Foulger Consulting

1025 Paradise Way
Palo Alto, CA 943062637, USA
Tel: 650/4932553
Cell: 650/9968886
FAX: 866/5326907
gillian@foulgerconsulting.com
http://www.foulgerconsulting.com/

November 19, 2014

WEEKLY REPORT #7 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, vigorous earthquake activity has occurred in response to renewed injection. These earthquakes appear to be located slightly further to the NW than earlier earthquakes. They are restricted in time and the largest of them had a larger magnitude than any previous earthquake in the 8-week-long sequence.

Preliminary relative locations suggest that these later earthquakes may have partly filled the gap between the two earlier, separate seismogenic volumes. This result is preliminary and needs to be looked at more carefully in future, perhaps relative locating these later earthquakes separately from the earlier ones.

An additional 11 moment tensor results were obtained, including a result for the largest, M2.2 event. This event was complex and it proved difficult to either locate it or derive a moment tensor. Subsequent to our initial result, which showed a thrust mechanism, we obtained additional information on the calibration of the instruments. This moment tensor will be re-studied in the light of that new information. The general pattern of P- T- and I-axis orientations remains similar to what was observed earlier.

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 and preparation 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 11 moment tensors, bringing the total number derived up to 65 (Appendix 1). We have provided the locations and moment-tensor decomposition data 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 located all the earthquakes hand-picked by ISTI to date, using our in-house location program *qloc*. A map showing the entire set is given in Figure 1.

Figure 2 and Figure 3 show the locations on a week-by-week basis. Of particular interest is the map of the week 11/14 - 11/18, which shows the locations of the most recent earthquakes that occurred after injection was resumed. The earthquakes appear to locate further to the NW. A map showing the depth distribution of all the earthquakes as a function of time is given in Figure 4. The earthquakes are restricted in time, and span the entire depth range activated in previous weeks.

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

We picked an additional 11 earthquakes for the purpose of moment-tensor derivation, bringing the total in hand to 65. We have updated our map of these and the results are shown in Figure 5 and Figure 6.

