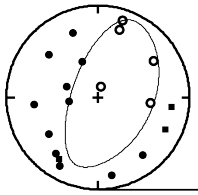

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November 26, 2014

WEEKLY REPORT #8 TO ALTAROCK ENERGY INC.

PROCESSING OF INDUCED EARTHQUAKES ASSOCIATED WITH THE NEWBERRY EGS INJECTION STARTING SEPTEMBER 2014

GILLIAN R. FOULGER & BRUCE R. JULIAN

Brief summary

During the last week we concentrated on studying the November swarm with a view to examining whether it had different characteristics from the September/October earthquake activity. This seems indeed to be the case:

- *The swarm comprises two bursts, the first peaking in intensity about 16 November and the second peaking in intensity about 21 November.*
- *The earthquakes of the second burst are ~ 300 m deeper than those of the first burst.*
- *Both the absolute locations of the 6 moment-tensor events studied from the November swarm and the relative locations of the November-only earthquakes suggest that a more northerly striking planar feature was activated (~ N15˚W, compared with N60˚W for the September/October planar feature).*
- *The depth range of the earthquakes spanned the zone that was aseismic during September/October, closing the "aseismic gap".*
- *Moment tensor calculations suggest that the P- and T-axes are orientated systematically differently, namely the T-axes plunge more steeply and trend more westerly, and the P-axes trend more northerly. This consistent with a different stress field and a rotated plane of failure.*

During the forthcoming week we will work to increase the size of our relative-location and moment-tensor data set for the November earthquakes in order to test these preliminary results.

1 Task 1 – Planning, conference calls, discussion of work, correspondence, followup

We continued to maintain contact with team members as before. The work continued to run smoothly.

2 Task 2 – System Setup

No additional system setup was done during the last week.

3 Task 3 – Quality control of prepicked MEQs for relocation and moment tensor calculation

We continued to derive moment tensors using the procedure described in our Weekly Report #1. We report here an additional 5 moment tensors from 16, 17 and 21 November. This brings the total number derived up to 70 (Appendix 1). We have provided the locations of these new moment tensors to Trenton Cladouhos of AltaRock electronically, by email attachment.

4 Task 4 –Improved locations and relative locations

4.1 Absolute locations–ISTI picks

We locate all the earthquakes hand-picked by ISTI as a routine matter, using our in-house location program *qloc*. In our report #7 of 19 November, we presented week-by-week maps of the earthquake locations which showed the development with time of the activity. Here we update the incomplete week shown in that report and add an additional week. Figure 1 shows maps of the earthquakes for November 14-20 and November 21-24 (incomplete week).

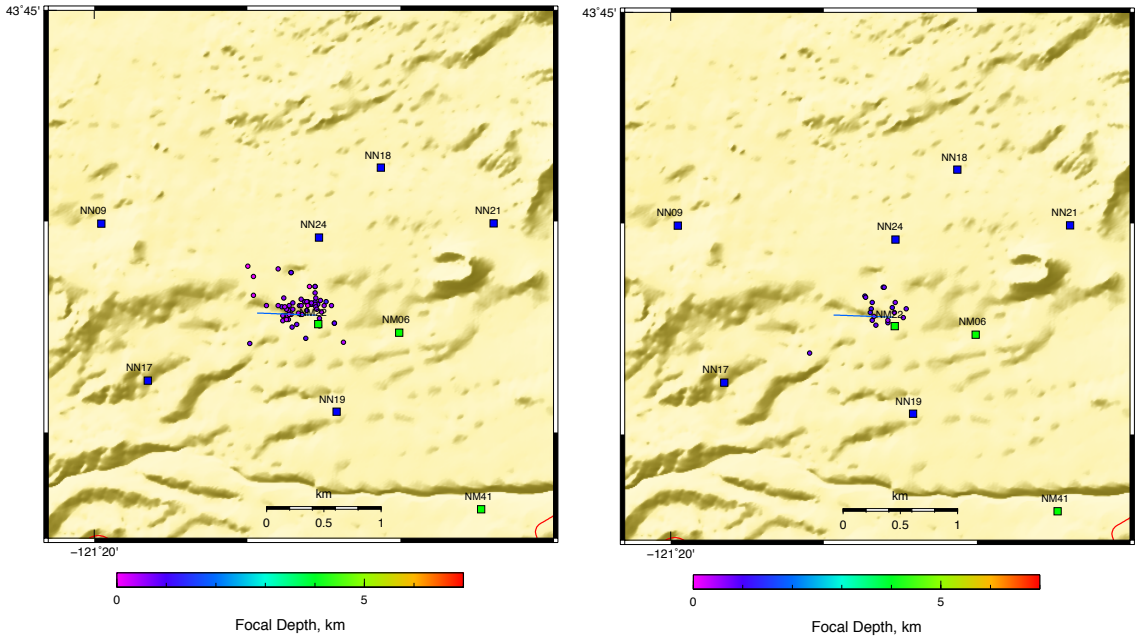

Figure 1: Earthquakes located using ISTI picks, and our in-house *qloc* location program for the weeks (left) November 14-20 and (right) November 21-24 (incomplete week).

Figure 2 shows the depths of all the earthquakes as a function of time (*qloc* locations, using ISTI picks). The November swarm comprises two bursts, the first peaking in intensity about 16 November and the second peaking in intensity about 21 November. The earthquakes of the second burst are significantly (~ 300 m) deeper than those of the first burst.

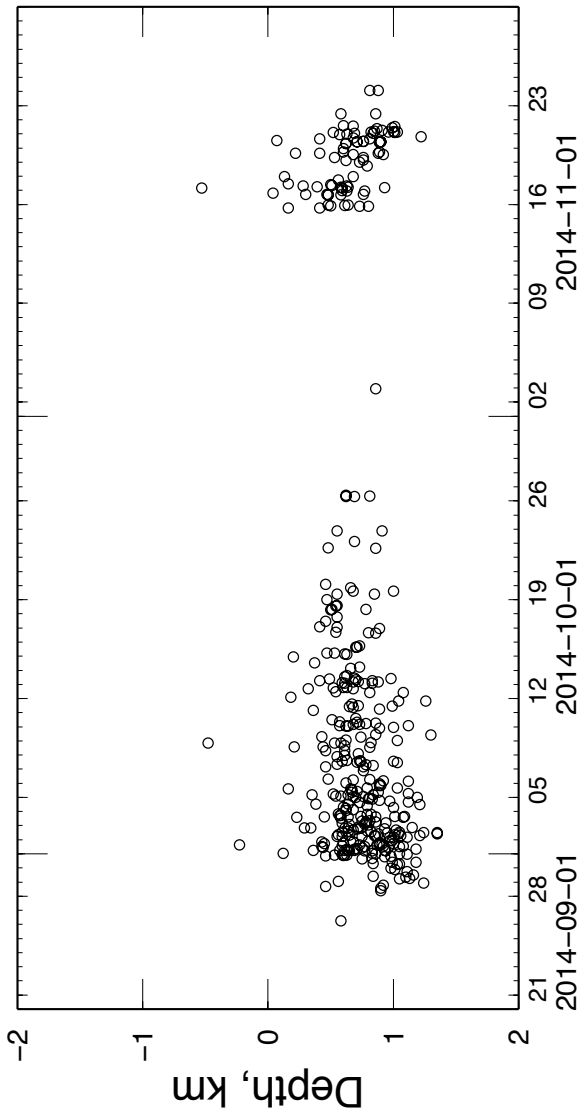

Figure 2: Estimated depths, with respect to sea level, of the earthquakes within the NMSA network as a function of time. These depths were obtained by using *qloc* to invert *P*- and *S*-phase arrival times measured by personnel of the ISTI Corporation on digital seismograms from the NMSA network.

4.2 Absolute locations–Foulger Consulting picks for moment-tensor derivation

We picked an additional 5 earthquakes for the purpose of moment-tensor derivation, bringing the total in hand to 70. Figure 3 shows a map of the 6 earthquakes that occurred in November, for which moment tensors have been derived. These locations are exceptionally accurate, being a by-product of the moment tensor deriviation process. The epicenters lie in a linear zone that trends more northerly than the entire earthquake set (see previous reports). This result agrees well with the results of relative locations of the November swarm as a whole (Section 4.4).

A map of all 70 moment-tensor-earthquake locations is shown in Figure 4.

