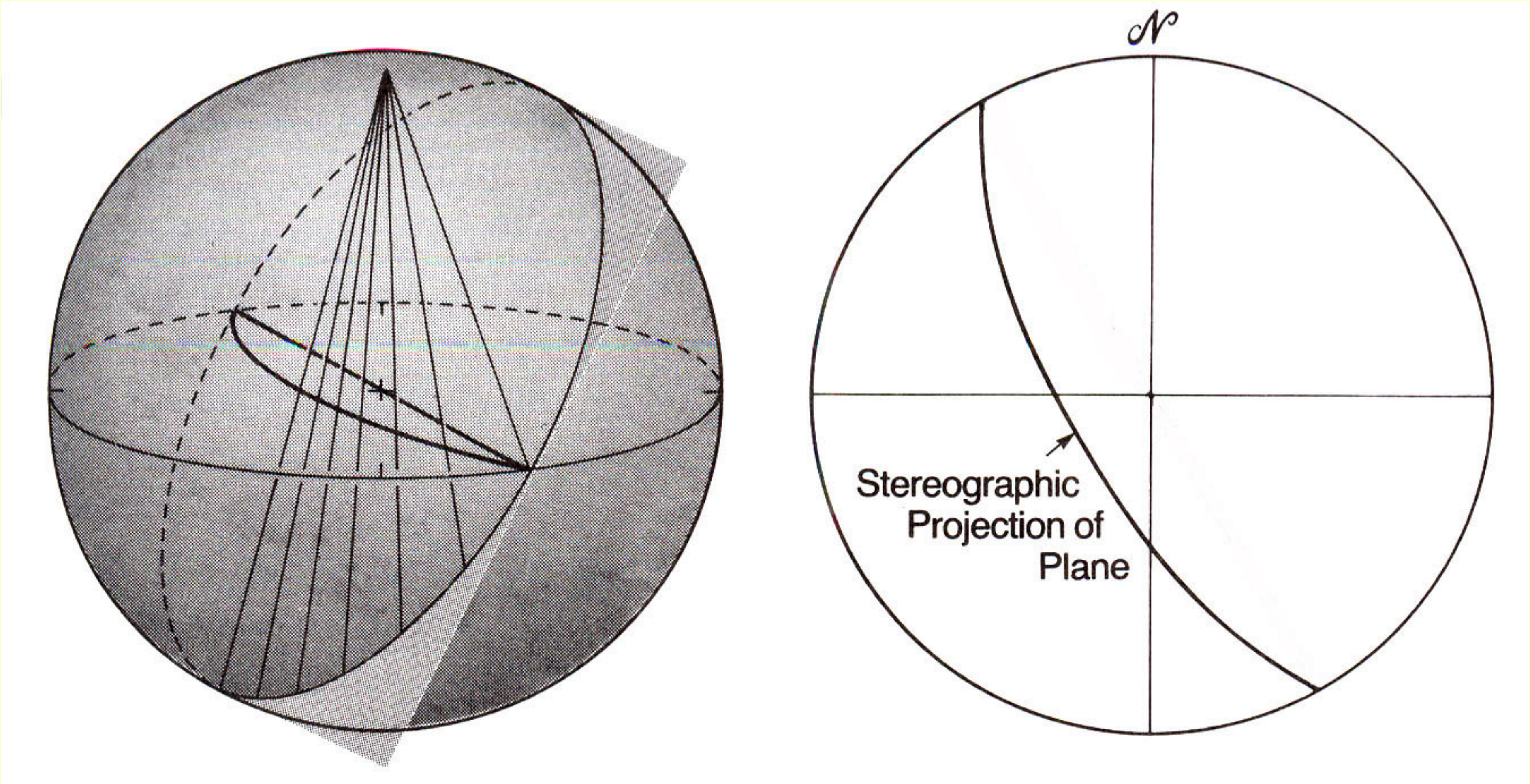


Projecting Planes Continued...