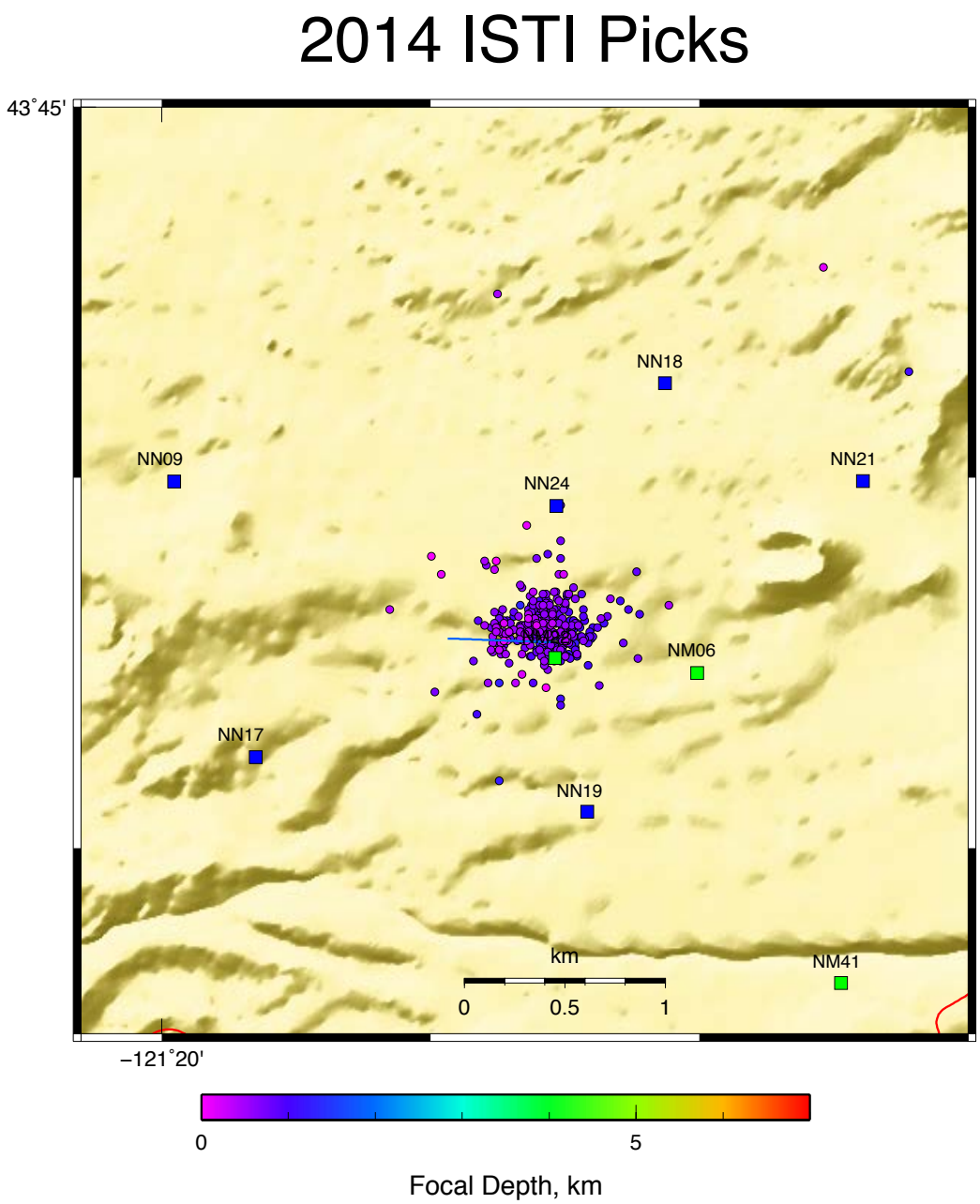


Figure 1: All earthquakes located using ISTI picks, and the *eloc* location program.

