AMHERST COLLEGE - GEOLOGY DEPARTMENT
GEOLOGY 41 - Environmental and Solid Earth Geophysics
FAULT PLANE SOLUTION LAB

I) A hypothetical earthquake...

Listed below are a series of seismograph stations. For each is given

(1) the azimuth (clockwise from north) from the epicenter of one earthquake to the seismograph station

(2) the angle of incidence (i) for the incoming ray path (that is, the takeoff angle from horizontal for the ray path at the earthquake focus)

(3) a record of the nature of the first arrival at the station.

STATION INFORMATION

STATION	AZIMUTH	ANGLE (I)	FIRST MOTION
I	137	18.6	U
II	111	22.9	U
III	327	22.4	D
IV	266	22.8	U
V	337	22.5	D
VI	304	22.7	U
VII	27	22.1	D
VIII	48	22	U
IX	168	28	D
X	195	22.1	D
XI	230	23	D

1) Determine the first motion of the P-wave recorded at each station. For a dilational first motion, the initial pen motion on the record is down (D). For a compressional first motion the initial pen motion is up (U).

2) On a Schmidt (equal area) stereonet, plot each first motion at the lower hemisphere projection of each ray path relative to the earthquake focus at the center of the stereonet by using the seismic station azimuths and ray path angles of incidence. Use open circles for plotting dilations and filled circles for compressions.

3) Draw the lower hemisphere projection of the two nodal planes to fit the pattern of compressional and dilational first motions. Determine the strike and dip of the nodal planes.

4) Shade the compressional quadrants of your plot.

5) Based on your fault plane solution, what type of fault (normal, thrust, strike-slip) was produced by the stress release associated with this earthquake? What are the possible senses of motion on the nodal planes?

6) For both possible solutions, name one SPECIFIC (i.e. non-generic) location where such an earthquake might occur today.

7) For these data the azimuth and angle of incidence had already been determined. Describe how the azimuth and angle of incidence are determined knowing the location of a seismic station and the focal location of an earthquake. To answer this consider an earthquake (10 km focal depth) in Los Angeles that is received at a seismograph in Amherst.

II) Fault plane solutions from seismograms

1) Go to the IRIS WILBER II site (http://www.iris.edu/cgi-bin/wilberII_page1.pl)
Look at the map of recent seismicity and choose (double click) on an earthquake. This will bring up a new window with a list of recent earthquakes.
Select one of the these earthquakes. This brings up a window with a list of seismic networks that recorded that earthquake, check **ALL** and **PROCEED**. This brings up a window that lists all of the seismic stations that recorded the earthquake (this number may be very large).

Click on **Plot** just below **Station Map** to see a map of seismic station that recorded this event. Was the event recorded at seismic stations at a range of epicentral angles and azimuths? If so, then close the window with the map and proceed using this earthquake. If not, close the window and go back and select another earthquake.

2) My earthquake that was recorded at a range of stations at different epicentral angles and azimuths is:
Approx. Location:
Long:
Lat:
time:

3) Boxes are checked next to the names of the seismic stations. Uncheck ALL of the boxes. This is done most easily by selecting **DISTANCE** from **0** to **5** deg and **AZIMUTH** from **0** to **10** deg, then clicking on **Apply Filter**. This will uncheck most of the boxes, you can uncheck the rest manually. By checking boxes, you can download seismograms from each of the stations.

4) Select (check the boxes) 5 stations that are relatively close to the focus (within 20-30 deg), and select the short-period E-W seismogram **BHE** under **CHANNEL.** Then click on **Plot** below **RECORD SECTION**. In selecting seismic stations be sure to choose ones with a range of azimuths.

a) This will bring up another window. Under **OPTIONS**, select a **TIME WINDOW** from **30 sec** before **P** to **1 min** after **P.** Under **LAYOUT,** select **plot height autofit, each trace height 4 cm, vertical spacing stacked.** Then click on **Plot. This should bring up very readable seismograms of the time arounf the P arrival at each of your stations.**

b) Examine the seismograms and determine direction the first motions. An upward motion should represent a first motion to the E. An downward motion should represent a first motion to the W.

c) For each station record:
azimuth
epicentral angle
first motion: BHE
degree of confidence (certain, good, poor)

5) Close the window with the seismograms and repeat 4 a) with the short-period N-S seismograms. Select E-W seismogram **BHN** under **CHANNEL.** Then click on **Plot** below **RECORD SECTION**. This will bring up the seismogram window. Follow the instructions in 4 a) and b). An upward motion should represent a first motion to the N. An downward motion should represent a first motion to the S.

a) For each station record:
first motion: BHN
degree of confidence (certain, reasonable, good, poor)

6) Close the window with the seismograms and repeat 4 a) with the short-period vertical seismograms. Select vertical seismogram **BHZ** under **CHANNEL.** Then click on **Plot** below **RECORD SECTION**. This will bring up the seismogram window. Follow the instructions in 4 a) and b). An upward motion should represent a compression. An downward motion should represent a dialation.

a) For each station record:
first motion: BHZ
degree of confidence (certain, reasonable, good, poor)

7) Look at the 3d first motions. Do they represent compressions or dialations? Consider a station with an epicentral angle of 12 deg and an azimuth of 122 deg (i.e. the station is to the SE of the focus). From the 3 seismograms seismogram the first motions are:
- BHE (east component) UP
- BHN (north component) DOWN
- BHZ (vertical component) UP

Or putting them all together the first motion was out of the ground and towards the SE. This is away from the focus or a COMPRESSIONAL first motion.

8) You should now have first motions determined for 5 seismic stations close to the focus. Close the seismogram window. Uncheck the boxes for your 5 seismic stations and select (check the box) 5 more that are farther from the focus. Be sure to choose ones that have a range of epicentral angles and azimuths. Examine each of the 3 short period seismigrams (BHE, BHN, BHZ) for each of the stations and determine the direction of first motions (i.e., repeat 4, 5, 6, 7 for these stations).

9) Continue until you have ~20 first motions from stations with epicentral angles as large as ~100 deg (past that you would have to look at PKP which is more complex).

10) From the epicentral angles determine the approximate inclinations. If we ignore refraction due to velocity changes within the mantle: inclination = epicentral angle/2

11) Plot the inclinations/azimuths on a stereonet as you did for Part I (2-5). Were you able to determine a fault plane solution? If not make sure that you are not basing your

conclusions on poorly resolved (low confidence)first motions.

12) Determine the type of fault? Its possible orientations? Find your fault on a geological or bathymetrical map. Is there a fault or topographic scarp there? Does it strike parallel to one of your nodal planes? What type of fault do you have?

MAP NAME or URL: