Structural Geology

Practical 1

Introduction to Stereographic Projection
1) INTRODUCTION AND NOTES CONCERNING THE SCHMIDT NET AND STEREOGRAPHIC PROJECTION.

Geological structures contain lines and planes. Stereographic projection is the tool used by structural geologists to:

a) Represent graphically the orientation of lines and planes in 3-D space.

b) To solve geometrical problems involving the orientation of lines and planes.

Problems we can solve include determining:

- the orientation of the line of intersection between two planes,
- the angle between two lines,
- the angle between two planes,
- the angle between a line and a plane,

We can also rotate geometrical shapes consisting of lines and planes about vertical, horizontal or inclined axis and determine the resulting orientations.

We can do this 3-D problem on 2-D paper using a Schmidt Net!

The Schmidt Net is a drawing of what we would see if we were to slice the sphere in half and look vertically down into it.

- Points on this drawing mark the position of the points of intersection of lines with the lower hemisphere of the sphere.
- Great circles mark the lines of intersection of planes with the lower hemisphere of the sphere. (A great circle is a line which traverses the entire circumference of a sphere, like the equator and lines of longitude on the earth).

Thus, in summary, the Schmidt Net is a projection of a 3-D sphere onto a 2-D horizontal plane.

The projection has been calibrated by marking the intersection of planes and lines of known strike and dip direction with our sphere. These planes and lines project vertically upwards so that they intersect the horizontal plane represented by the Schmidt Net.

For example:

- the great circles marked on the stereonet represent the projection of planes which have a common strike i.e. 000-180° north-south. A number of planes have been projected, with dip intervals of 2°. The strike lines of these planes pass through the centre of the sphere marked by the centre point of the stereonet.

- the intersection points of the east-west line with the great circles represent lines which plunge below the horizontal. These intersection points are marked every 2° along the 090-270° line.
These lines also pass through the centre of the sphere marked by the centre point of the stereonet.

We can use the lines on our stereographic projection as a 3-D protractor with which to measure angles between lines and planes.

Remember:

Planes are represented by lines on the Schmidt Net Stereographic Projection.
Lines are represented by points on the Schmidt Net Stereographic Projection.

PROBLEM 1: PLOTTING THE PLUNGE AND PLUNGE DIRECTION OF A LINE

(Remember:- a line plots as a point on a stereographic projection).

- Push a drawing-pin through the stereographic projection and then place a tracing paper overlay onto the pin.
- Mark the north index on your tracing paper overlay.

We are going to plot the projection of a line which plunges at 26° towards 040°.

- Count 40° clockwise from the north index around the edge of the stereonet (just as if it were a compass), put a mark on the overlay on the edge of the stereonet. Label the mark as 040° (Each line equals two degrees).

Having established the 040° direction, we need to plot a point which plunges 26° from horizontal in the direction of 040°. The point we wish to plot lies on the line which joins the 040° mark and the centre of the stereonet, because this line has a "compass bearing" of 040-220°.

- Rotate the overlay until the 040° mark over-lies the 090° east-west line on the stereonet, because this line is calibrated in degrees of below horizontal.
- The plunge is measured by counting in along the east-west line from the perimeter towards the centre of the stereonet. Mark the point which represents the projection of line which plunges at 26°.
- Rotate the overlay until the north index returns to north.

The point you have plotted is the answer required, and is a 2D representation of a 3D phenomena; that of the orientation of a line intersecting a sphere.

PROBLEM 2: PLOTTING THE STRIKE AND DIP OF A PLANE

(Remember:- a plane plots as a great circle on a stereographic projection).

Using a new sheet of tracing paper plot the projection of a plane which has a strike of 310° and a dip of 26°.

- Count 310° clockwise around the edge of the stereonet from the north index (just as if it were a compass) and put a mark on the overlay on the edge of the stereonet. Label the mark as 310°.
- Rotate the overlay until the 310° mark rests over the north pole of the stereo net (000°). As the dip direction is by convention 90° clockwise from strike, the we can mark the dip of the plane by counting in along the east-west line (090°) from the perimeter towards the centre of the stereonet. i.e. count in 26°.

- Now trace onto your overlay the great circle which the point you have plotted lies upon. (Hint: the great circles are the lines which join the north and south poles of the stereonet).

This line is the stereographic projection of the plane 310/26°).

- Rotate the overlay until the north index returns to north.

ANALYSIS OF RESULTS

Figure 1 shows a sketch of a fault plane which has some slickenside lineations on it. The fault plane has a dip and strike of 310/26 and the slickenside lineations on the fault plane plunge at 26° towards 040°. If you overlay both pieces of tracing paper used in problems 1 & 2 onto the Schmidt Net, you will see what this fault plane and slickenside lineations look like when plotted on a stereonet!

So if you found this outcrop of fault in your mapping area you could:-

a) First measure and record the orientation of the fault plane and slickensides (Field classes on the use of compass clinometers to measure structures to follow!).

b) Communicate your findings to another geologist using stereonets!

PROBLEM 3

Using a third sheet of tracing paper, plot the orientations of the following lines and planes.

<table>
<thead>
<tr>
<th>Planes</th>
<th>340/56</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>187/20</td>
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<tr>
<td></td>
<td>057/90</td>
</tr>
<tr>
<td></td>
<td>280/00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lines</th>
<th>20Æ180</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>45Æ333</td>
</tr>
<tr>
<td></td>
<td>00Æ245</td>
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<td></td>
<td>90Æ010</td>
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</tbody>
</table>
The photographs on the following page illustrate several kinds of linear and planar structures. Structural geologists can plot the orientations of such features on stereonets.

Planar structures include the bedding planes, the joint fracture planes, and the dipping laminations of the current ripples.

Linear structures include the trace of joints on the bedding surfaces and the traces of ripple crests on the bedding surfaces.
Photographs of a plunging fold in Carboniferous rocks near Bude, SW England. Note the associated joints and current ripples.

The fold axis is indicated by the arrows. Note the plunge (decrease in elevation) of the fold axis to the right.

Located on the opposite side of the fold (out of view in the overview photograph) are current ripples. Note how they form a linear pattern on the surface.

Joints are fracture planes cutting through the rocks. Note the variety of joint orientations.

Close-up of the ripples.