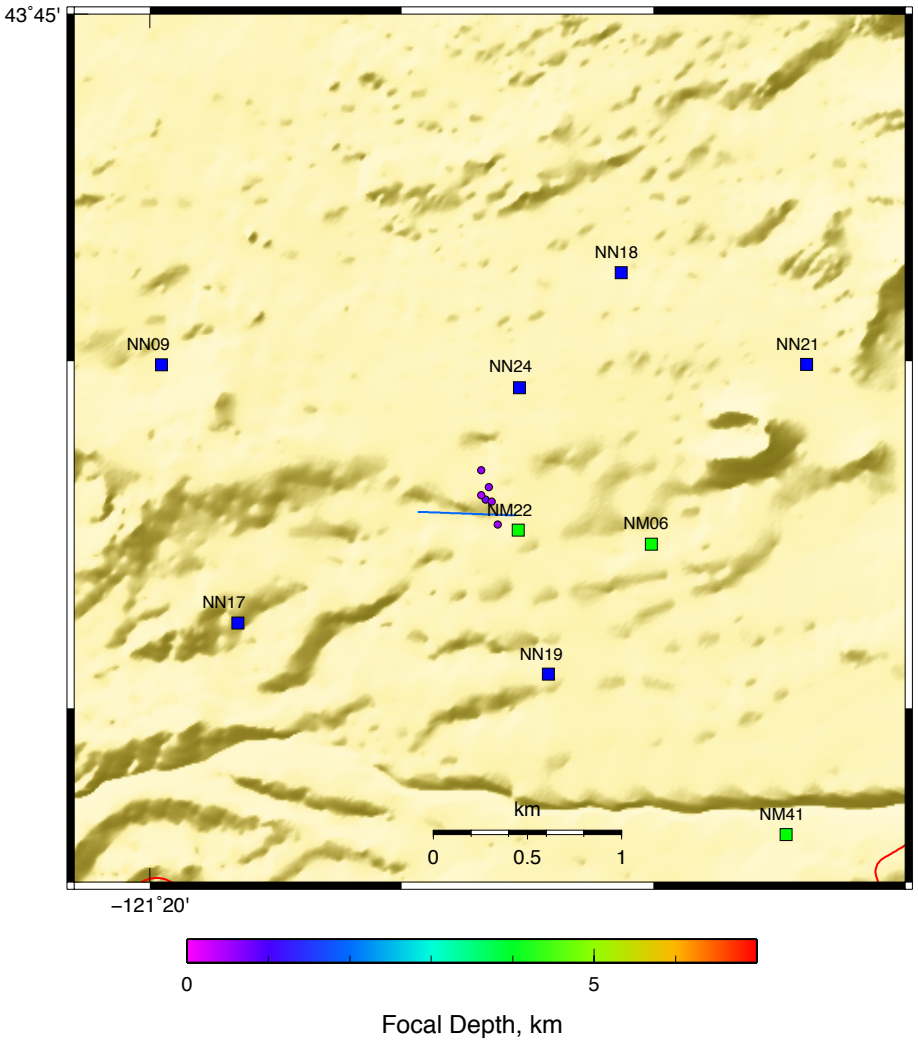

Figure 3: High-quality estimated hypocenters of 6 microearthquakes that occurred in November. Moment tensors were derived for these events. The locations are computed using arrival times measured using advanced (and more time-consuming) methods in connection with the moment-tensor analysis. Well NWD 55-29 is shown in blue.

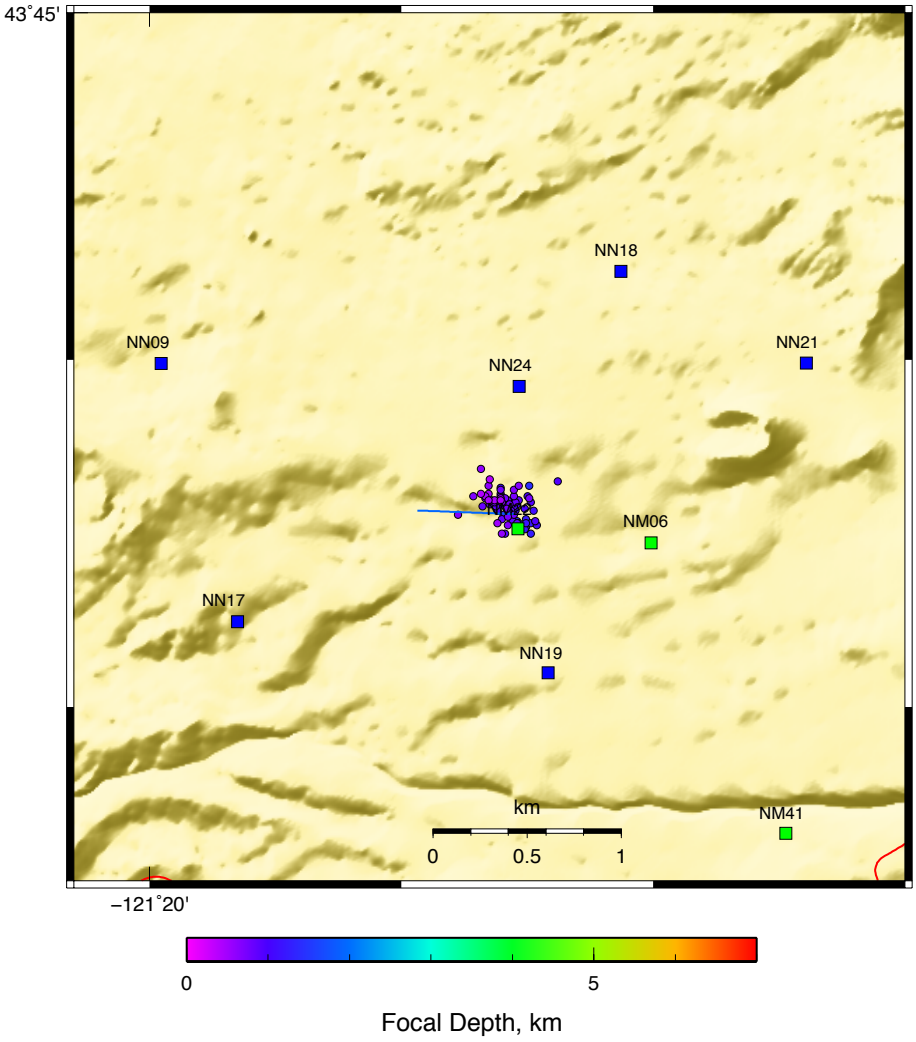

Figure 4: High quality estimated hypocenters of the entire 70-earthquake set for which moment tensors have been derived. Well NWD 55-29 is shown in blue.

4.3 Relative locations: the entire catalog

We continued with the relative location work, applying the method to the catalog of ISTI-picked events up to and including 21 November. This set contained 376 earthquakes. We relative located this catalog using the following input parameters:

- *minclust* = 10;
- *maxit* = 25;
- *maxsep* = 0.20 km;
- *minlinks* = 18.

A higher threshold of *minlilnks* = 18 could be used because of the larger size of the catalog. 25 earthquakes passed the thresholds and were located.

The results are shown in Figure 5 and Figure 6.

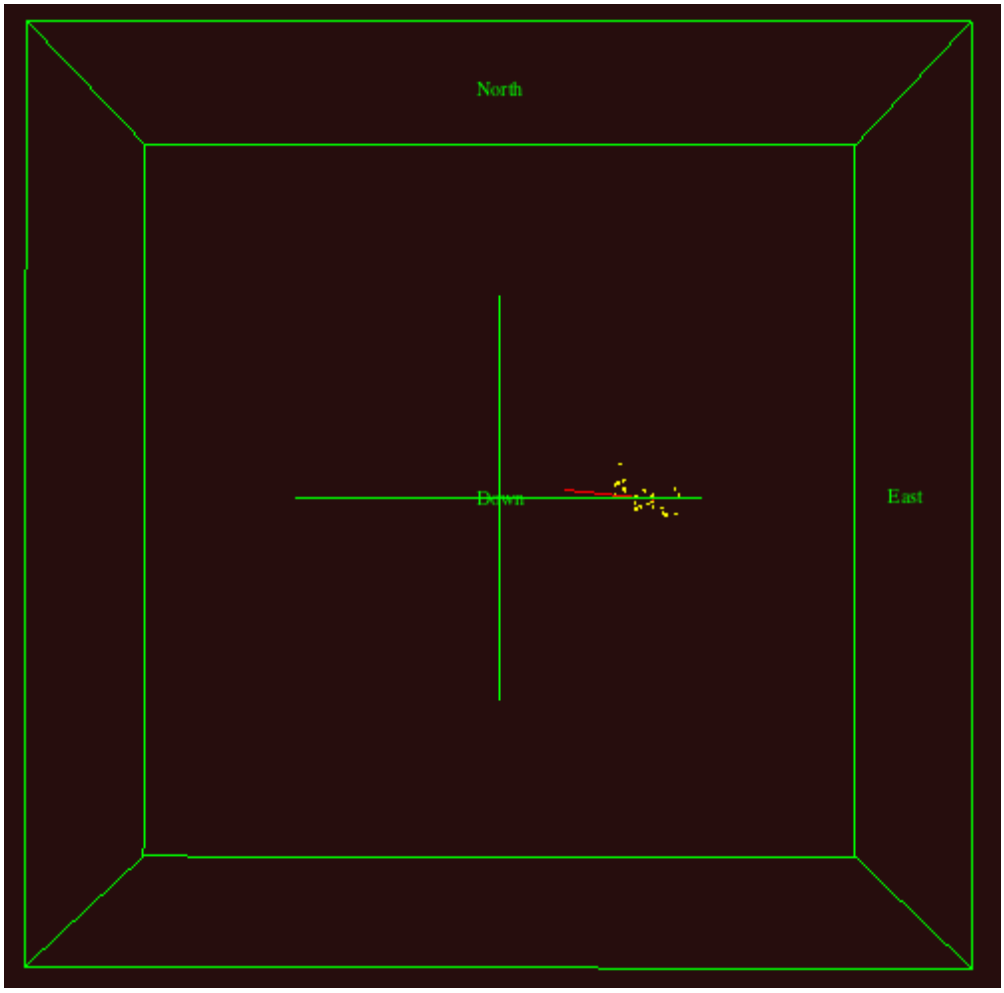

Figure 5: Map of relative locations of 25 earthquakes that occurred in the time period 26 September - 21 November, 2014. Runtime parameters used were *minclust* = 10, *maxit* = 25, *maxsep* = 0.20 km, *minlinks* = 18.