- planes plot as great circles on stereonets

Projecting Steep Planes

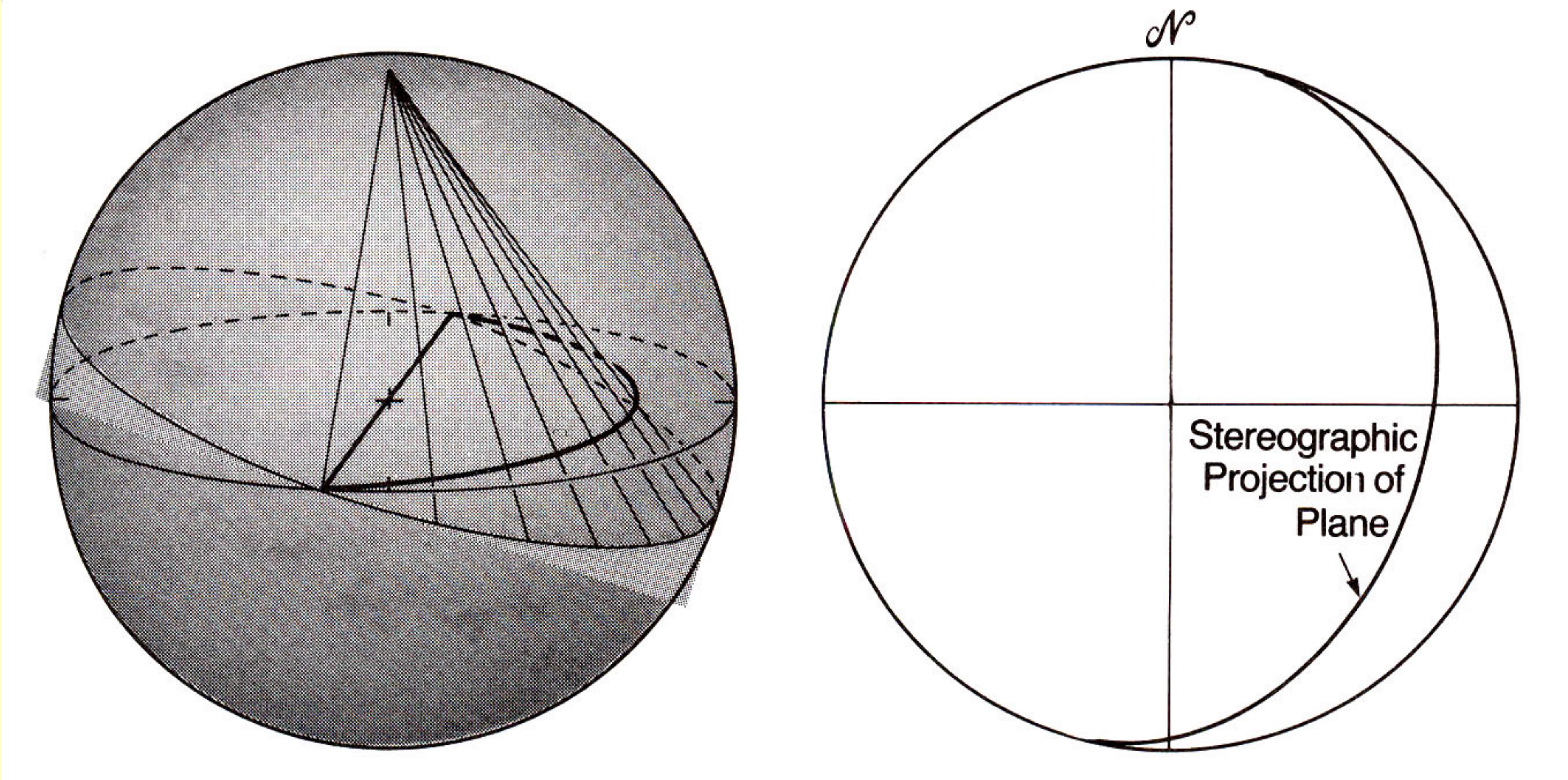


Spherical Projection

Equatorial Plane

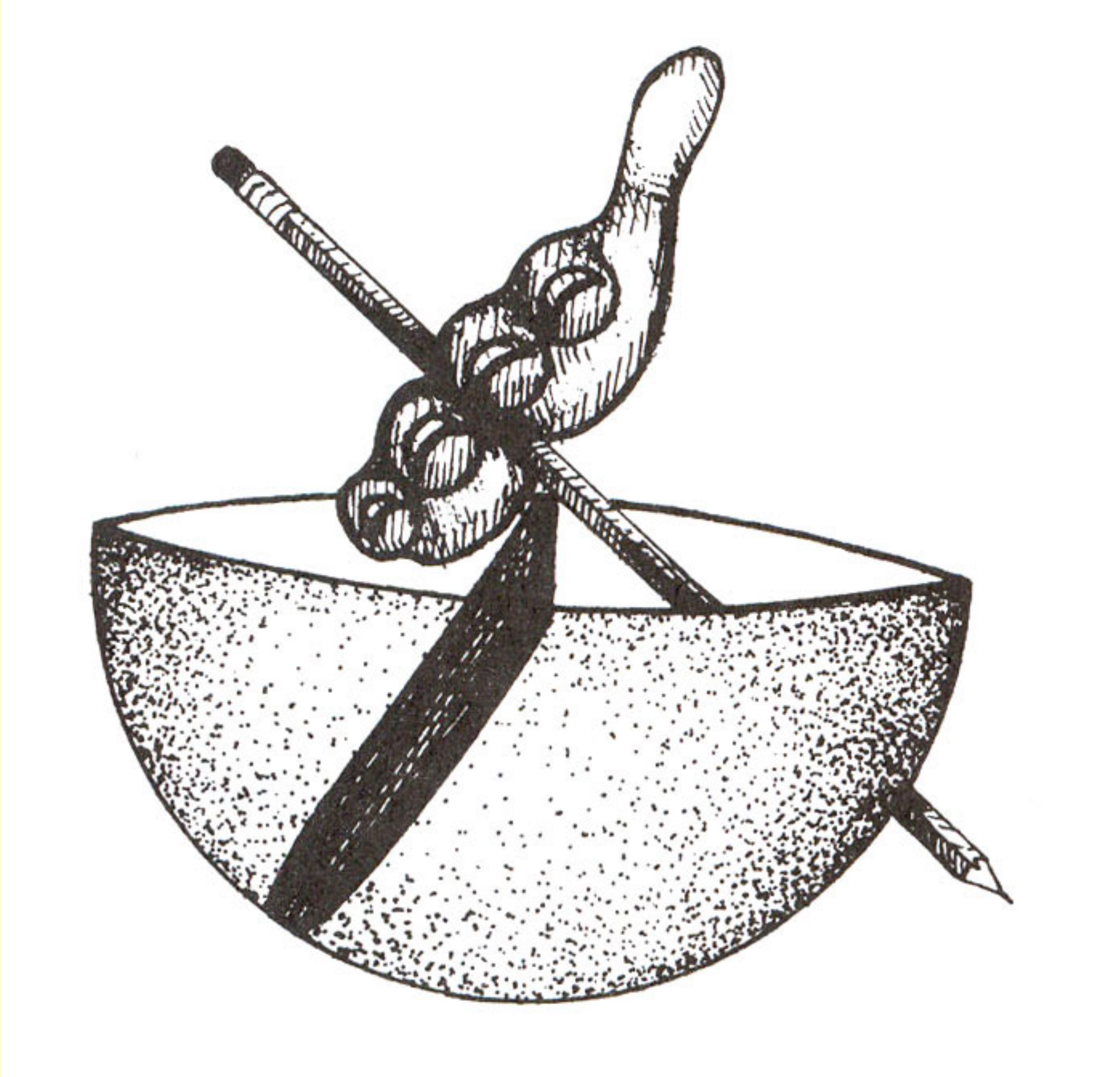
steeply dipping planes will be straighter and plot closer to the center (vertical)

Projecting Shallow Planes



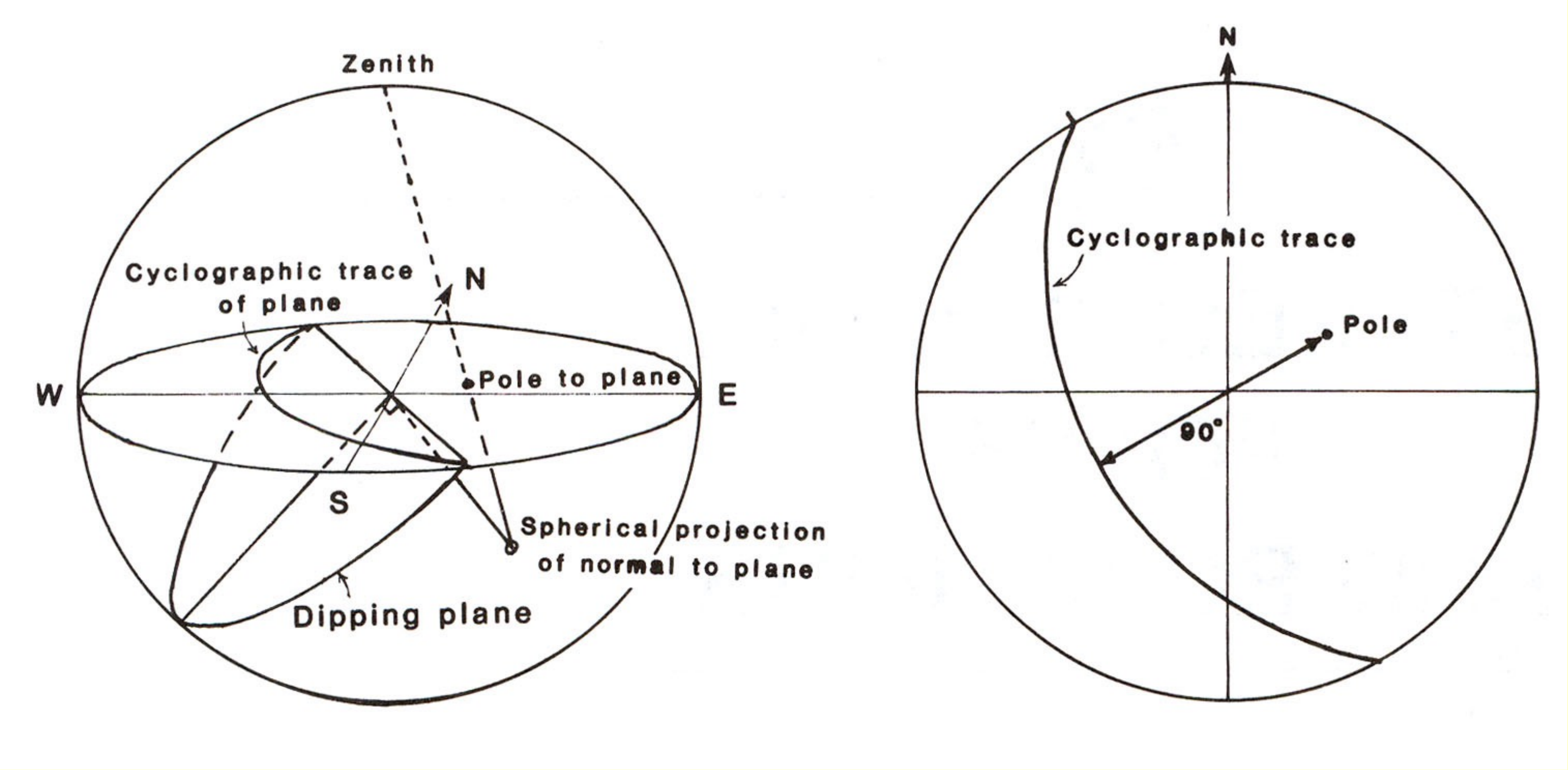
- shallowly dipping planes will be more curved and will plot closer to the outer edge (horizontal)

Poles to Planes



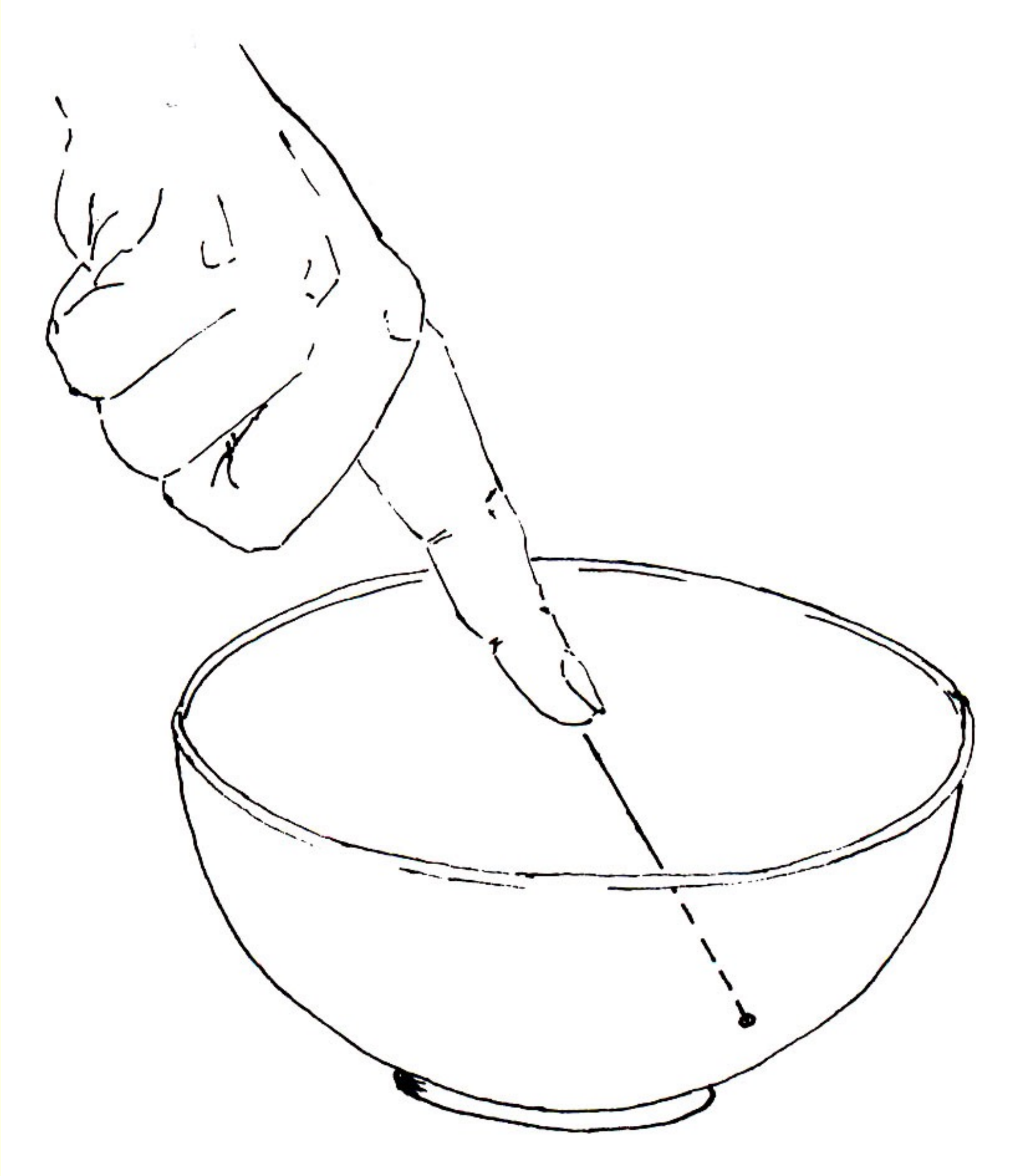
to make data easier to visualize we can plot the poles to planes

Poles to Planes Continued...