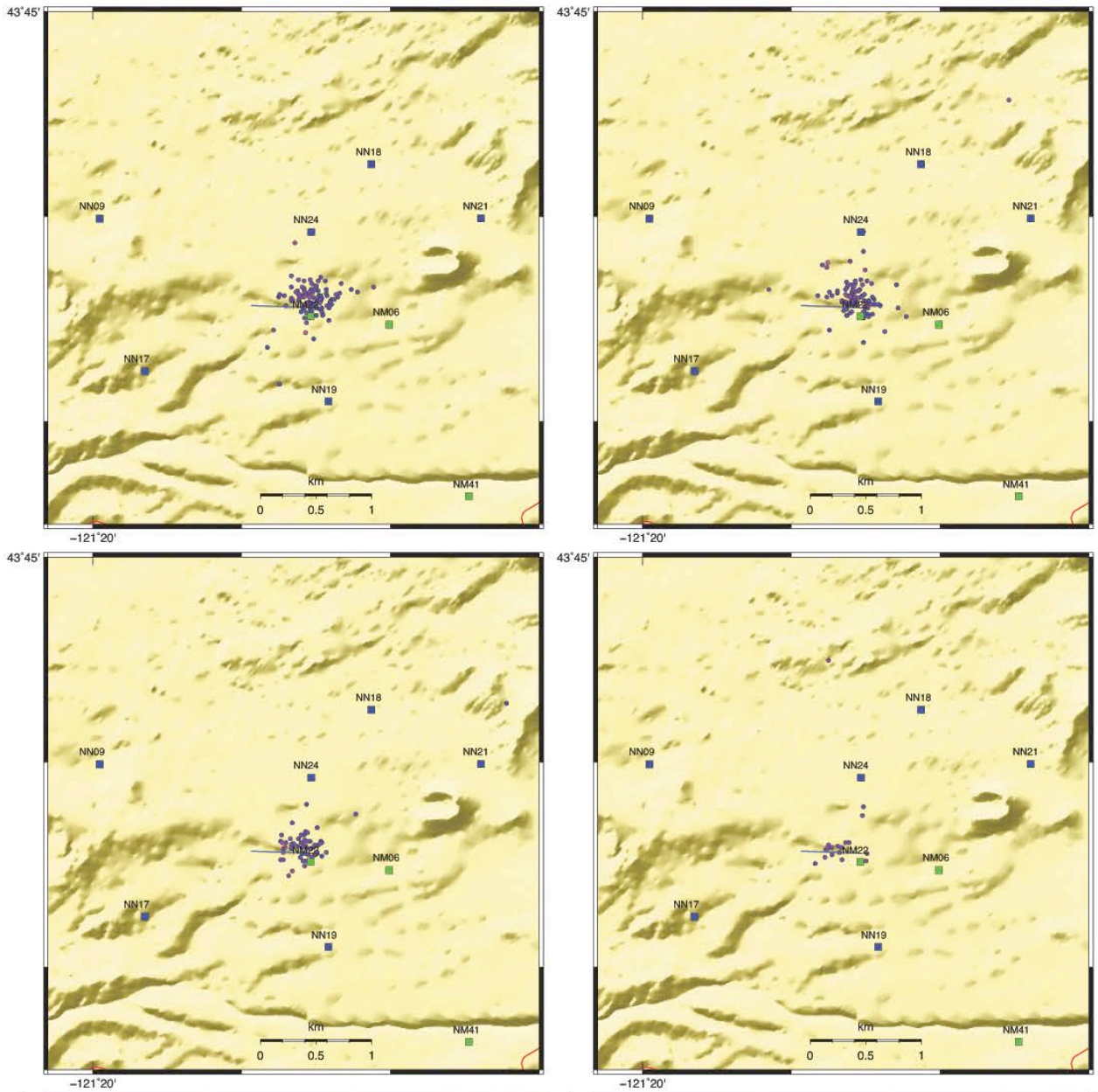


Figure 2: Top left, top right, lower left, lower right, plots of *eloc* Locations, using ISTI picks, for the weeks 09/26-10/02, 10/03-10/09, 10/10-10/16 and 10/17-10/23.

