Assignment 17

Department of Earth and Atmospheric Sciences **EASA-4620**

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Focal Mechanisms

Goals:

- **Introduction to the use of stereonets**
- **Determination of nodal planes from first motion data**

Data set:

The following first motion observations were made for the earthquake of 2015/11/09 22:42:06

Azimuth	IO	Pol	Station
179	62	1	'BCOK '
137	62	1	'BLOK '
163	62	1	'CHOK '
205	62	1	'CROK '
284	108	-1	'KAN01 '
265	100	-1	'KAN05 '
303	99	1	'KAN06 '
290	97	1	'KAN08 '
270	62	-1	'KAN10 '
289	98	1	'KAN11 '
300	62	1	'KAN12 '
133	102	1	'KAN13 '
238	62	-1	'KAN14 '
286	62	-2	'KAN16 '
234	105	1	'KAN17 '
27	107	1	'KS20 '
348	102	1	'KS21 '
171	62	1	'OK025 '
174	62	1	'OK029 '
150	62	1	'OK030 '
151	62	1	'OK031 '
235	62	-1	'OK032 '
141	62	1	'QUOK '
326	62	1	'R32B '
113	44	-2	'RLOK '
79	44	-1	'S39B '
102	62	-1	'T35B '
236	62	-1	'U32A '

This is the output of running the program **elocate** which uses the results obtained by picking arrival times and first motions with the *ppk regional* command of **gsac.**

The output consists of the azimuth, takeoff andgle and polarity for each observation. The station name is given for reference. The use of the quotes ' ' is an easy way to read in a string with FORTRAN.

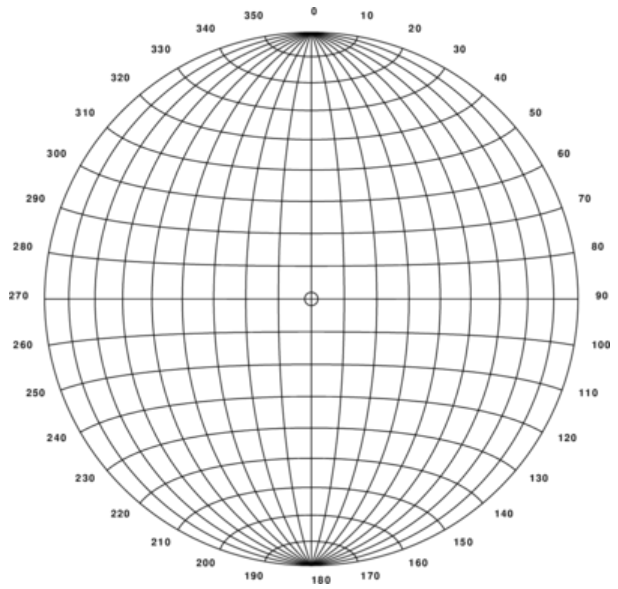
Azimuth is measured with respect to north and the takeoff angle is measured with respect to the downward vertical axis. A takeoff angle greater than 90 degrees represents a ray leaving the source in an upward direction. The meaning of the polarity is as follows:

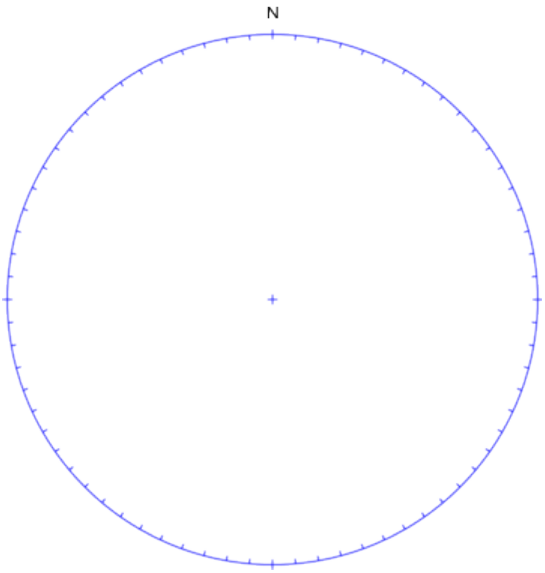
1 - strong compression (circle)
2 - weak compression (plus)
-1 - strong dilatation (delta)
-2 - weak dilatation (minus)
0 - uncertain (X)

Step 1: Prepare graphics

(a) Obtain a stereographic projection

(b) On a clear piece of tracing paper draw a circle of the same radius, and mark N, E, W, S





Step 2: Correct all data to lower hemisphere

For a plot of all data on the lower hemisphere, convert rays that go upward, e.g., IO > 90, to their equivalent position in the lower hemisphere. This is a valid procedure for moment tensor source. Just replace the entry (Azimuth, IO) by (Azimuth + 180, 180-IO). In the data set here, this means that we would replace

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284   108    -1 'KAN01 '
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by

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104    82    -1 'KAN01 '
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Step 3: Plot first motions