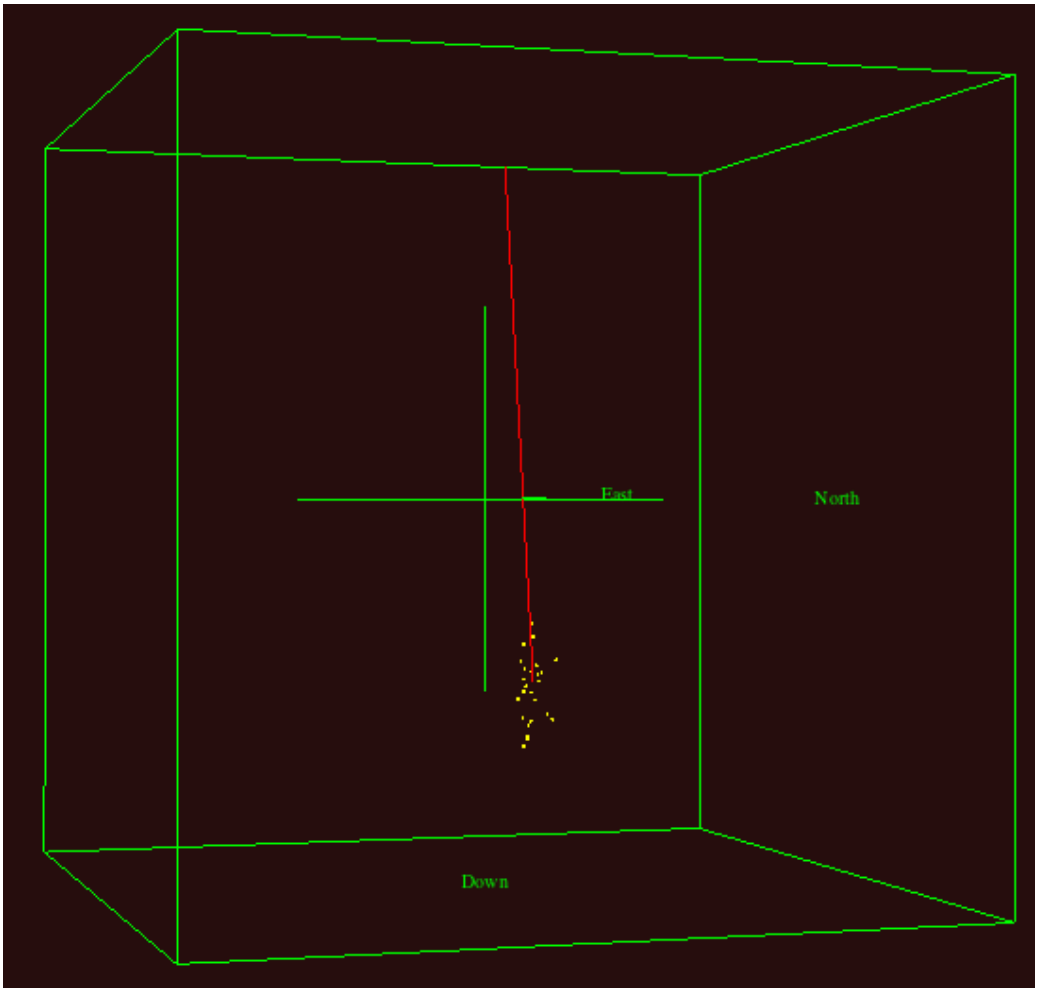

Figure 6: Same as Figure 5 except looking along the strike of the epicentral trend, to the NW.

The northwesterly trending epicentral zone continues to be apparent.

4.4 Relative locations: The November swarm

Relative locations were calculated for the November swarm only, using earthquakes that occurred in the period 15 - 21 November. This subset of the data comprised 78 earthquakes. The following input parameters were used. These yielded the best balance between selecting out the highest-quality locations, whilst not reducing the number of earthquakes to a very small number:

- *minclust* = 10;
- *maxit* = 25;
- *maxsep* = 0.20 km;
- *minlinks* = 14.

Of the original 78 earthquakes, 17 were located. The results are shown in Figure 7 and Figure 8.

Interestingly, these earthquakes delineate a sub-vertical, planar feature, but in contrast to the September/October earthquakes, the strike of the November feature is more northerly. It strikes just slightly west of north (Figure 7). This seems to be consistent with an apparent change in the orientation of the P-, and T-axes detected in new moment tensors derived (see Section 5).

The depth range of the November earthquakes includes the layer that was aseismic in September/October, separating those earthquakes into two clusters. This is consistent with the depth distribution of the entire catalog no longer showing a division into two clusters (Figure 6).

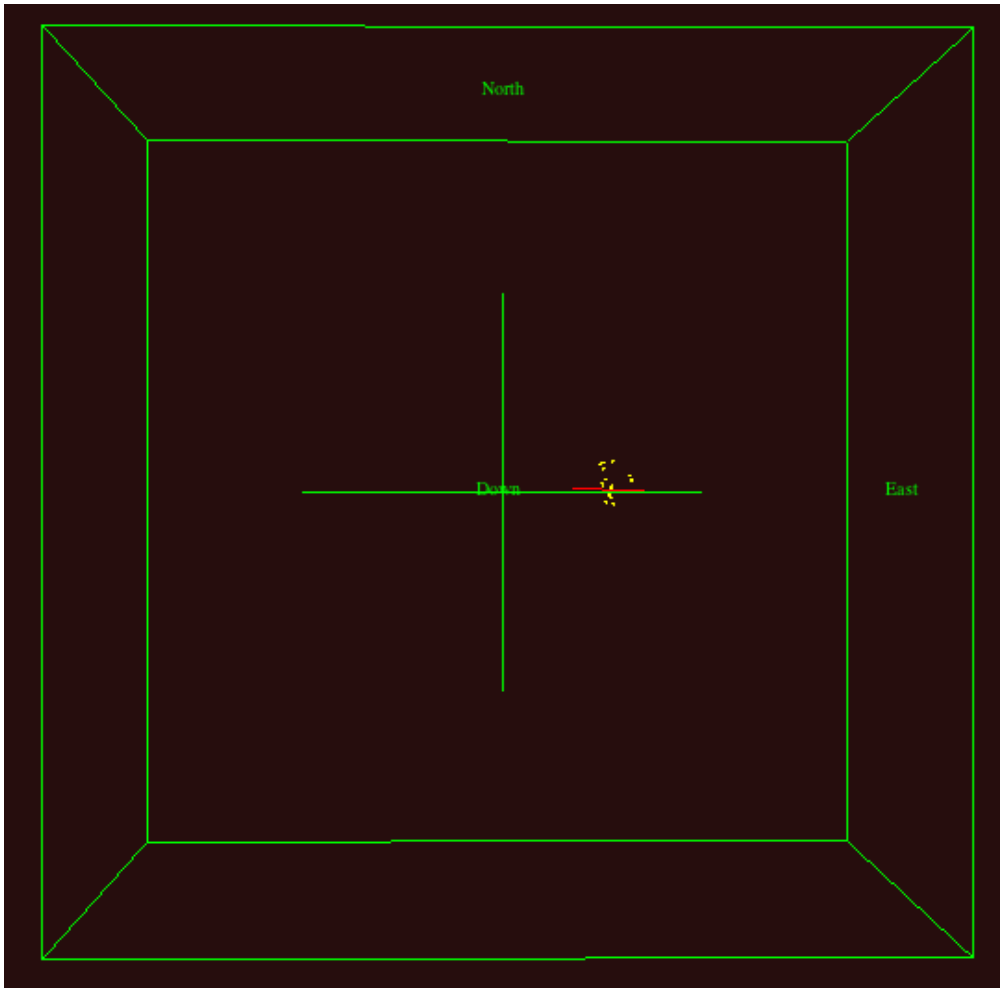

Figure 7: Map of relative locations of 17 earthquakes that occurred in the time period 15 - 21 November, 2014. Runtime parameters used were *minclust* = 10, *maxit* = 25, *maxsep* = 0.20 km, *minlinks* = 14.