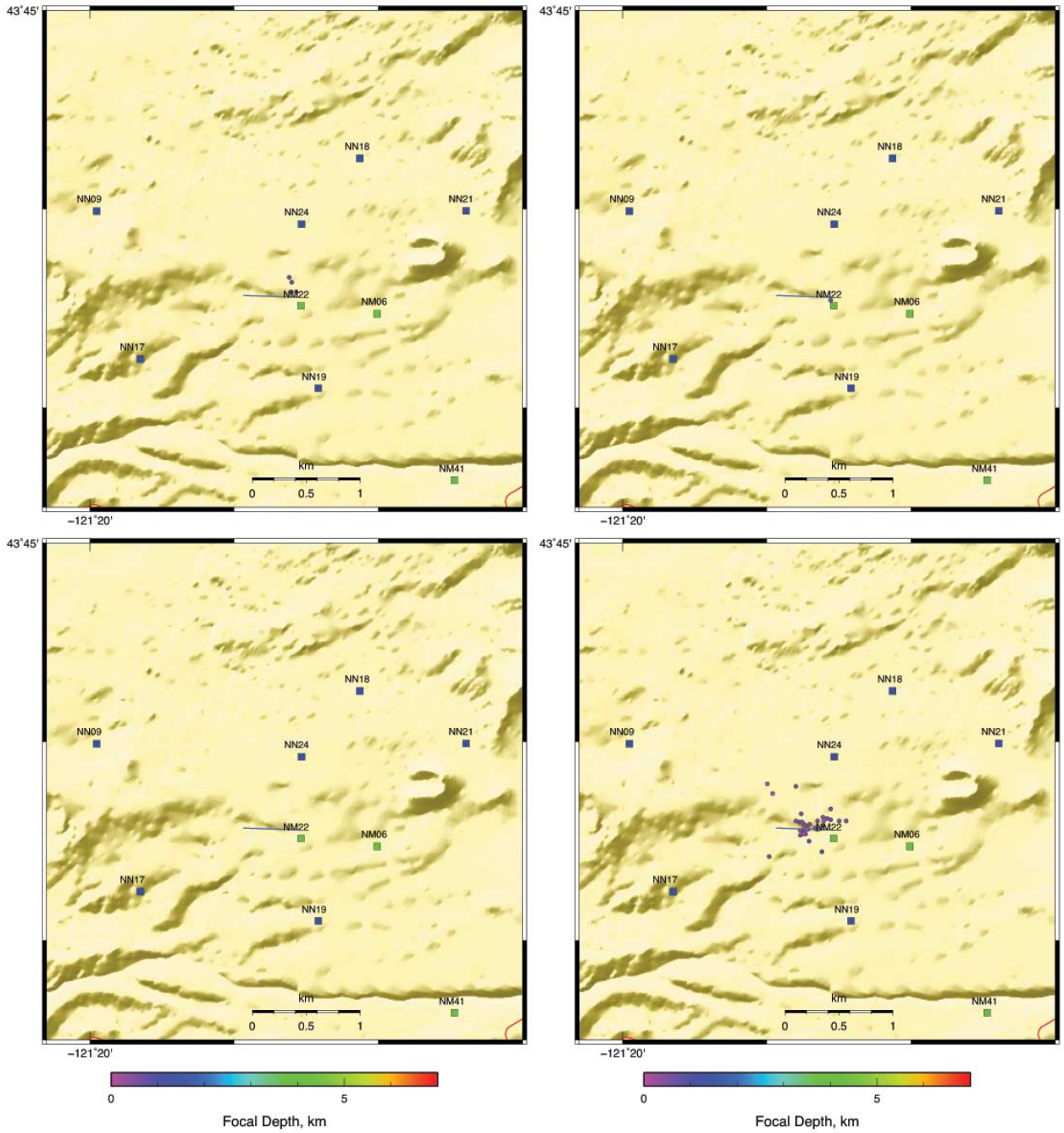


Figure 3: As Figure 2 except for the weeks 10/24-10/30, 10/31-11/06, 11/07-11/13 and 11/14-11/18 (incomplete week).

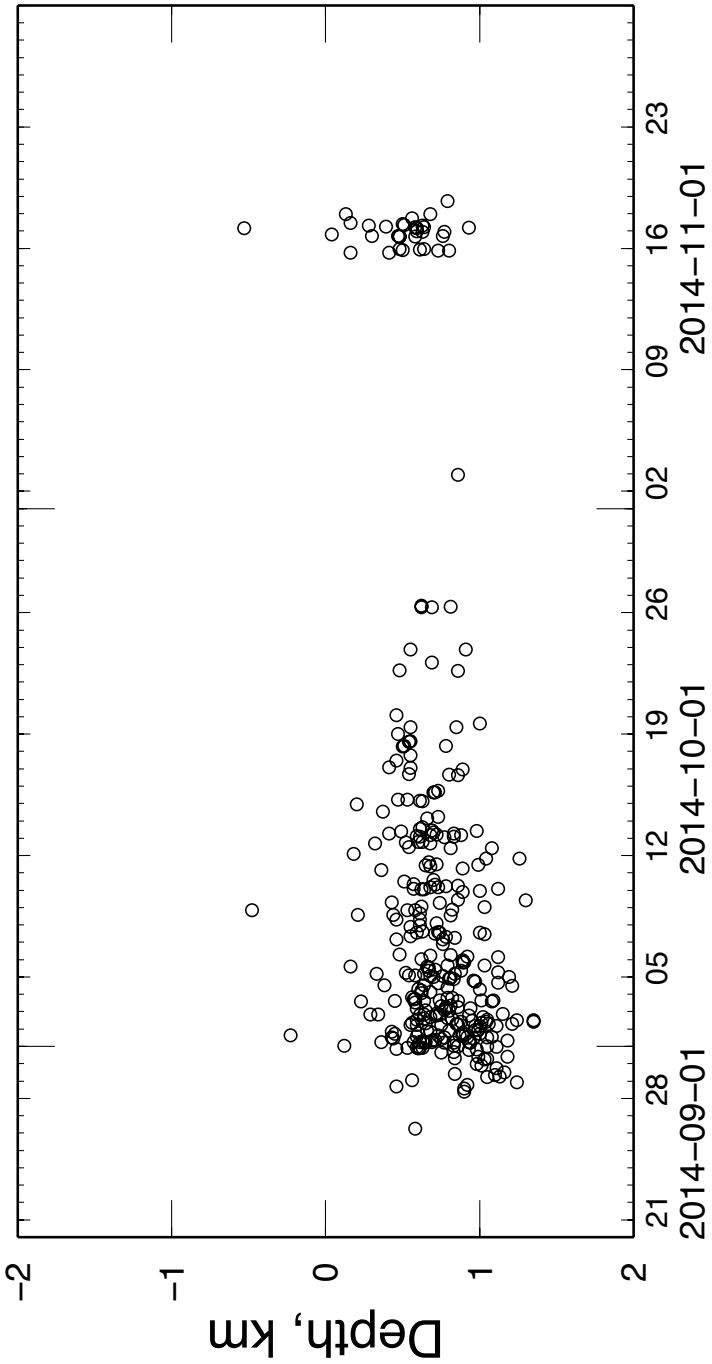


Figure 4: Estimated depths, with respect to sea level, of the earthquakes within the NMSA network as a function of time. These depths were obtained by using *qloc* to invert *P*- and *S*-phase arrival times measured by personnel of the ISTI Corporation on digital seismograms from the NMSA network.