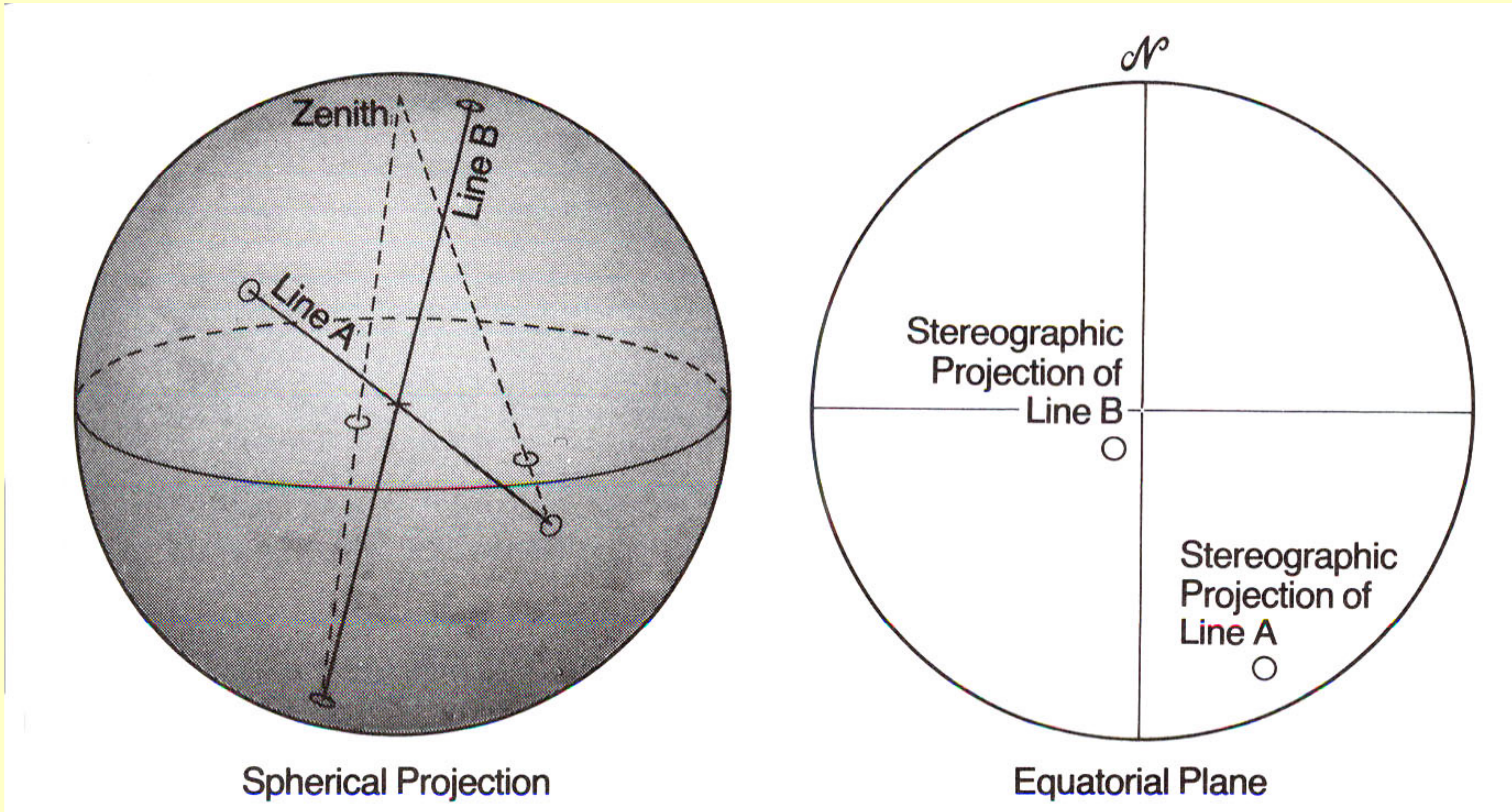
- poles are plotted as a point that is normal (i.e., 90º) to a plane

Projecting Lines



- think of looking down into a bowl when you try to visualize data plotted on a stereonet

Projecting Lines Continued...

