

12.001 Exercise 3 – Stereonets

We have already seen earthquake focal mechanisms in the recent earthquake lab. You have learned that these represent the projection of fault planes onto the bottom half of a sphere as viewed from above. You have learned that these provide two possible fault planes along which the earthquake occurred, and that we then have to look at the geology and large-scale tectonics to determine the correct fault plane.

The way that these fault planes are plotted is by way of **stereographic projection** – a projection that allows you not only to plot but also to visualize 3D features in 2D. A plane will therefore become a line (as in the focal mechanisms) and a line will become a point. Furthermore, we can determine such features as fold axes by looking at the intersection of planes. You will need to know how to do this for next week's geologic mapping lab, so it is worth your while to spend some time familiarizing yourself with these techniques.

This exercise is designed to familiarize you with the basic structure and use of a **stereonet**, which we use to draw our projections. In this exercise we will actually use **equal-area** projections rather than true stereographic projections, because they are easier to draw while being just as useful for most purposes.

1. Plotting Lines

First, we will familiarize ourselves with plotting lines on a stereonet (remember that these will appear as points, representing the point where the line pierces the bottom of our hemisphere).

Lay a piece of tracing paper over your stereonet, draw in the outer circle and mark and label the four corners: N (0/360), E (90), S (180), W (270). This is the way we always set up our stereonet.

We will practice with a line (it could be a fold axis or a mineral lineation or the dip of a bed) that has a bearing of 060 and a plunge of 60°

- Beginning with your tracing paper lined up so that N is at the top, lightly mark the point on the perimeter of the circle that represents the bearing of your line. This is the direction that your line is pointing as viewed from the center of your hemisphere.
- Next, move the point so that it is at one of the four corners (i.e. a straight line connects it to the center of the circle). Count in along that line the degrees of the plunge from horizontal and mark it with a point. You have plotted your line on a stereonet!

Repeat this exercise for the following lines and try to visualize how these points look in 3D.

1. 174 - 32°
2. 308 – 80°

3. 000 - 10°
4. 225 - 0°

2. Plotting Planes

As you will have noticed from the field trip and the earthquake exercise, the most common features that we plot are planes – faults, beds and foliations. Planes are represented as lines on our stereonet. Remember for this exercise that we try to follow the right-hand rule. That is, if we are looking down the strike direction, the dip is to our right (dip *direction* = strike + 90°).

Set up a new piece of tracing paper as in the previous question and mark it with NESW. We will start with a bedding plane with strike = 248, dip = 30°

- Beginning again with your tracing paper lined up so that N is at the top, mark the point on the perimeter of the circle that represents the strike direction.
- Rotate the paper so that your mark is at the top of your circle.
- Count the dip angle inward from E.
- Draw in the “great arc” – the curve on your stereonet template that connects the top and bottom of the circle with your dip. You have plotted your bedding plane on a stereonet! Think back to the earthquake focal mechanisms and try to visualize this in 3D.

On the same stereonet, plot the following strike and dip data (these are real data from beds on opposite limbs of a fold – after we have plotted them, we will use our stereonet to find the fold axis!)

1. 240 / 45°
2. 268 / 16°
3. 035 / 35°
4. 041 / 50°
5. 020 / 20°

You will notice that these lines overlap at one point. This is the fold axis! Try to visualize how this works, with planes dipping in opposite directions on either side of the fold. What is the bearing and plunge of the fold axis?

3. Plotting poles to planes

You can imagine that drawing dozens of lines on a single stereonet can get messy, so we want a more concise way of representing a plane. The way we do this is by drawing in **poles to planes**. Imagine one of the planes that you plotted above. If you imagine it as a spinning plate on a stick, the pole to that plane is the bearing and plunge of that stick (it is the line orthogonal to the plane which pierces the plane’s center). If you imagine the plane as a wheel then the pole to that plane

is the axle. Any plane will have a unique pole to that plane, so we can now plot all the information about a plane in a single point!

To make things easier, we will use the same strike-dip data as in Section 2, and we will plot the poles to our planes *on the same stereonet*. Again, we will begin with the bedding plane with strike = 248, dip = 30°.

Plotting a pole to a plane follows exactly the same steps as plotting the plane, except that instead of drawing in the great arc, you will continue to count in along the E-W line – count in 90° more than the dip and mark a point. This is the pole to your plane! Try to visualize this line piercing the center of your plane.

What is the bearing and plunge of the fold axis?

Why is this data useful?