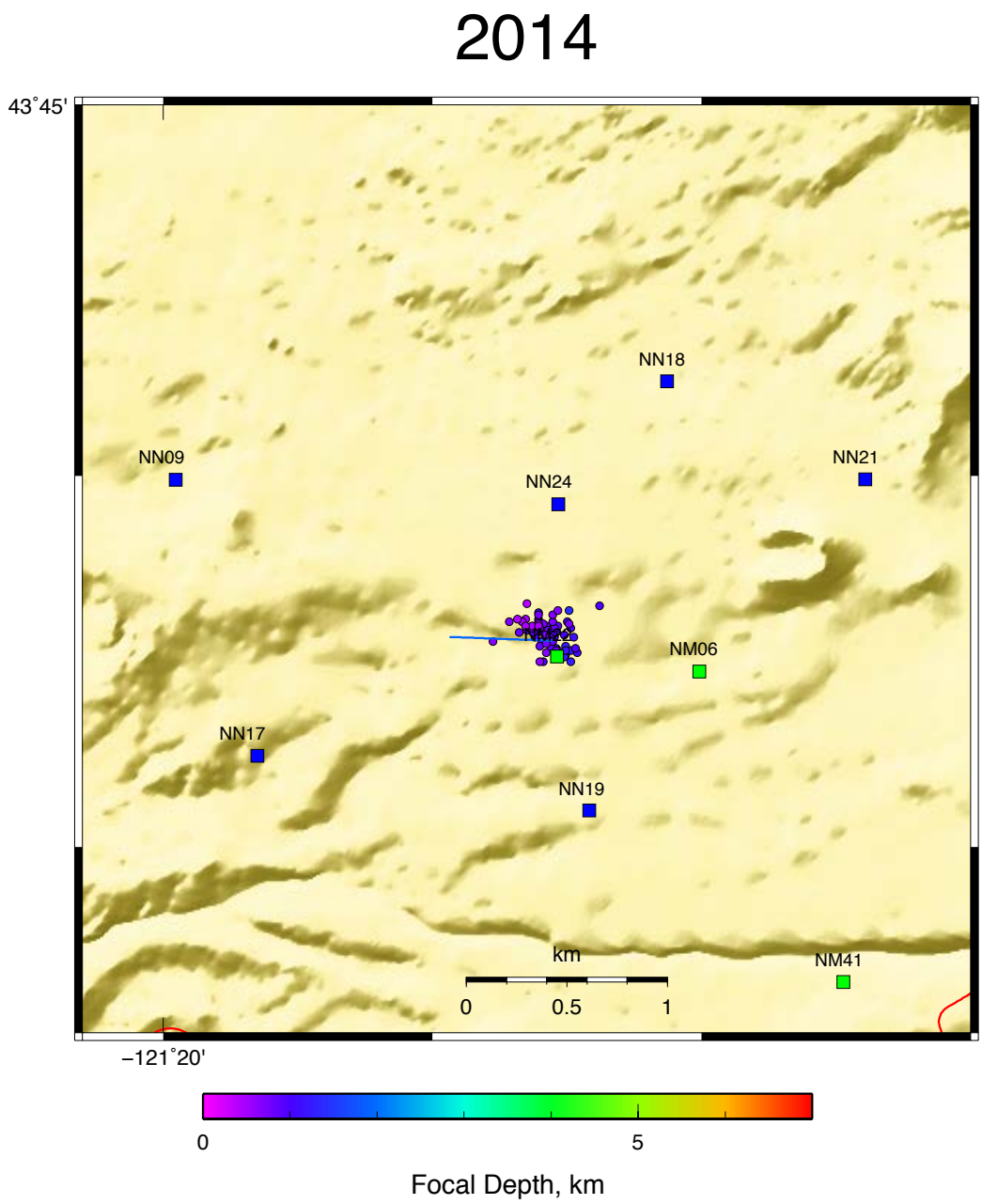


Figure 5: High quality estimated hypocenters of 65 microearthquakes that occurred between Sept. 29 and Oct. 23, 2014, plus one event from Nov. 17. Moment tensors were derived for these events. The locations are computed using arrival times measured carefully in connection with the moment-tensor analysis. Well NWD 55-29 is shown in blue.

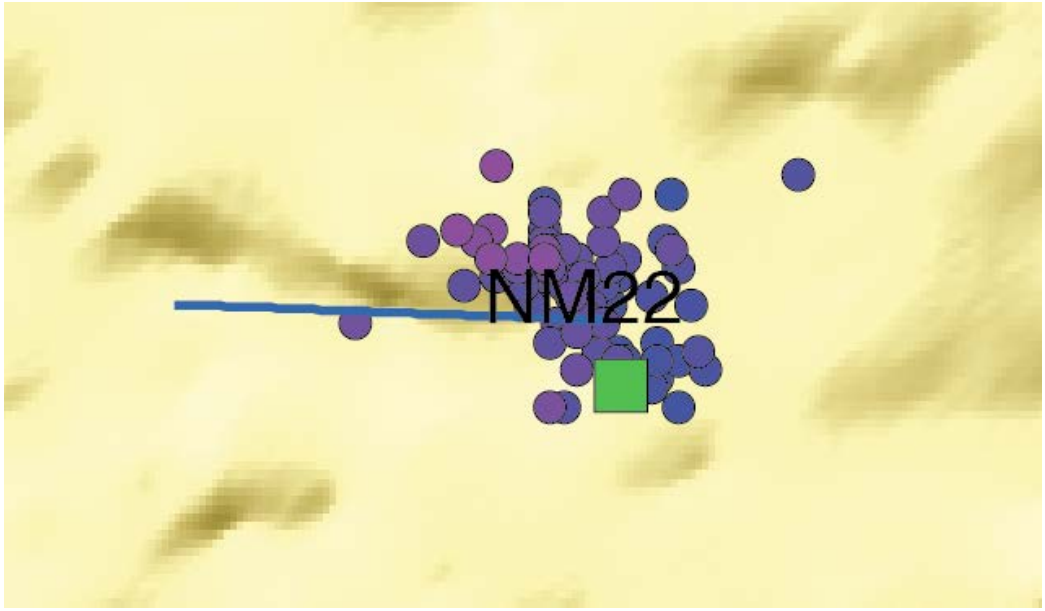


Figure 6: Expanded view of the locations of the earthquakes for which moment tensors were derived.

4.3 Relative locations

We continued with the relative location work, applying the method to the full catalog of ISTI-picked events up to 19 November. This contained 332 earthquakes. We relative located this catalog using the same input parameters as used and reported in our Weekly Report #4 of 29 October. These parameters were:

- *minclust*–the minimum number of earthquakes to define a cluster (a value of 10 was used);
- *maxit*–the maximum allowed number of relocation iterations (optimal value identified = 25);
- *maxsep*–the maximum separation allowed between linked pairs of earthquakes (optimal value identified = 0.15 km);
- *minlinks*–the minimum number of "links" (i.e., measured station/phases in common between pairs of earthquakes) needed for an earthquake to be passed to the final relocated set (optimal values identified = 14).