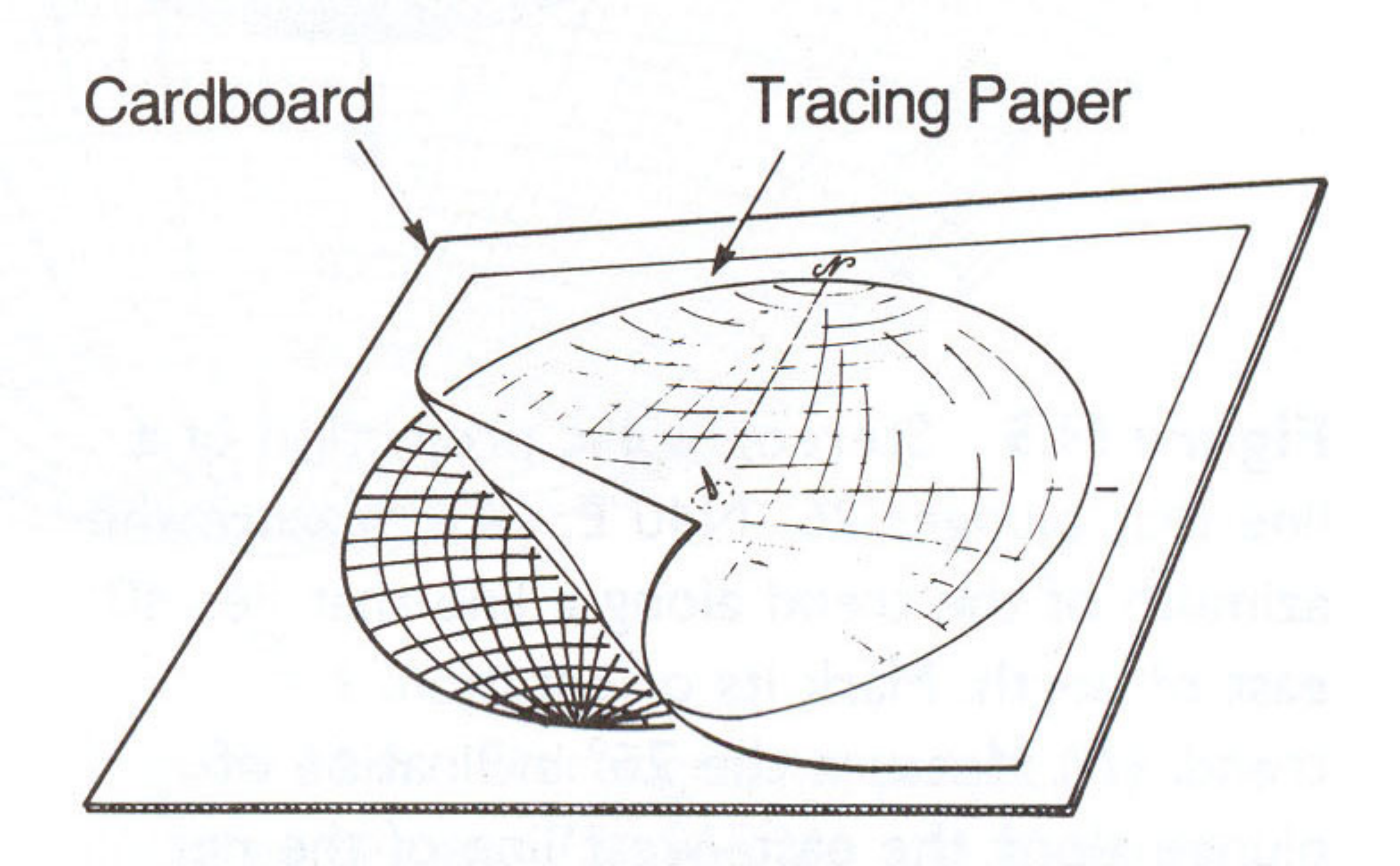


- lines plot as points on stereonets

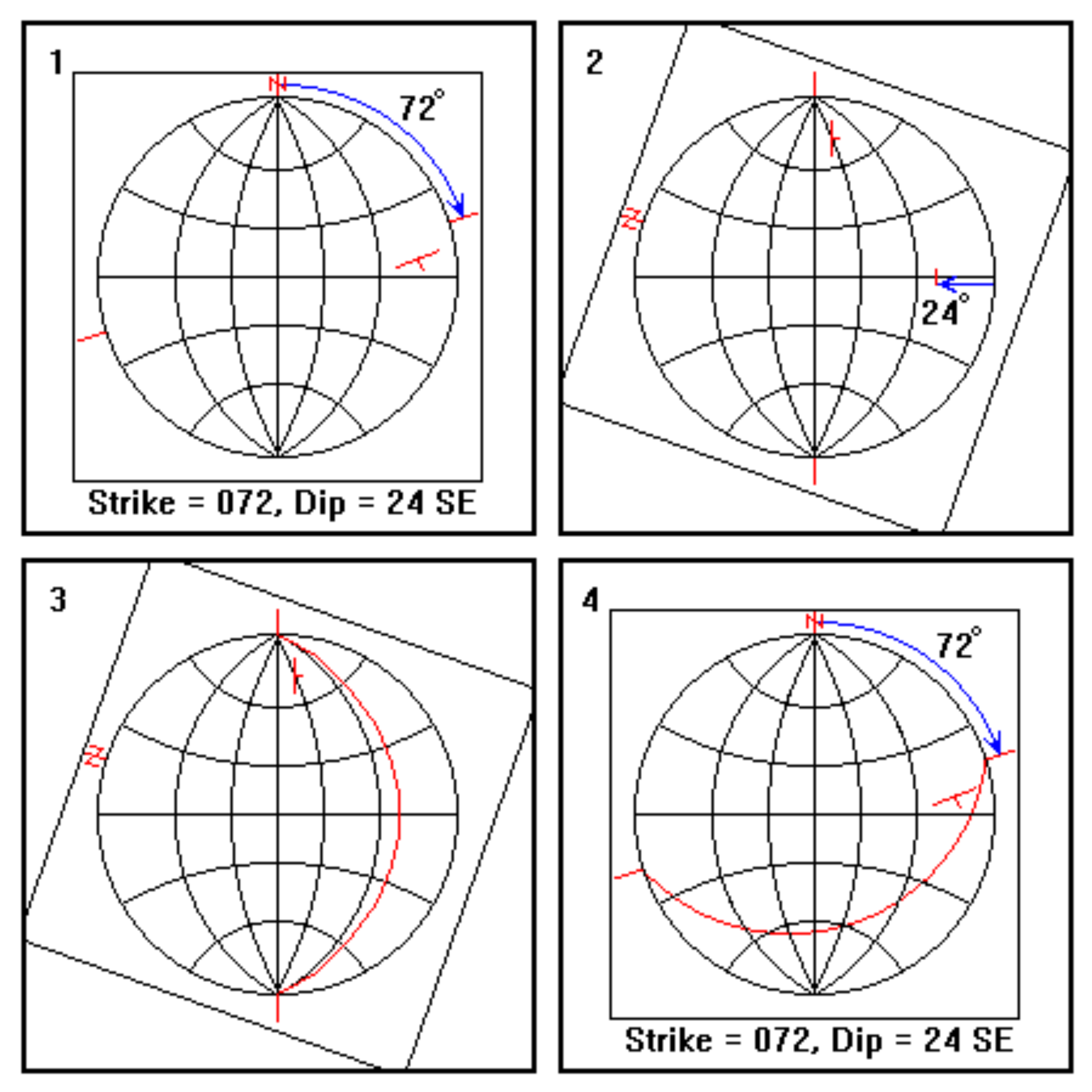
Tips for Using Stereonets

- <u>ALWAYS</u> think in 3-D!
- use your hands to help visualize what planes and lines are doing in space
- be neat
- clearly label all lines and points drawn on the stereonet
- always label north (N), east (E), south (S), and west (W) before starting to plot anything

Using a Stereonet



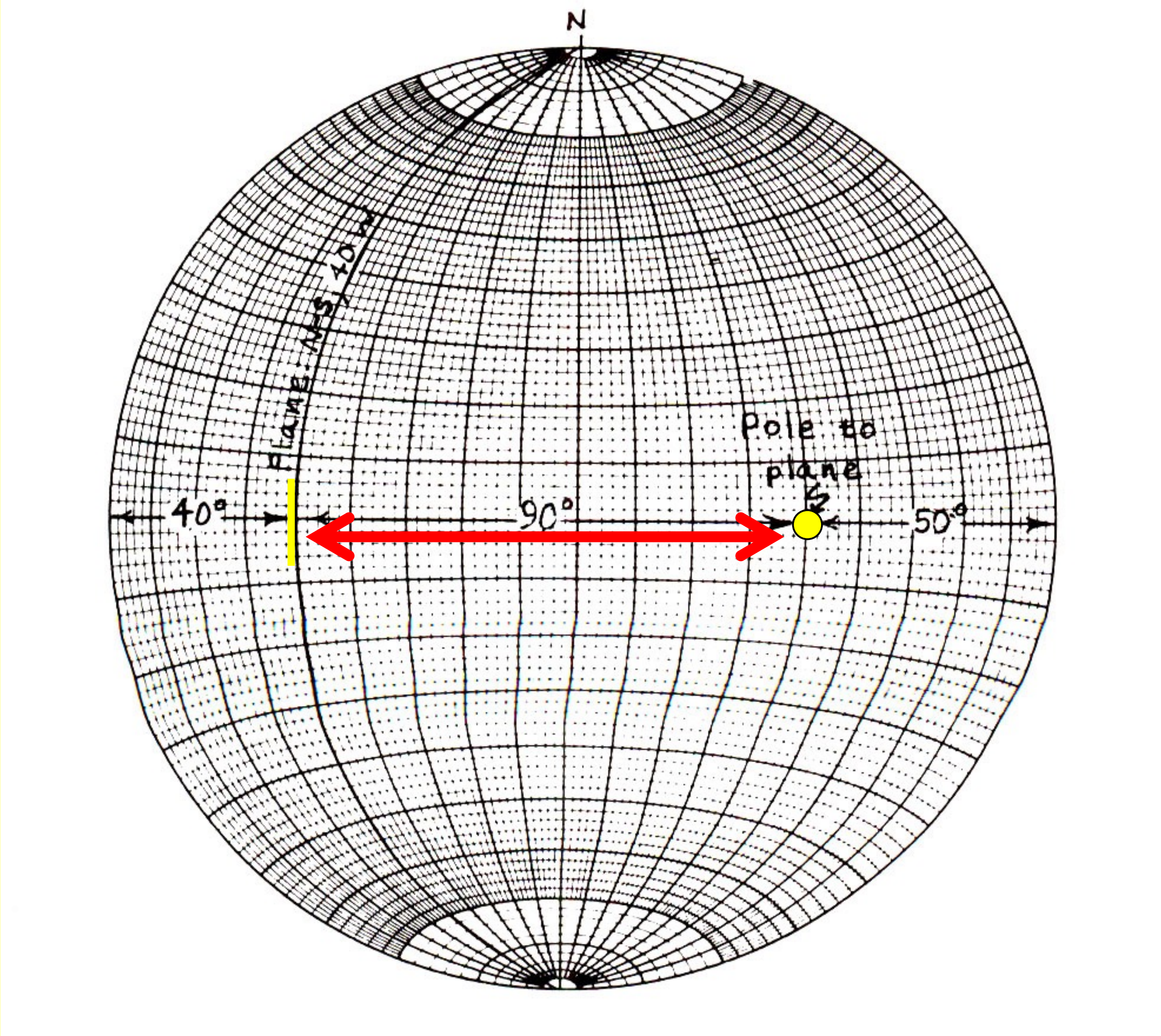
Plotting Planes



A plane 072° ,24° SE

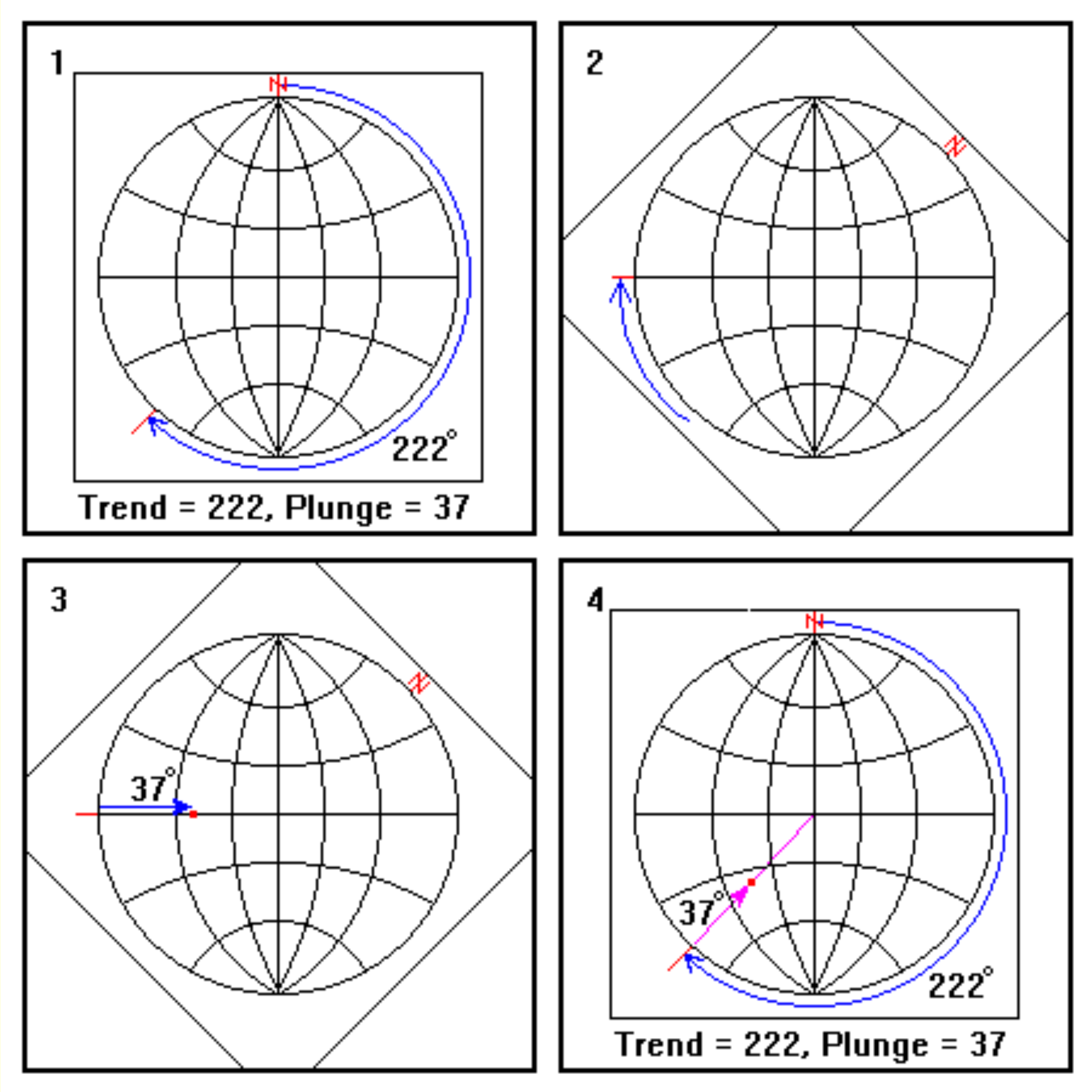
1. Mark North
2. Mark off strike direction (both ends)
2. Rotate strike to North or South
3. Count dip along the equator from the outer circle
4. Trace a great circle to connect strike and dip
5. Rotate back to North