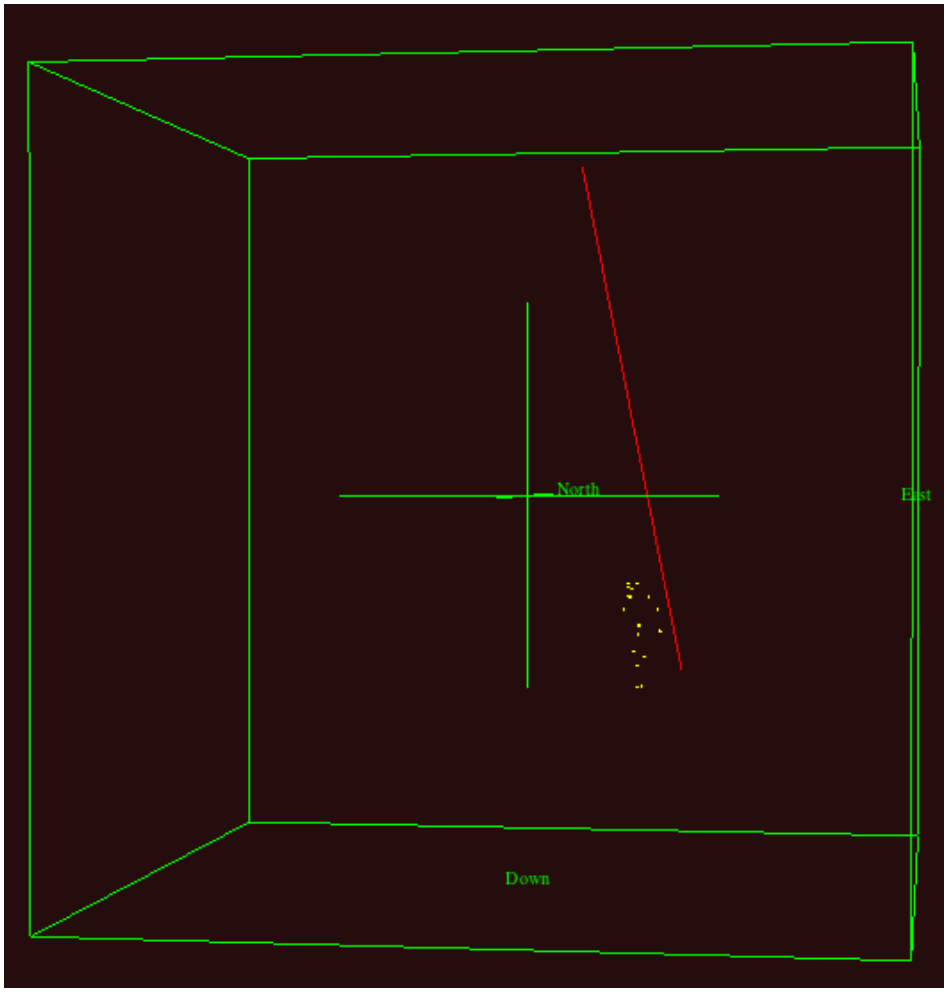

Figure 8: Same as Figure 7 except looking along the strike of the epicentral trend, to the NNW.

5 Task 5 Moment tensors

We continued to derive moment tensors and report here an additional 5. We focused on the earthquake sequence that occurred in mid-November, and report mechanisms for events from 16, 17 and 21 November.

The entire list of earthquakes processed to date is given in Appendix 1. The numerical results of the entire moment-tensor catalog, including the 5 new results are given in Appendix 2. Graphical results for the additional 5 events are given in Appendix 3. We have provided the decomposition data of these new moment tensors to Trenton Cladouhos of AltaRock electronically, by email attachment.

The source types for the 6 moment tensors we have now derived for the November sequence are shown in Figure 9. The distribution lies along the +Dipole to -Dipole range, but does not occupy the full range. Mechanisms range from strongly implosive (-Dipole) to mildly explosive. This suggests that

these earthquakes were dominantly volume-decreasing. The dataset is small, and it will be interesting to see if this is confirmed when more mechansims from this sequence are derived.

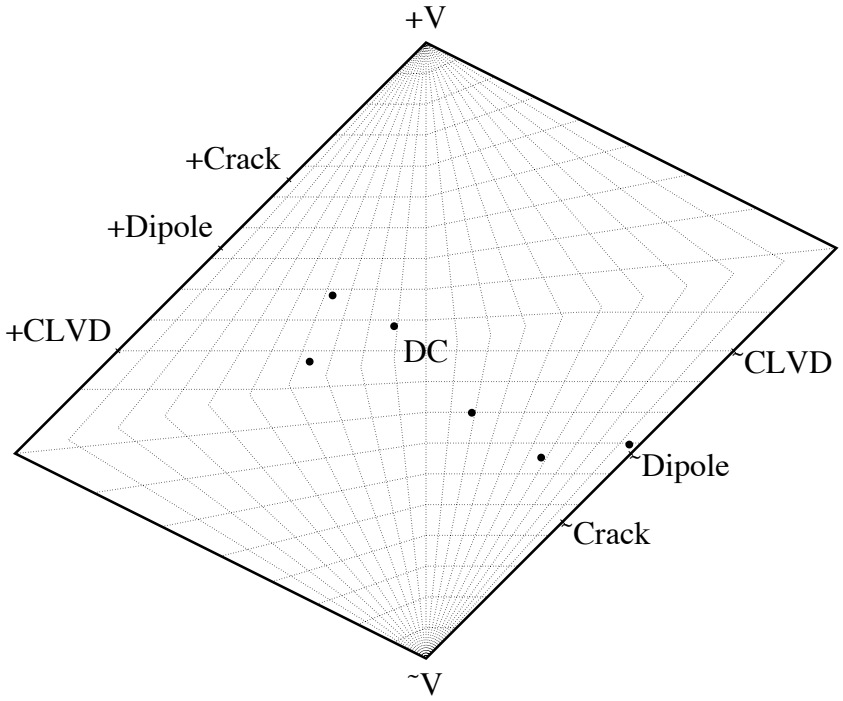

Figure 9: Source-type plot showing the 6 earthquakes from November for which moment tensors have been derived to date.

Figure 10 shows plots of the P-, T- and I-axes, approximately corresponding to the directions of σ_1, σ_3 and σ_2. The plot on the left is of the 65 events from September and October, reported in our Weekly Report #7 of 19 November. The plot on the right is of the 6 events from the November swarm.

The number of events is small, but there appears to be a significant difference in the orientation of the P-, T- and I-axes compared with the events of September and October. The T-axes dip more steeply and are somewhat more westerly oriented. The P-axes are distributed around the north direction, and do not preferentially trend NE as was the tendency in the earlier earthquakes.

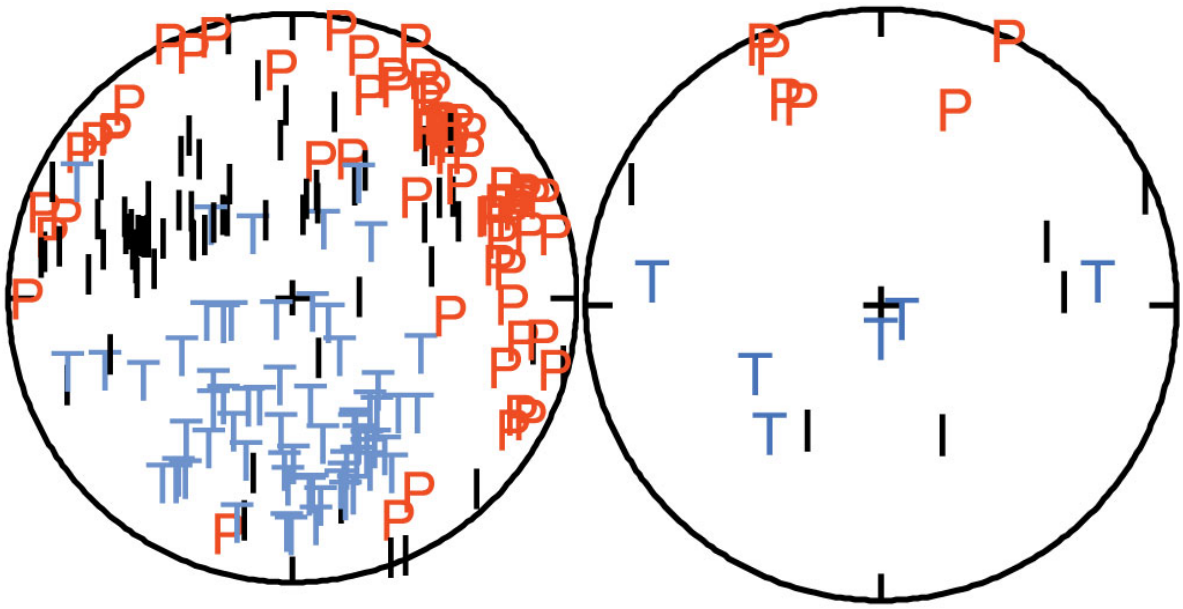

Figure 10: Plots of pressure (P ~ σ_1) and tension (T ~ σ_3) and intermediate (I ~ σ_2) axes. Left: the 65 earthquakes that occurred in September and October; Right: the 6 earthquakes that occurred 16, 17 and 21 November.

