Structural Geology Lab 5: Introduction to Stereonets

I. Graphical Representation of Lines and Planes in Structural Analysis

A. Stereonets

1. Stereographic projection of lines and planes onto a circular grid or net
   a. Essentially taking a 3-D sphere and projecting it to a 2-D piece of paper (analogous to projecting the globe on world maps)

   b. Schmidt Net or Equal Area Net

      (1) Areas on the 3-D sphere are preserved as true on the 2-D projection of the net

         (a) Angles are not preserved, they become distorted

         (b) Most commonly used since structural problems require assessment of areal density distribution

   c. Wulff Net or Stereographic Net

      (1) Areas are not preserved, but angle are.

2. Schmidt Net Basics

   a. Primitive Circle = outline of sphere
   b. North-South and East-West Reference Lines
   c. Plane Projection

      (1) Lower Hemisphere Projections of Planes

         (a) Great circles formed by intersection of inclined plane with lower hemisphere of the reference sphere
         (b) Great circles are plotted on the stereonet

            i) horizontal plane: dip = 0, plots as great circle on primitive circle of net
            ii) vertical plane: dip = 90, plots as straight line passing through center

(2) Lower Hemisphere Projections of lines

(a) Lines plot as points of intersection between line and lower hemisphere
(b) horizontal lines plot as points on outer primitive circle
(c) vertical lines plot as points at center of net.

d. Poles to planes

(1) Imagine a line drawn perpendicular to plane, passing to lower hemisphere of reference sphere

(a) will plot as point on stereonet

e. Techniques for Plotting Planes, Lines and Poles to Planes on the Schmidt Net

(1) Read detailed instructions on p. 61 and 62 of lab manual

II. Stereonets Revisited

A. Remember... on Schmidt Net (Equal Area Projection)

1. Planes plot as great circles

a. given strike and dip of planes, plot as great circles projected to the southern hemisphere of the stereo projection

b. types of planes in structural geology

(1) bedding planes
(2) fault planes
(3) joints/fracture planes
(4) dikes, sheet intrusives
(5) quarry walls, road cuts
(6) veins, mineralized zones
(7) foliations: planar rock fabric

Class Example 1: Draw the great circle projections of the following two planes: Strike = N.38W Dip = 65 SW, Strike = N.60E Dip = 78 NW

2. Poles to planes

a. poles = lines drawn perpendicular to planes and projected into the southern hemisphere of stereonet

b. poles to planes plot as points

Class Example 2: Draw the poles the the planes from Example 1 above.

3. Lines plot as points

a. given trend and plunge on lines, plot as point projections to the southern hemisphere of the stereoprojection.

b. types of lines in structural geology

(1) mineral lineations
(2) slickenlines
(3) the line of intersection between two intersecting planes (e.g. faults and beds).

B. Steroenet Tricks

1. Determining the orientation of a line of intersection between two planes

a. Draw a great circle projection for each plane
(1) there will be one unit point of intersection between the two great circles
b. Rotate tracing paper so point of intersection lies on east-west line of stereonet
(1) make tick mark on primitive circle showing direction of line of intersection
(2) determine the angle of plunge of the point of intersection measured from the primitive circle toward the center of the net
c. Rotate tracing paper back to primary orientation
(1) determine trend of intersection point, by reading the bearing of the tick mark from 1.b.(1) above.

Class Example 3: Determine the trend and plunge of the line of intersection formed by the planes in Example 1 above.

2. Determining rake or pitch of a line contained within a plane

a. E.g. determine the rake of a slickenline contained within a fault plane

(1) Draw great circle of plane in question.

(2) The point plot of the slickenline will have a trend and plunge, thus plots as a point

(a) Since the slickenline is contained within the fault plane... the point projection will be located on the line of great circle plane projection

(3) Angle of rake measured along great circle. Angle measured from the origination point of the great circle on the primitive circle.

Class Example 4: Draw great circle projection of a fault plane with Strike = N.52W Dip = 20 NE. Project a slickenline lineation to that plane having a plunge of 43 E.