Of the original 332 earthquakes, the *maxsep* cut-off reduced the number to 100 and the *minlinks* threshold reduced it further to 73. This may be compared with the result we reported 29 October had 66 events remaining after these filters.

The results are shown in Figure 7 - Figure 9.

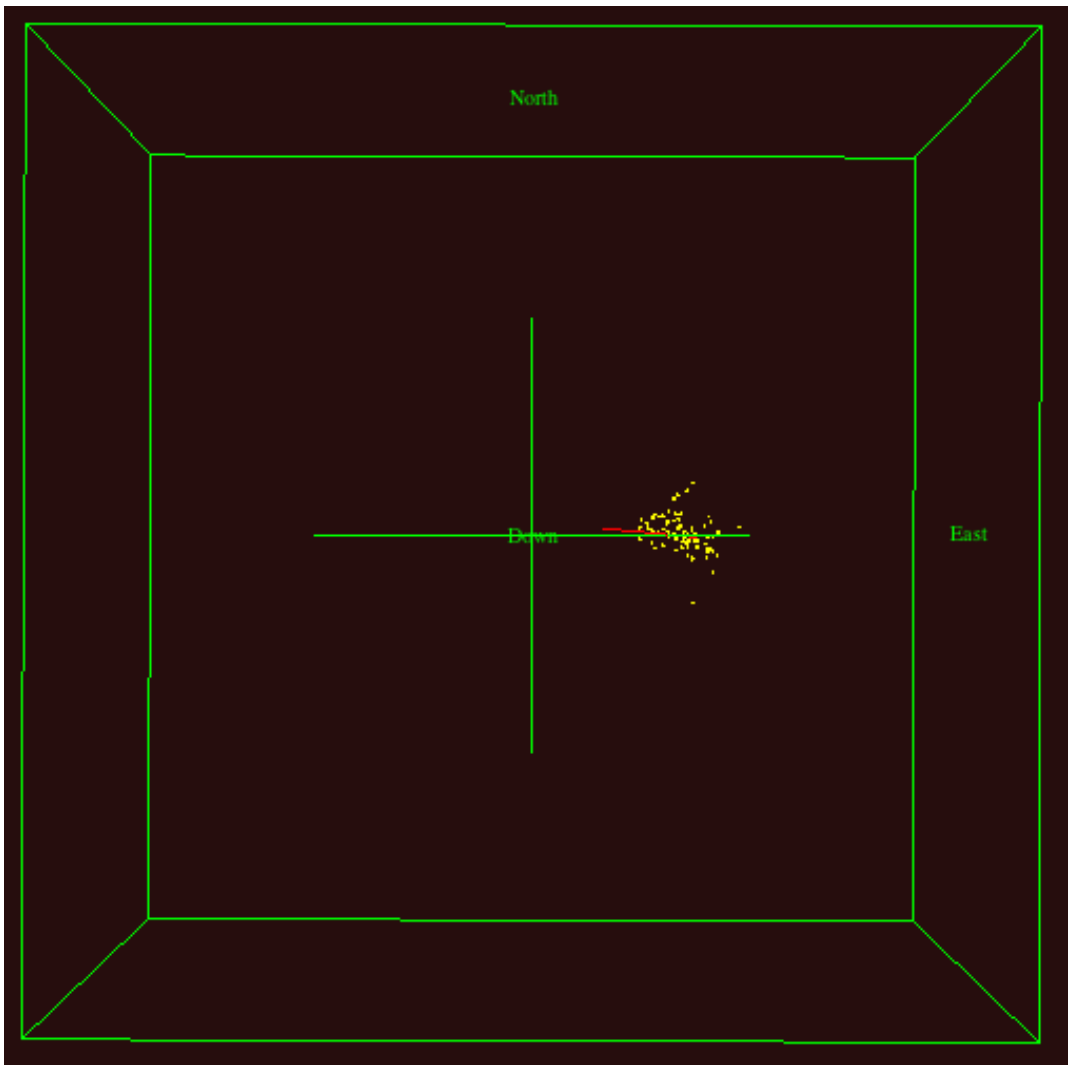


Figure 7: Map of relative locations of 73 earthquakes that occurred in the time period 26 September - 19 October, 2014. Runtime parameters used were *minclust* = 10, *maxit* = 25, *maxsep* = 0.15 km, *minlinks* = 14.