6 Brief summary statement

During the last week we concentrated on studying the November swarm with a view to examining whether it had different characteristics from the September/October earthquake activity. This seems indeed to be the case:

- The swarm comprises two bursts, the first peaking in intensity about 16 November and the second peaking in intensity about 21 November.
- The earthquakes of the second burst are ~ 300 m deeper than those of the first burst.
- Both the absolute locations of the 6 moment-tensor events studied from the November swarm and the relative locations of the November-only earthquakes suggest that a more northerly striking planar feature was activated (~ N15˚W, compared with N60˚W for the September/October planar feature).
- The depth range of the earthquakes spanned the zone that was aseismic during September/October, closing the "aseismic gap".
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During the forthcoming week we will work to increase the size of our relative-location and moment-tensor data set for the November earthquakes in order to test these preliminary results.

Appendix 1: The 70 earthquakes for which moment tensors have been obtained to date. Locations given below are from the webpage http://fracture.lbl.gov/Newberry/locations.txt.

jday	month	day	hour	minute	sec	lat	lon	depth	magnitude
272	9	29	9	57	54.34	43.7245	-121.30857	0.845	0.721
272	9	29	18	3	37.724	43.72365	-121.30658	1.274	0.669
273	9	30	9	23	48.799	43.71965	-121.30908	0.854	0.853
273	9	30	21	30	43.689	43.72667	-121.313	0.387	0.972
274	10	1	1	3	14.64	43.7239	-121.30957	0.714	0.987
274	10	1	8	8	58.215	43.72623	-121.31412	1.196	0.848
274	10	1	10	50	55.229	43.72275	-121.30868	1.051	0.787
274	10	1	12	3	16.881	43.72658	-121.3158	1.587	1.086
274	10	1	14	53	5.102	43.72545	-121.31355	0.613	1.381
274	10	1	15	1	55.056	43.72775	-121.31227	0.923	0.682
274	10	1	16	56	11.256	43.72232	-121.30712	1.65	0.901
274	10	1	19	5	16.377	43.72662	-121.31117	0.517	1.259
274	10	1	20	47	39.649	43.72612	-121.30912	0.826	0.505
274	10	1	22	13	54.154	43.72238	-121.30277	1.344	0.566
275	10	2	6	38	47.428	43.7243	-121.31328	1.153	0.951
275	10	2	6	47	52.916	43.72632	-121.31322	1.323	1.117
275	10	2	7	7	11.646	43.72488	-121.31192	0.708	1.378
275	10	2	7	21	48.731	43.72303	-121.30773	1.09	0.538
275	10	2	9	3	53.33	43.72217	-121.31288	0.736	0.519
275	10	2	11	1	48.042	43.72567	-121.31168	0.666	1.22
275	10	2	12	39	9.082	43.7264	-121.31438	1.332	0.852
275	10	2	16	12	20.481	43.72583	-121.30738	0.746	0.566
275	10	2	18	53	48.447	43.72082	-121.31372	1.671	0.957
275	10	2	20	36	50.997	43.72377	-121.31323	1.499	0.991
276	10	3	6	6	22.727	43.72528	-121.31493	0.928	1.157
276	10	3	15	27	57.912	43.72257	-121.31562	1.054	0.919
276	10	3	18	54	54.199	43.72678	-121.31125	0.647	1.021
277	10	4	5	29	8.347	43.72578	-121.31068	0.946	0.922
277	10	4	17	32	52.716	43.72207	-121.31693	0.376	1.521
277	10	4	18	51	11.991	43.72295	-121.31227	0.496	1.97
277	10	4	21	29	47.632	43.72813	-121.30428	0.988	0.586
278	10	5	2	6	17.079	43.7266	-121.31217	0.925	0.86
278	10	5	2	14	37.358	43.72433	-121.30915	0.459	0.665

278	10	5	4	7	30.446	43.725	-121.31322	0.659	1.696
278	10	5	15	55	21.373	43.73483	-121.30918	0.702	0.695
278	10	5	16	7	32.904	43.7253	-121.30967	1.205	0.819
278	10	5	23	22	16.638	43.72368	-121.3116	1.055	0.931
279	10	6	4	2	55.851	43.72307	-121.30835	0.835	0.637
279	10	6	6	13	48.787	43.72425	-121.3097	0.638	0.604
280	10	7	6	12	8.757	43.72372	-121.31015	0.564	0.791
280	10	7	7	26	23.29	43.71807	-121.31032	0.962	0.574
280	10	7	10	47	21.079	43.72403	-121.3095	1.136	0.822
281	10	8	7	5	6.107	43.72662	-121.3048	0.864	0.541
281	10	8	19	8	20.701	43.71945	-121.31087	1.267	0.523
281	10	8	21	16	58.206	43.73442	-121.31173	1.703	0.522
282	10	9	6	24	33.517	43.72232	-121.31203	0.735	0.769
282	10	9	10	16	9.958	43.7172	-121.31332	1.378	0.722
284	10	11	3	29	5.813	43.72417	-121.31338	0.409	0.852
284	10	11	10	53	26.568	43.72493	-121.30897	1.292	0.824
285	10	12	10	12	29.727	43.7257	-121.3135	0.783	0.863
285	10	12	16	37	43.42	43.72515	-121.3151	0.49	1.482
285	10	12	16	47	1.174	43.7297	-121.3126	1.07	0.681
285	10	12	18	33	4.878	43.72363	-121.30787	0.359	0.743
285	10	12	21	10	18.995	43.72783	-121.31002	0.653	0.792
286	10	13	0	57	6.873	43.72382	-121.3175	0.242	1.197
286	10	13	4	12	29.232	43.72657	-121.30698	0.882	1.179
286	10	13	10	22	29.146	43.7302	-121.3153	0.831	0.907
287	10	14	5	46	14.161	43.71765	-121.31087	0.161	0.904
288	10	15	15	3	44.691	43.72658	-121.30768	0.897	0.781
288	10	15	15	37	26.034	43.72713	-121.30915	0.934	0.883
289	10	16	16	53	27.596	43.72378	-121.31295	-0.186	0.736
291	10	18	23	57	3.867	43.72965	-121.31732	0.116	0.781
292	10	19	9	7	50.375	43.73525	-121.3113	0.837	0.776
296	10	23	21	2	22.32	43.7257	-121.30855	0.819	0.6
320	11	16	16	44	39.436	43.72772	-121.31492	1	1.099
320	11	16	18	52	9.671	43.72657	-121.31147	0.868	0.864
321	11	17	3	34	37.593	43.7274	-121.31807	0.203	1.088
321	11	17	4	41	53.061	43.7249	-121.31087	0.708	2.229
321	11	17	23	31	42.368	43.72523	-121.3094	-0.399	1.12
325	11	21	9	57	35.294	43.72682	-121.31657	0.475	1.219

Appendix 2: Numerical moment tensor results for the 70 MEQs studied to date. N=North, E=East, D=Down.