(a) Mark the azimuth on the circumference of the circle of the overlay

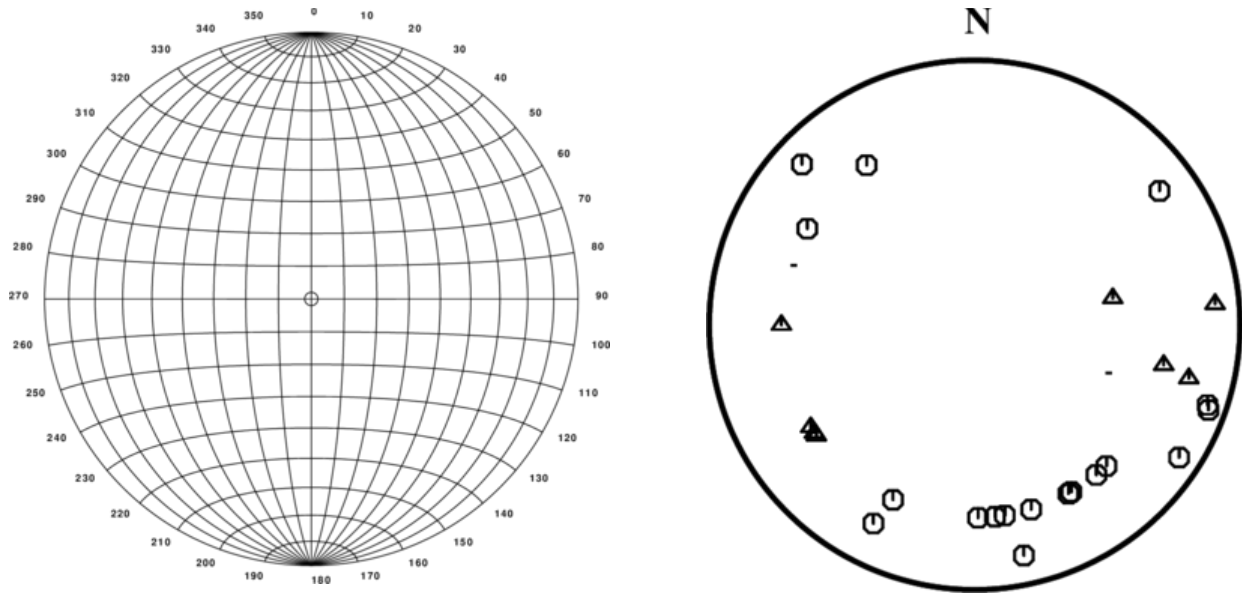
(b) Rotate the overlay so that the mark aligns with N of the stereonet (or E, S or W).

(c) Mark the takeoff angle by counting from the center of the stereonet

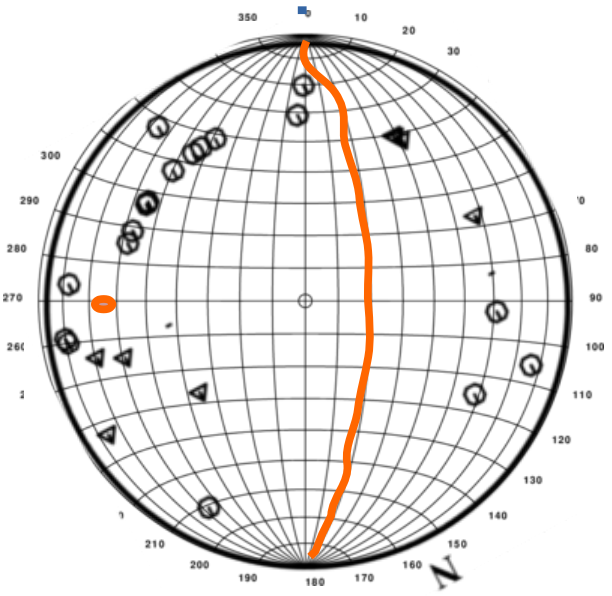
(b) Indicate the polarity with a symbol

Step 4:

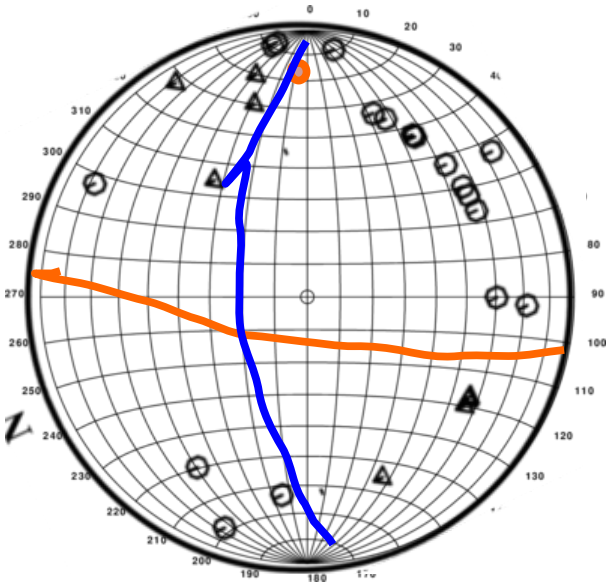
After plotting all first motions you will have the figure at the right. We will now define the nodal planes.