Plotting Poles



- poles plot at 90° to planes

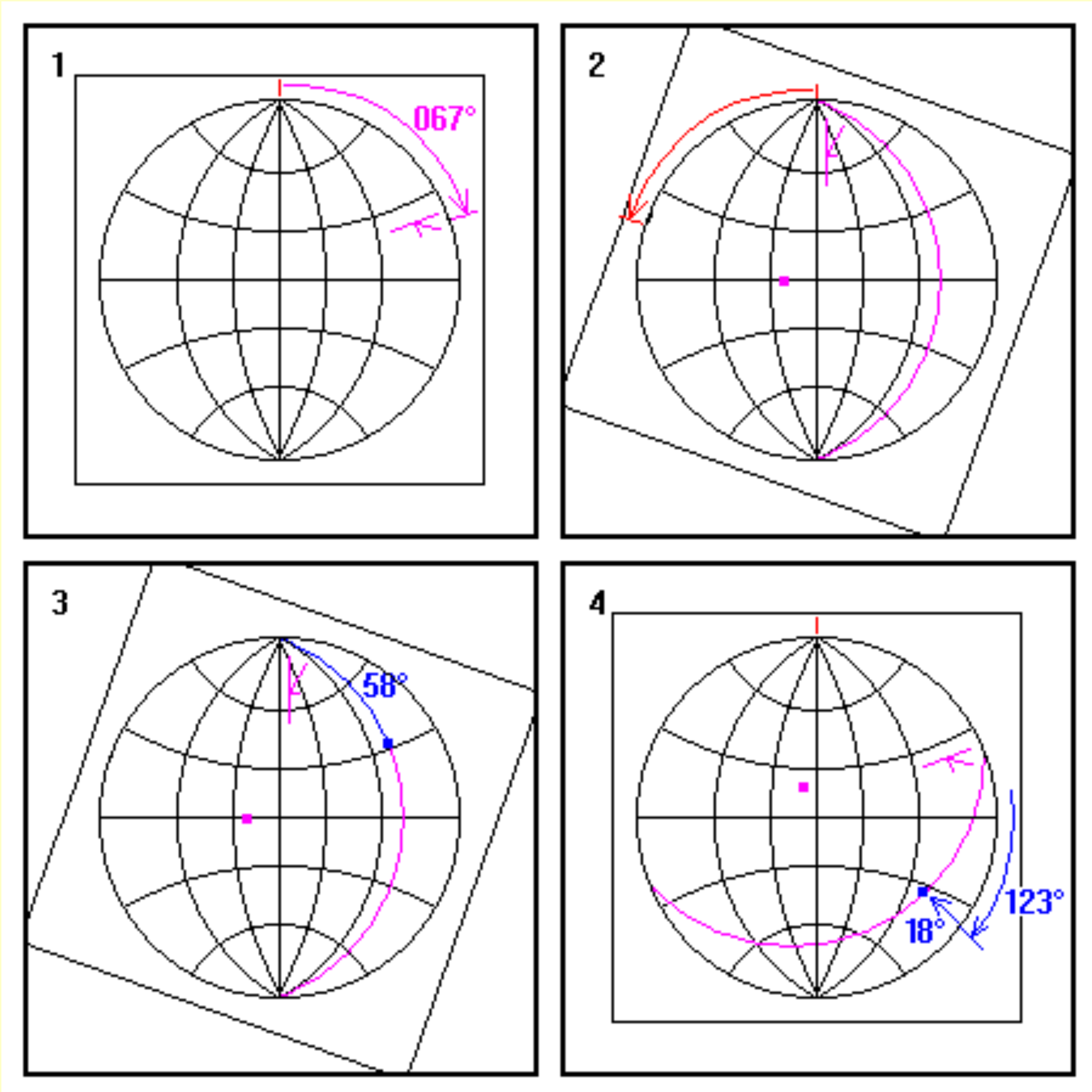
Plotting Lines



A line 37° , 222°

1. Mark North
2. Mark off trend direction
3. Rotate trend to N/S/W/E
4. Count in plunge from the outer circle
5. Rotate back