NN	NE	EE	ND	ED	DD	Year	Mo	Day	Hr	min	Sec	Quality
1.578e-01	3.466e-02	6.671e-02	2.482e-01	6.317e-02	8.338e-02	2014	10	01	14	53	05.23	excellent
2.172e-01	-3.673e-02	-6.417e-02	2.346e-01	7.204e-02	3.184e-02	2014	10	01	19	05	16.54	excellent
8.713e-02	1.262e-01	-4.193e-02	1.814e-01	8.429e-02	8.722e-02	2014	10	04	18	51	12.00	excellent
-1.029e-01	1.325e-01	-1.185e-01	1.480e-01	5.508e-02	1.074e-01	2014	10	04	17	32	52.76	excellent
-1.165e-01	1.705e-01	-1.989e-01	1.394e-01	-2.430e-02	1.639e-02	2014	10	02	07	07	04.16	excellent
2.406e-01	-7.298e-02	-9.789e-02	1.731e-01	4.297e-02	8.349e-02	2014	10	02	11	01	42.38	excellent
-1.461e-02	9.643e-02	-3.978e-01	2.595e-02	1.691e-01	-4.693e-03	2014	10	02	06	47	52.94	excellent
6.066e-03	-2.231e-01	-9.157e-02	1.941e-01	3.367e-02	-6.184e-04	2014	10	03	06	06	22.76	excellent
-5.772e-02	-1.655e-01	-1.427e-01	1.464e-01	7.811e-02	-1.952e-02	2014	10	03	18	54	53.93	fair
2.004e-01	-1.410e-01	-1.461e-01	1.400e-01	-8.713e-03	7.412e-02	2014	10	01	12	03	16.94	good
5.304e-02	6.783e-02	-1.175e-01	1.615e-01	7.508e-02	2.206e-01	2014	10	05	04	07	20	excellent
-1.777e-01	-1.053e-01	-1.512e-01	7.111e-02	1.063e-01	1.057e-01	2014	10	01	01	03	14.49	excellent
-2.667e-01	1.320e-01	-6.399e-02	6.063e-02	1.031e-01	7.787e-02	2014	09	30	21	30	43.50	excellent
-1.871e-01	8.995e-02	-9.473e-02	-1.446e-01	-2.491e-02	1.992e-01	2014	10	05	23	22	16.49	good
1.684e-01	-3.350e-02	-9.826e-03	2.952e-01	3.542e-02	9.350e-02	2014	10	04	05	29	08.25	fair
2.449e-01	-8.111e-02	-1.972e-01	1.741e-01	1.624e-02	1.507e-02	2014	10	03	15	27	57.66	good
-2.209e-01	-8.132e-02	-2.190e-02	-1.520e-01	3.521e-02	2.201e-01	2014	10	01	16	56	11.34	good
1.477e-01	-1.175e-01	-1.492e-01	1.577e-01	-3.130e-02	9.546e-02	2014	10	01	00	08	57.99	excellent
-3.263e-02	2.220e-01	-3.373e-01	1.644e-02	7.162e-02	9.879e-03	2014	10	01	10	50	55.10	excellent
-1.038e-01	1.463e-01	-2.541e-01	1.246e-01	-1.332e-02	7.335e-02	2014	10	01	15	01	54.95	excellent
2.306e-03	-1.802e-01	-9.214e-02	2.203e-01	-4.354e-03	9.593e-02	2014	10	02	18	54	03.15	good
1.619e-01	4.200e-02	-2.041e-01	2.158e-01	-2.044e-02	7.759e-02	2014	10	02	06	39	02.99	excellent
-6.570e-02	-1.851e-01	-1.140e-01	1.691e-01	4.183e-02	2.826e-02	2014	10	02	12	39	24.31	good
1.420e-01	-1.373e-01	-1.638e-01	1.721e-01	1.076e-02	5.384e-02	2014	10	02	20	37	06.04	good
-1.365e-01	-1.837e-01	-5.911e-02	1.611e-01	-1.124e-02	9.224e-02	2014	10	05	00	06	16.96	excellent
2.866e-01	-3.707e-02	-1.787e-01	9.263e-02	1.263e-01	2.268e-02	2014	10	05	16	07	32.77	excellent
-2.286e-01	1.607e-01	-7.209e-02	-9.281e-02	8.007e-02	-3.216e-02	2014	10	05	15	55	21.00	good
-1.352e-01	-1.174e-01	-4.098e-02	1.996e-01	-5.345e-02	8.302e-02	2014	10	12	10	12	29	good
-2.211e-01	1.542e-01	4.959e-02	9.042e-02	8.191e-02	7.603e-02	2014	10	12	22	10	23.31	good
-4.882e-01	-1.017e-01	5.620e-02	5.965e-02	-1.844e-03	1.292e-01	2014	10	12	16	37	43.28	excellent
-5.873e-02	-1.252e-01	-2.804e-01	6.116e-02	1.409e-01	6.331e-03	2014	10	13	00	57	06.71	good
2.607e-02	-1.181e-01	-2.888e-01	8.025e-02	1.234e-01	4.154e-02	2014	10	13	04	12	29.12	excellent
-1.162e-01	-1.387e-01	-1.174e-01	1.514e-01	5.536e-02	7.558e-02	2014	10	13	00	22	29.08	excellent
-1.128e-01	-2.729e-02	-2.406e-01	5.661e-02	5.175e-02	3.753e-01	2014	10	14	05	46	13.91	excellent
-5.101e-02	-1.756e-01	-8.505e-02	1.953e-01	1.276e-03	1.195e-01	2014	10	15	15	37	25.94	excellent
-1.267e-01	-1.699e-01	3.343e-02	1.566e-01	-5.422e-02	7.857e-02	2014	10	15	15	03	44.60	excellent

6.492e-02	-9.495e-02	-2.842e-01	6.736e-02	1.452e-01	-3.577e-02	2014	09	30	09	23	48.626	good
-1.426e-01	-1.356e-01	3.347e-03	1.557e-01	-5.829e-02	1.550e-01	2014	10	11	03	29	05.667	good
3.707e-03	3.866e-02	-3.573e-01	5.614e-02	2.090e-01	2.164e-02	2014	11	11	10	53	26.502	good
4.380e-02	2.443e-01	-1.804e-01	4.365e-02	9.993e-02	-2.176e-05	2014	10	07	10	47	20.916	good
2.443e-02	7.095e-02	-2.428e-02	-8.639e-02	-1.620e-01	3.127e-01	2014	10	09	06	24	33.418	excellent
-4.203e-02	-1.463e-01	-3.196e-01	-5.380e-04	1.433e-01	5.826e-02	2014	10	18	23	57	03.695	good
-1.860e-01	8.584e-02	-2.758e-01	1.397e-01	-1.349e-02	6.014e-02	2014	11	19	09	07	50.325	good
2.027e-01	-2.424e-02	-3.047e-01	1.709e-01	-4.330e-02	1.575e-02	2014	11	12	18	33	04.693	moderate
1.319e-01	1.004e-01	-3.874e-01	3.120e-02	9.894e-02	1.908e-02	2014	11	07	06	12	08.593	good
-4.011e-01	-1.326e-01	-3.893e-03	1.173e-01	1.595e-02	6.345e-02	2014	11	16	16	53	27.374	good
7.443e-02	8.687e-02	-6.603e-02	-1.453e-01	-9.859e-02	1.981e-01	2014	11	09	10	16	09.945	moderate
1.913e-01	-1.220e-01	-8.473e-02	1.936e-01	2.385e-02	4.506e-02	2014	10	29	09	57	54.158	excellent
4.999e-02	-1.926e-01	-1.244e-01	1.754e-01	2.482e-02	3.990e-02	2014	10	29	18	03	37.660	excellent
4.020e-02	-1.230e-01	-2.565e-01	1.610e-01	1.968e-02	9.601e-02	2014	11	12	16	47	01.137	excellent
-2.448e-02	-1.879e-01	-1.233e-01	1.689e-01	9.679e-03	1.193e-01	2014	11	05	02	14	37.168	excellent
-8.061e-02	-9.300e-02	-2.670e-01	6.013e-02	1.629e-01	-2.038e-02	2014	11	06	04	02	55.789	good
-2.166e-01	-2.314e-01	4.005e-02	5.036e-02	7.205e-02	3.578e-02	2014	11	02	16	12	35.315	weak
-3.561e-01	1.589e-01	1.186e-01	5.145e-02	2.877e-02	4.702e-02	2014	11	06	06	13	48.626	excellent
-1.403e-02	-2.150e-01	-6.153e-02	2.265e-01	1.118e-03	3.928e-02	2014	11	23	21	02	22.252	good
-4.159e-01	-1.860e-04	4.651e-02	1.890e-01	-7.142e-02	1.642e-02	2014	11	04	21	29	47.537	moderate
2.446e-01	-1.186e-01	-1.136e-01	1.673e-01	-1.161e-02	4.689e-02	2014	11	07	07	26	23.180	good
1.281e-01	1.267e-01	-6.919e-02	8.793e-02	1.446e-01	-8.415e-02	2014	11	01	21	13	54.151	good
3.027e-02	-1.918e-01	-9.497e-02	1.993e-01	1.073e-02	7.111e-02	2014	11	01	20	47	39.521	excellent
3.771e-01	-1.266e-02	-1.422e-01	1.286e-01	8.113e-02	3.587e-02	2014	11	02	07	22	03.575	good
5.178e-02	-1.721e-01	-2.476e-02	2.088e-01	-2.967e-02	1.023e-01	2014	11	02	09	04	08.647	good
2.550e-02	1.506e-01	-2.807e-01	1.688e-02	1.792e-01	-4.140e-04	2014	11	08	07	05	05.941	weak
-7.821e-03	2.190e-01	-2.873e-01	2.798e-02	1.012e-01	-8.510e-03	2014	11	08	19	08	20.619	excellent
-1.751e-01	-2.003e-01	-6.441e-02	1.282e-01	-1.701e-02	6.958e-02	2014	11	08	21	16	58.200	good
-2.488e-01	-8.809e-02	-1.116e-01	3.179e-02	-3.713e-02	3.255e-01	2014	11	17	04	41	52.962	excellent
-1.087e-01	-7.561e-02	2.844e-01	6.334e-02	1.557e-01	1.754e-02	2014	11	17	23	31	42.142	good
-2.517e-01	1.276e-01	-4.558e-02	1.389e-01	-5.853e-02	-5.262e-02	2014	11	17	03	34	37.422	good
-1.488e-01	8.762e-02	2.022e-01	7.869e-02	-1.506e-01	1.524e-02	2014	11	16	16	44	39.138	excellent
-2.700e-01	1.514e-01	-2.262e-02	7.176e-02	8.808e-02	8.496e-02	2014	11	16	18	52	09.588	moderate
-3.774e-01	1.336e-01	-1.288e-01	7.077e-02	-2.171e-02	4.149e-02	2014	11	21	09	57	35.096	good

Appendix 3: The additional 5 moment tensors derived over the reporting week.