3. Apparent Dip Problems with the Stereonet

a. True Dip from Strike and Apparent Dip

(1) Given Data: Strike of Plane, Apparent Dip direction, apparent dip angle

(2) Draw straigtht line representing the strike of the plane (depict azimuth through center of stereonet)

(3) Make tick mark on primitive circle depicting apparent dip direction

(4) Rotate tracing paper so apparent dip tick mark is on east-west axis of net, measure plunge of apprent dip angle inward from primitive circle, make point projection.

(5) Rotate tracing paper so that strike line of 3.a.(2) is on N-S axis of stereonet, draw a great circle from straight line through projection point of 3.a.(4)

(a) This great circle represents the true dip of the plane.

Class Example 5: A fault has known strike of N10E, Apparent dip direction trends S26E, and apparent dip angle is 35 to the SE. Determine the true dip of the fault plane.

b. Strike and Dip from Two Apparent Dips

(1) Given Data: The strike and dip of a bedding plane are not known, but the unit is cut by two quarry walls. .. so there are two apparent dip directions.

(2) Plot the two apparent dips as point projections with trend and plunge

(3) Rotate stereonet until the two points lie on a great circle

(4) draw in the plane of the great circle, its orientation will represent the strike and dip of the bed

Class Example 6: Two quarry walls cut a limestone bed. Apparent Dip 1 is on a wall oriented S18E with dip of 13 SE. Apparent Dip 2 is on a wall oriented S.52W with dip of 19 SW. What is the strike and dip of the limestone bed?

4. Rotation of planes and lines on the stereonet

a. Statement of Problem: in some cases, it is necessary to restore tilted geologic beds to horizontal to determine the geologic history of a region.

(1) Goal: to restored tilted / deformed beds to horizontal to properly analyze geologic information prior to deformation (i.e. in undeformed orientations)

(2) Some Examples

(a) Paleocurrent indicators (e.g. x-beds) in tilted sedimentary layers
(b) Paleomagnetic samples obtained from tilted and deformed layers
(c) Angular unconformities with multiple deformation events.
(d) To unravel fracture patterns that have been subsequently tilted and deformed.

b. Stereonet procedures for restoring tilted beds

Class Example 7

Intuitive example: plot a great circle of a plane having a strike of N 0 and dip of 40E. Two lineations are found in that plane, one oriented N90E, the other oriented N30 E. Draw the great circle of the plane, and plot the two lineation point projections on that great circle.

Now: rotate the plane back to horizontal, ie. draw a new great circle with strike N0 and Dip = 0.

Rotate the lineation point projections to the primitive circle, "slide" the points along the small circles of the strereonet until they reach the outer, primitive circle. Plot the new projections of the points

Determine the new azimuth orientations of the lineations.

(1) Moral of the story,

(a) planes may be rotated back to horizontal by rotating them to the primitive, outer circle about the strike line passing through the center of the stereonet.

(b) Any pole plot (e.g. pole to bedding, trend and plunge of lineation) may be rotated the same no. of degrees as the plane by translocation along the small circles of the strereonet.

Class Example 8 Two-tilt problem

Formation Y lies in angular unconformity on top of Formation O. Y attitude = Strike N60 W, Dip 35 NE. O attitude = N.50E 70SE.

Geologic history:

-Formation O deposited in horizontal layers
-Formation O structurally deformed and tilted.
-O exposed at surface and subject to erosion.
-Formation Y deposited in horizontal layers on top of O
-Formation O and Y subsequently subject to more tilting (35 degrees to the NE)

Question: what was the structural attitude of Formation O prior to tilting of Formation Y???? (i.e. lets remove the effects of Y tilting using the stereonet)

Technique

a. plot poles to bedding for formation O and Y
b. rotate net so that point Y is located on East-West axis of net.
c. "slide" point Y 35 degrees along E-W axis so that pole to bedding is restored to the center of the net.
d. without rotating the net, likewise "slide" pole O 35 degrees in the same direction as Y along the small circle of the net... This is the restored orientation of bed Y!!! Determine the new strike and dip of the pole for Fm Y.

Lab Exercise from lab manual

A. Stereonet Problems (complete each problem on separate sheet of tracing paper, label each overlay according to question no., write in any verbal answers on the tracing overlay itself).

1. complete the following problems: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10