(a) Put the first motion plot on top of the stereo net, and rotate the first motion plot until you see a dipping plane that separates the compression and tension quadrants. (b) the following rotations are adequate: 208 degrees and 115 degrees. Rotate the first motions over the stereonet so that that compressions and dilatations are well separated. Trace out the dipping nodal plane and then mark the pole. The pole is perpendicular to the dipping plane – so in this plot it will be west and 90 degrees away.



Rotation by 208 degrees

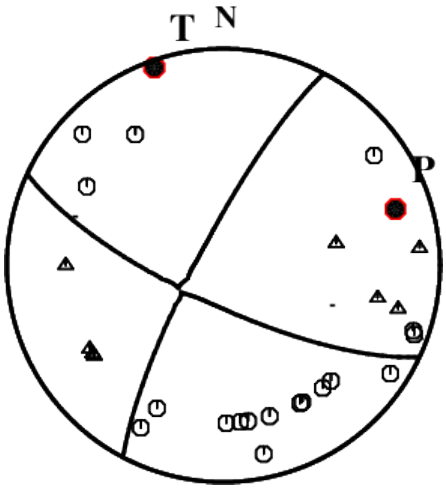


Rotation by 115 degrees

Now rotated the first motions to fine a plane that separates the first motions but also goes through the pole of the first plane.

The two rotations cannot be done independently because the second nodal plane must go through the pole of the first nodal plane, and vice versa.

Step 5: The solution



Plane	Strike	Dip	Rake
NP1	208	80	-165
NP2	115	75	-10

Principal Axes:

Axis	Value	Plunge	Azimuth
T	2.24e+21	4	341
N	0.00e+00	72	239
P	-2.24e+21	18	72

Assignment:
Determine the focal mechanism for the following two data sets. The azimuth, takeoff angle and polarity of each observation is listed. The takeoff angle is measured with respect to the downward vertical. The meaning of the polarity is as follows:

1 - strong compression (circle)	-1 - strong dilatation (delta)
2 - weak compression (plus)	-2 - weak dilatation (minus)
0 - uncertain (X)	

Earthquake of 20151123211746

Azimuth	IO	Pol	Station
147	62	2	'ADOK '
235	44	-1	'AMTX '
154	62	1	'BCOK '
94	62	1	'BLOK '
330	44	1	'CBKS '
160	62	1	'CCOK '
141	62	1	'CHOK '
142	62	1	'CROK '
154	62	1	'FNO '
98	95	1	'GORE '
97	44	-2	'HHAR '
52	62	1	'KAN01 '
52	62	1	'KAN01 '
50	62	2	'KAN05 '
50	62	1	'KAN05 '
39	62	2	'KAN06 '
39	62	1	'KAN06 '
32	62	1	'KAN08 '
32	62	1	'KAN08 '
60	62	2	'KAN09 '
60	62	2	'KAN09 '
28	95	1	'KAN10 '
28	95	1	'KAN10 '
38	62	1	'KAN11 '
38	62	1	'KAN11 '
26	62	1	'KAN12 '
26	62	1	'KAN12 '
74	62	1	'KAN13 '
74	62	2	'KAN13 '
64	95	2	'KAN14 '
64	95	2	'KAN14 '
50	62	2	'KAN15 '
24	62	1	'KAN16 '
24	62	1	'KAN16 '
62	62	2	'KAN17 '
62	62	2	'KAN17 '
161	44	-1	'LOOK '
147	62	1	'OK025 '
146	62	1	'OK029 '
125	62	1	'OK030 '
126	62	1	'OK031 '
110	112	1	'OK032 '
153	62	1	'OKCFA '
116	62	1	'QUOK '
348	62	1	'R32B '
85	62	2	'T35B '
231	62	-1	'U32A '
94	44	-1	'U40A '
145	44	-1	'W35A '
190	44	-1	'WMOK '
190	44	-1	'WMOK '
170	44	-1	'X34A '
132	44	-1	'X37A '
165	44	-1	'Z35B '

Earthquake of **20151118120840**

Azimuth	IO	Pol	Station
175	62	1	'BCOK '
28	62	-1	'BLOK '
180	62	1	'CCOK '
138	62	1	'CHOK '
325	62	1	'CROK '
166	62	1	'FNO '
340	62	1	'GORE '
355	62	1	'KAN01 '
351	62	1	'KAN06 '
347	62	1	'KAN08 '
1	62	1	'KAN09 '
340	62	1	'KAN10 '
349	62	1	'KAN11 '
346	62	1	'KAN12 '
8	62	1	'KAN13 '
343	62	1	'KAN14 '
354	62	1	'KAN17 '
3	62	1	'KS20 '
153	91	1	'OK029 '
104	62	-1	'OK030 '
103	62	-1	'OK031 '
326	62	1	'OK032 '
166	62	1	'OKCFA '
85	62	-1	'QUOK '
48	62	-1	'T35B '
97	62	-1	'TUL1 '
214	62	-1	'WMOK '
214	62	-1	'WMOK '
185	62	1	'X34A '