/Users/foulger/SeismicProcessing/Newberry/Data/2014/11/17/201411172331 42.32.or

2014 Nov 17 23:31:42.142 UTC
Lat: 43.7255 Lon: -121.31 Depth: 0.532
43:43.5282 N 121:18.6192 W

Solve

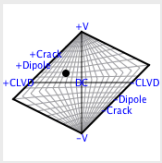
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NM03	3.06	12	108	EHU	P	0.011	–		-1.61e+01	2.46e+01
2	NM03	3.06	12	108	EHT	SH	0.082	–		-2.11e+02	1.42e+01
3	NM06	0.83	97	154	EHU	P	0.017	–		-2.12e+02	1.38e+01
4	NM06	0.83	97	154	EHR	SV	0.098	+	0.020	3.33e+03	1.85e+01
5	NM22	0.11	104	176	EHU	P	-0.024	+		3.46e+02	1.29e+01
6	NM22	0.11	104	176	EHT	SH	0.016	+		2.13e+03	1.51e+01
7	NM42	3.76	42	102	EHU	P	-0.023	–		-1.20e+02	1.15e+01
8	NM42	3.76	42	102	EHR	SV	0.107	–		-9.16e+02	2.07e+01
9	NM42	3.76	42	102	EHT	SH	0.125	+		1.13e+03	1.79e+01
10	NN07	3.13	338	105	EHU	P	0.015	–		-3.27e+01	1.61e+01
11	NN07	3.13	338	105	EHR	SV	0.034	–		-2.72e+02	2.26e+01
12	NN07	3.13	338	105	EHT	SH	0.047	–		-2.08e+02	1.88e+01
13	NN09	1.99	296	122	EHZ	P	0.001	+		5.36e+01	1.64e+01
14	NN09	1.99	296	122	EHN	SN	0.028	+		8.53e+02	2.66e+01
15	NN09	1.99	296	122	EHE	SE	0.025	–		-1.14e+03	1.10e+01

	Sta	Type	Penalty
1	NM03	P:SH	
2	NM06	P:SV	0.050
3	NM42	P:SV	0.012
4	NM42	P:SH	
5	NM42	SV:SH	0.027
6	NN07	P:SV	0.002
7	NN07	P:SH	
8	NN07	SV:SH	
9	NN17	P:SV	
10	NN17	P:SH	
11	NN17	SV:SH	
12	NN18	P:SH	
13	NN19	P:SV	
14	NN19	P:SH	
15	NN19	SV:SH	

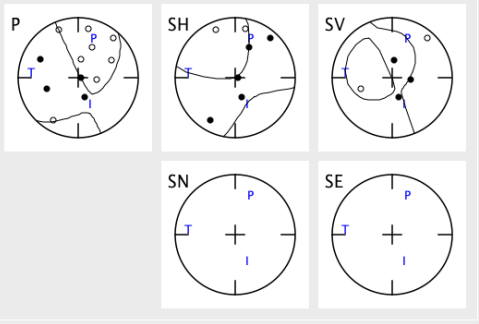
	North	East	Down
North	-1.09e-01	-7.56e-02	6.33e-02
East	-7.56e-02	2.84e-01	1.56e-01
Down	6.33e-02	1.56e-01	1.75e-02

Scalar M0 = 2.837e-01
T = -0.368 k = 0.179

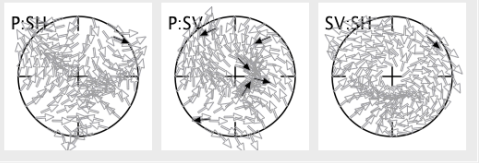
Total Penalty = 0.166



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/11/17/201411170334337.57.or

2014 Nov 17 3:34:37.422 UTC
Lat: 43.7283 Lon: -121.311 Depth: 0.527
43:43.6992 N 121:18.6774 W

Solve

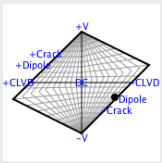
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NM03	2.77	15	112	EHU	P	0.023	–		-2.21e+01	1.79e+01
2	NM06	0.99	115	149	EHU	P	0.036	+		2.98e+02	3.59e+01
3	NM06	0.99	115	149	EHR	SV	0.075	+		1.55e+03	8.63e+02
4	NM06	0.99	115	149	EHT	SH	0.038	+		1.41e+03	1.61e+01
5	NM22	0.39	151	167	EHU	P	-0.026	+		3.88e+02	1.56e+01
6	NM22	0.39	151	167	EHT	SH	-0.027	+		1.59e+03	1.51e+01
7	NM40	2.78	114	112	EHU	P	0.046	–			
8	NM40	2.78	114	112	EHT	SH	0.018	–		-2.96e+02	1.85e+01
9	NM42	3.58	46	103	EHU	P	-0.010	–		-9.63e+01	1.07e+01
10	NM42	3.58	46	103	EHR	SV	0.136	–		-7.50e+02	2.05e+01
11	NN07	2.80	337	109	EHU	P	0.033	–		-5.40e+01	1.34e+01
12	NN07	2.80	337	109	EHR	SV	0.094	–		-3.70e+02	1.54e+01
13	NN07	2.80	337	109	EHT	SH	0.066	–	0.014	-2.89e+02	1.31e+01
14	NN09	1.80	287	126	EHU	P	0.019	–		-2.48e+00	2.70e+01
15	NN09	1.80	287	126	EHR	SV	0.003	+		2.92e+02	1.54e+01

	Sta	Type	Penalty
1	NM06	P:SV	0.012
2	NM06	P:SH	0.008
3	NM06	SV:SH	
4	NM22	P:SH	0.013
5	NM42	P:SV	0.019
6	NN07	P:SV	
7	NN07	P:SH	
8	NN07	SV:SH	
9	NN09	P:SV	
10	NN09	P:SH	
11	NN09	SV:SH	
12	NN17	P:SV	0.007
13	NN17	P:SH	
14	NN17	SV:SH	
15	NN18	P:SV	

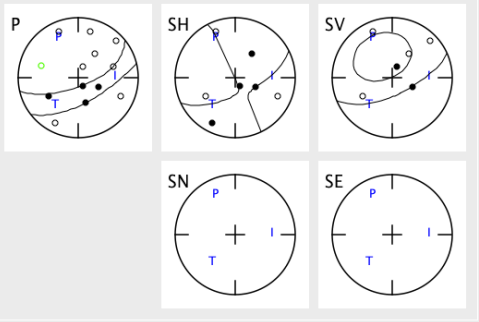
	North	East	Down
North	-2.52e-01	1.28e-01	1.39e-01
East	1.28e-01	-4.56e-02	-5.85e-02
Down	1.39e-01	-5.85e-02	-5.26e-02

Scalar M0 = 2.704e-01
T = 0.951 k = -0.306

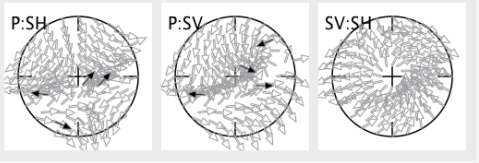
Total Penalty = 0.155



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/11/16/20141116185209.63.or

2014 Nov 16 18:52: 9.588 UTC
Lat: 43.7274 Lon: -121.311 Depth: 0.6
43:43.641 N 121:18.651 W

Solve

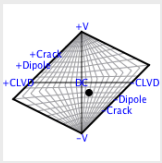
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NM06	0.92	110	153	EHU	P	0.028	☑ +	0.010	☑ 1.99e+02	1.84e+01
2	NM06	0.92	110	153	EHT	SH	0.042	☑ +	0.002	☑ 1.62e+02	1.59e+01
3	NM22	0.28	147	171	EHU	P	-0.027	☑ +		☑ 2.07e+02	1.58e+01
4	NM22	0.28	147	171	EHT	SH	-0.012	☑ +		☑ 6.72e+02	1.48e+01
5	NM42	3.63	45	105	EHU	P	0.053	☐ +		☑ 8.92e+01	1.06e+01
6	NM42	3.63	45	105	EHT	SH	0.089	☐ –		☑ -1.91e+02	1.16e+01
7	NN07	2.92	337	110	EHU	P	0.019	☑ –		☑ -2.48e+01	1.45e+01
8	NN07	2.92	337	110	EHR	SV	0.092	☑ +		☑ 1.46e+02	8.92e+00
9	NN07	2.92	337	110	EHT	SH	0.093	☐ +		☑ 1.96e+02	1.21e+01
10	NN09	1.86	290	126	EHU	P	0.020	☑ +	0.013	☑ 5.25e+00	1.79e+01
11	NN09	1.86	290	126	EHR	SV	0.002	☐ +		☑ 1.41e+02	1.84e+01
12	NN09	1.86	290	126	EHT	SH	0.035	☐ +		☑ 1.11e+02	1.98e+01
13	NN17	1.53	241	134	EHU	P	-0.012	☑ +		☑ 9.73e+00	2.83e+01
14	NN17	1.53	241	134	EHR	SV	0.019	☐ –		☑ -5.33e+02	1.56e+01
15	NN17	1.53	241	134	EHT	SH	-0.008	☐ –		☑ -3.01e+02	1.20e+01