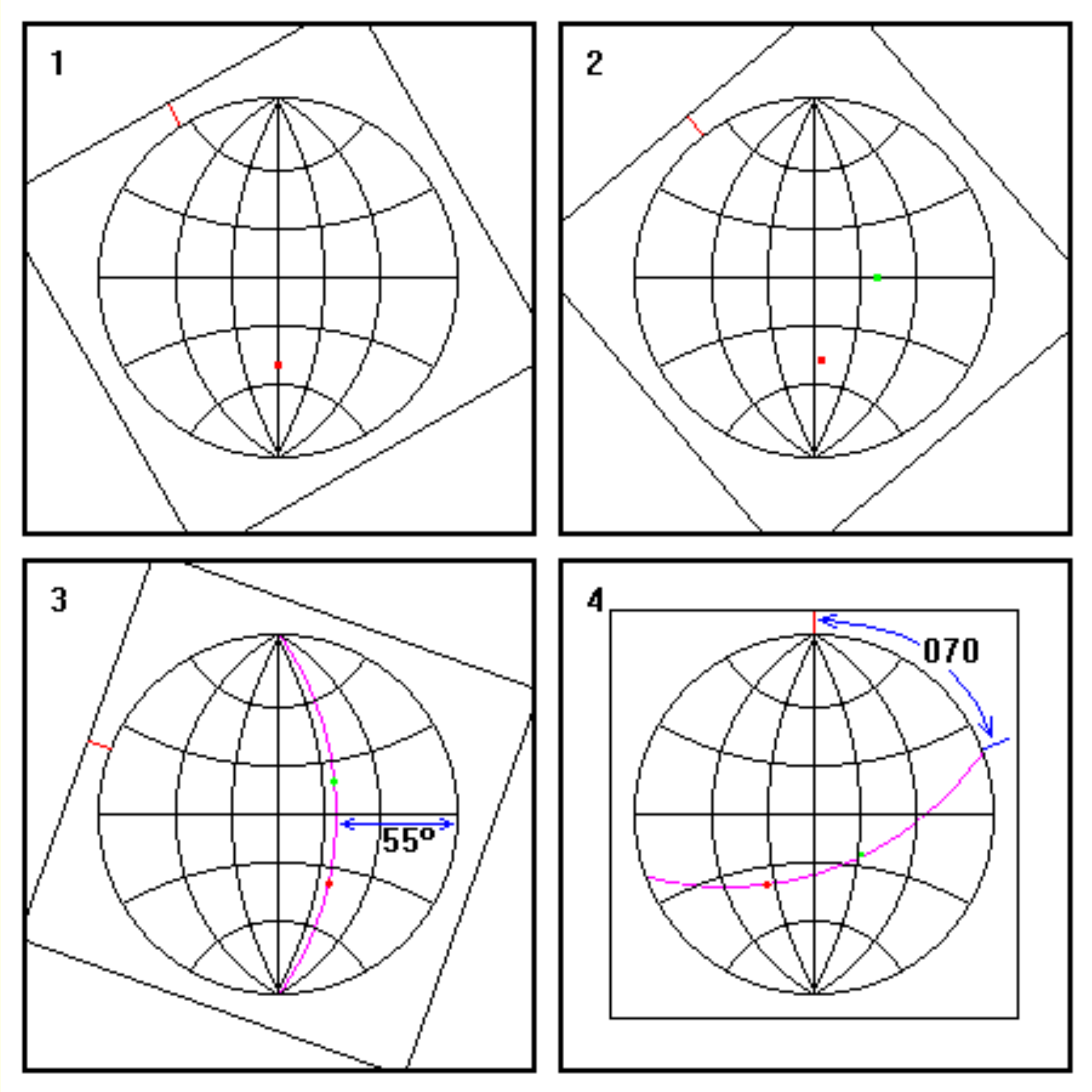
Finding Trend and Plunge Given Rake



Plane 067°,21°SE
Rake 58°E

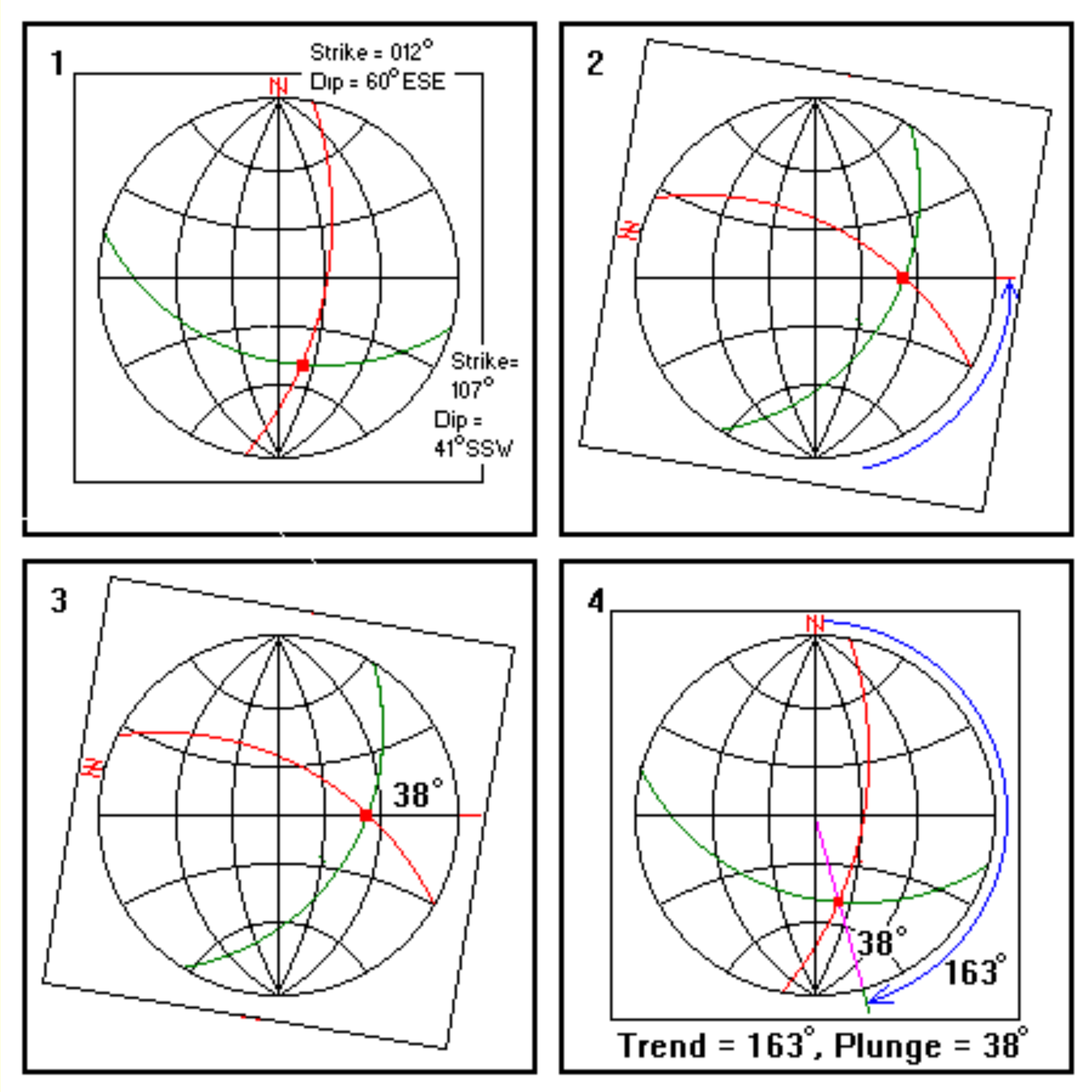
1. Mark the strike for the known plane
2. Rotate the strike to North or South
3. Plot a great circle to represent the plane
4. Count off the rake from the appropriate end of the great circle

Lines Contained Within Planes



1. Plot two points for two known lines
2. Rotate until the two points lie on a common great circle (pink)
3. Draw the great circle and count the dip in from the primitive circle
4. Rotate back to count off the strike

Intersection of Two Planes



1. Plot two great circles for two known planes
2. Mark the intersection point
3. Rotate the point until it reaches a vertical great circle
4. Mark the trend
5. Count in along the vertical great circle to find plunge
6. Rotate back and count off the trend

Class exercise

Using paper StereoNet, plot fault planes for:

- 2011 Tohoku-Oki Earthquake (Mw=9.1)
  - Plane 1: strike=203 dip=10 rake=88
  - Plane 2: strike=25 dip=80 rake=90
- 2002 Denali Earthquake (Mw=7.9)
  - Plane 1: strike=29 dip=82 rake=19
  - Plane 2: strike=296 dip=71 rake=171
- 2019 Northern Peru Earthquake (Mw=8.0)
  - Plane 1: strike=166 dip=33 rake=-94
  - Plane 2: strike=351 dip=57 rake=-87

1. What are their mechanisms?
2. Can you ID the fault vs. auxiliary plane?
3. What is the trend and plunge of the nodal axis?

Turn in paper stereonets with name for grading

Digital StereoNets

	Trend (°)	Plunge (°)
1	60	30
2	62	27
3	66	33
4	68	28
5	40	21
6	58	28
7	55	22

1. Create a dataset of lines and add datum individually using this table
2. Determine the average trend and plunge (Fisher Mean Vector)
3. Calculate the Planes from Poles
4. Calculate the Average Plane from the Poles (use average trend and plunge as a new line)
5. View results in ‘3D Viewer’

Digital StereoNets (if time)

Using digital StereoNet, plot:

- 2011 Tohoku-Oki Earthquake (Mw=9.1)
  - Plane 1: strike=203 dip=10 rake=88
  - Plane 2: strike=25 dip=80 rake=90

- 2002 Denali Earthquake (Mw=7.9)
  - Plane 1: strike=29 dip=82 slip=19
  - Plane 2: strike=296 dip=71 rake=171

- 2019 Northern Peru Earthquake (Mw=8.0)
  - Plane 1: strike=166 dip=33 slip=-94
  - Plane 2: strike=351 dip=57 slip=-87

1. Plot your earthquake faults on digital StereoNets (‘lines on planes’)
2. View in 3D