How does it relate to the conclusion you came to in Problem 1?

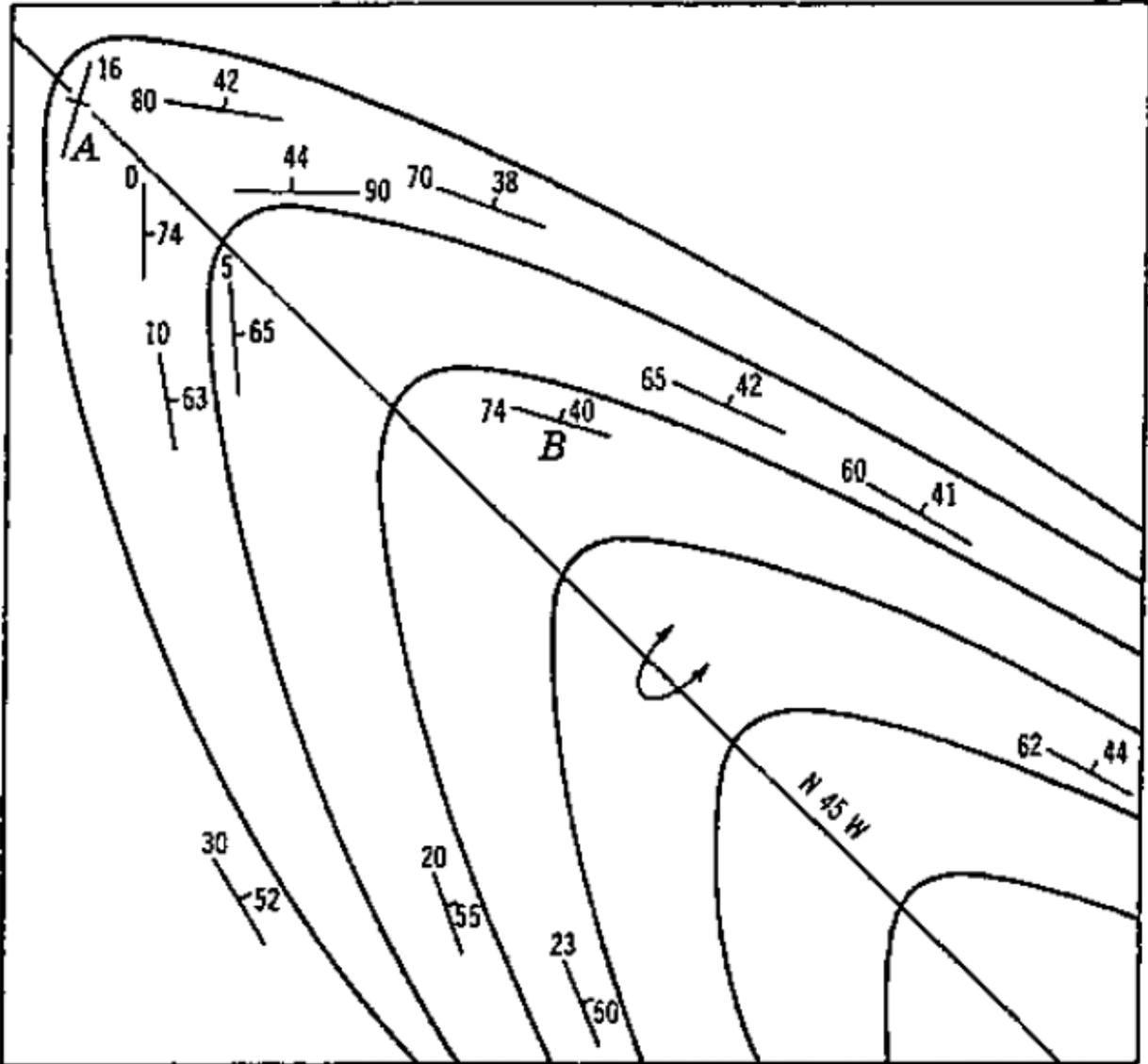
4. Practice Question

On the next page is a geologic map of an overturned fold. Plot the data (note that it is most useful to plot the poles to the planar data you are given). Remember to convert your strikes to the right-hand-rule where necessary.

Plot the bearing and plunge of the fold axis.

Plot the orientation of the axial plane of the fold and determine its attitude (essentially strike and dip for a fold axis).

Looking at the geological map, how could you have gotten a first quick approximate determination of the bearing and plunge of the fold axis?



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12.001 Introduction to Geology
Fall 2013

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