	Sta	Type	Penalty
1	NM06	☑ P:SH	
2	NM22	☑ P:SH	0.069
3	NM42	☐ P:SH	
4	NN07	☐ P:SV	
5	NN07	☐ P:SH	
6	NN07	☐ SV:SH	
7	NN09	☐ P:SV	
8	NN09	☐ P:SH	
9	NN09	☐ SV:SH	
10	NN17	☐ P:SV	
11	NN17	☐ P:SH	
12	NN17	☐ SV:SH	
13	NN18	☐ P:SV	
14	NN18	☑ P:SH	0.056
15	NN18	☐ SV:SH	

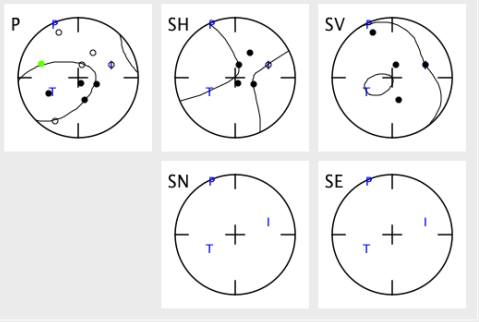
	North	East	Down
North	-2.70e-01	1.51e-01	7.18e-02
East	1.51e-01	-2.26e-02	8.81e-02
Down	7.18e-02	8.81e-02	8.50e-02

Scalar M0 = 2.759e-01
T = 0.186 k = -0.201

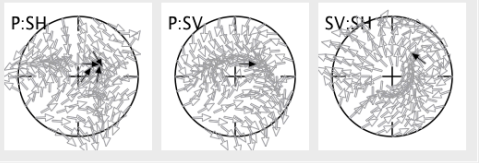
Total Penalty = 0.173



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/11/16/20141116164433.27.or

2014 Nov 16 16:44:39.138 UTC
Lat: 43.7266 Lon: -121.311 Depth: 0.616
43:43.5954 N 121:18.6342 W

Solve

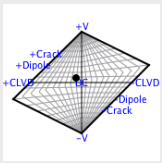
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NM03	2.94	13	112	EHU	P	0.038	☑ –		☑ -7.81e+00	4.18e+01
2	NM06	0.87	105	154	EHU	P	0.024	☑ +		☑ 2.51e+02	1.32e+01
3	NM22	0.20	139	174	EHU	P	-0.019	☑ +		☑ 4.75e+02	1.55e+01
4	NM41	2.36	139	121	EHT	SH	0.026	☑ –			
5	NM42	3.68	43	105	EHU	P	-0.016	☑ +		☑ 1.70e+01	2.10e+01
6	NM42	3.68	43	105	EHT	SH	0.059	☐ –		☑ -5.11e+02	9.49e+00
7	NN07	3.00	337	109	EHU	P	0.003	☑ –		☑ -7.22e+01	1.42e+01
8	NN07	3.00	337	109	EHT	SH	0.061	☑ +	0.027	☑ 4.32e+02	1.27e+01
9	NN09	1.92	292	126	EHU	P	0.007	☑ –		☑ -9.06e+00	2.21e+01
10	NN09	1.92	292	126	EHR	SV	-0.034	☐ +		☑ 3.92e+02	1.38e+01
11	NN09	1.92	292	126	EHT	SH	0.002	☐ +		☑ 2.51e+02	1.55e+01
12	NN17	1.51	245	135	EHU	P	-0.010	☑ +		☑ 2.08e+01	2.23e+01
13	NN17	1.51	245	135	EHR	SV	0.033	☑ –		☑ -1.19e+03	1.64e+01
14	NN17	1.51	245	135	EHT	SH	0.001	☑ –		☑ -5.62e+02	1.30e+01
15	NN18	1.40	29	139	EHU	P	-0.007	☑ –	0.016	☑ -7.04e+01	1.62e+01

	Sta	Type	Penalty
1	NM42	☐ P:SH	
2	NN07	☐ P:SH	
3	NN09	☐ P:SV	
4	NN09	☐ P:SH	
5	NN09	☐ SV:SH	
6	NN17	☑ P:SV	
7	NN17	☑ P:SH	
8	NN17	☑ SV:SH	
9	NN18	☑ P:SV	0.015
10	NN18	☐ P:SH	
11	NN18	☐ SV:SH	
12	NN19	☑ P:SV	
13	NN19	☑ P:SH	0.053
14	NN19	☑ SV:SH	0.013
15	NN21	☐ P:SV	

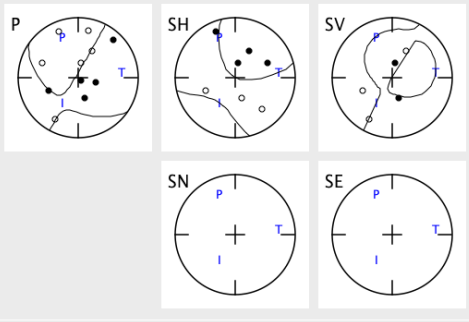
	North	East	Down
North	-1.49e-01	8.76e-02	7.87e-02
East	8.76e-02	2.02e-01	-1.51e-01
Down	7.87e-02	-1.51e-01	1.52e-02

Scalar M0 = 2.611e-01
T = -0.112 k = 0.079

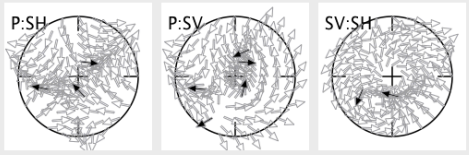
Total Penalty = 0.152



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/11/21/20141121095735.30.or

2014 Nov 21 9:57:35.096 UTC
Lat: 43.7273 Lon: -121.311 Depth: 0.76
43:43.6398 N 121:18.6504 W

Solve

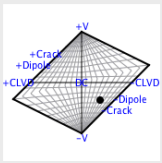
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
15	NN17	1.53	242	138	EHU	P	-0.012	+		4.06e+01	1.99e+01
16	NN17	1.53	242	138	EHT	SH	0.007	–		-1.44e+03	2.30e+01
17	NN18	1.34	32	143	EHU	P	0.002	–		-1.89e+02	1.66e+01
18	NN18	1.34	32	143	EHR	SV	0.006	–		-2.24e+03	1.39e+01
19	NN19	1.05	163	150	EHU	P	-0.002	+	0.013	4.58e+02	1.76e+01
20	NN19	1.05	163	150	EHT	SH	0.051	–	0.021	-1.53e+03	1.64e+01
21	NN21	1.81	69	133	EHU	P	-0.009	–		-6.16e+01	1.64e+01
22	NN21	1.81	69	133	EHT	SH	0.068	–		-1.36e+03	1.79e+01
23	NN24	0.55	17	164	EHU	P	-0.008	–		-6.56e+01	2.06e+01
24	NN24	0.55	17	164	EHR	SV	-0.001	+		2.16e+03	3.19e+01
25	NN24	0.55	17	164	EHT	SH	0.012	+		1.09e+03	3.66e+01
26	NN32	2.93	207	114	EHU	P	-0.041	–		-5.95e+01	1.40e+01
27	NN32	2.93	207	114	EHR	SV	0.018	–		-1.35e+03	1.78e+01
28	NN32	2.93	207	114	EHT	SH	0.050	+		9.08e+02	1.27e+01

	Sta	Type	Penalty
6	NN07	P:SH	
7	NN09	P:SV	
8	NN09	P:SH	
9	NN09	SV:SH	
10	NN17	P:SH	
11	NN18	P:SV	
12	NN19	P:SH	0.016
13	NN21	P:SH	
14	NN24	P:SV	
15	NN24	P:SH	0.003
16	NN24	SV:SH	0.030
17	NN32	P:SV	
18	NN32	P:SH	0.089
19	NN32	SV:SH	

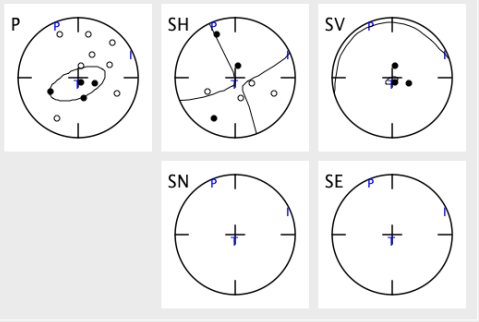
	North	East	Down
North	-3.77e-01	1.34e-01	7.08e-02
East	1.34e-01	-1.29e-01	-2.17e-02
Down	7.08e-02	-2.17e-02	4.15e-02

Scalar M0 = 3.221e-01
T = 0.574 k = -0.347

Total Penalty = 0.176



POLARITIES



AMPLITUDE RATIOS