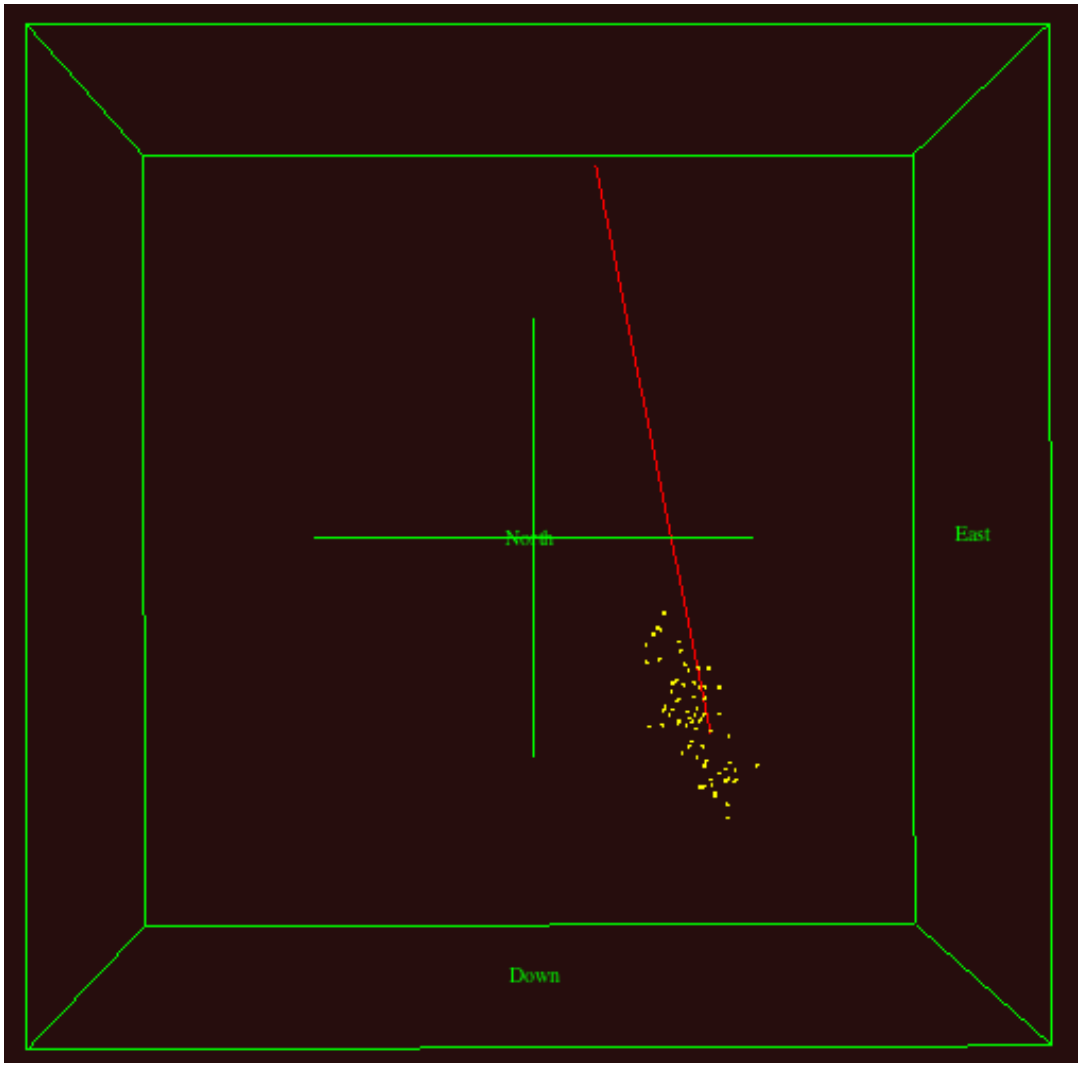


Figure 8: Same as Figure 7 except looking N.

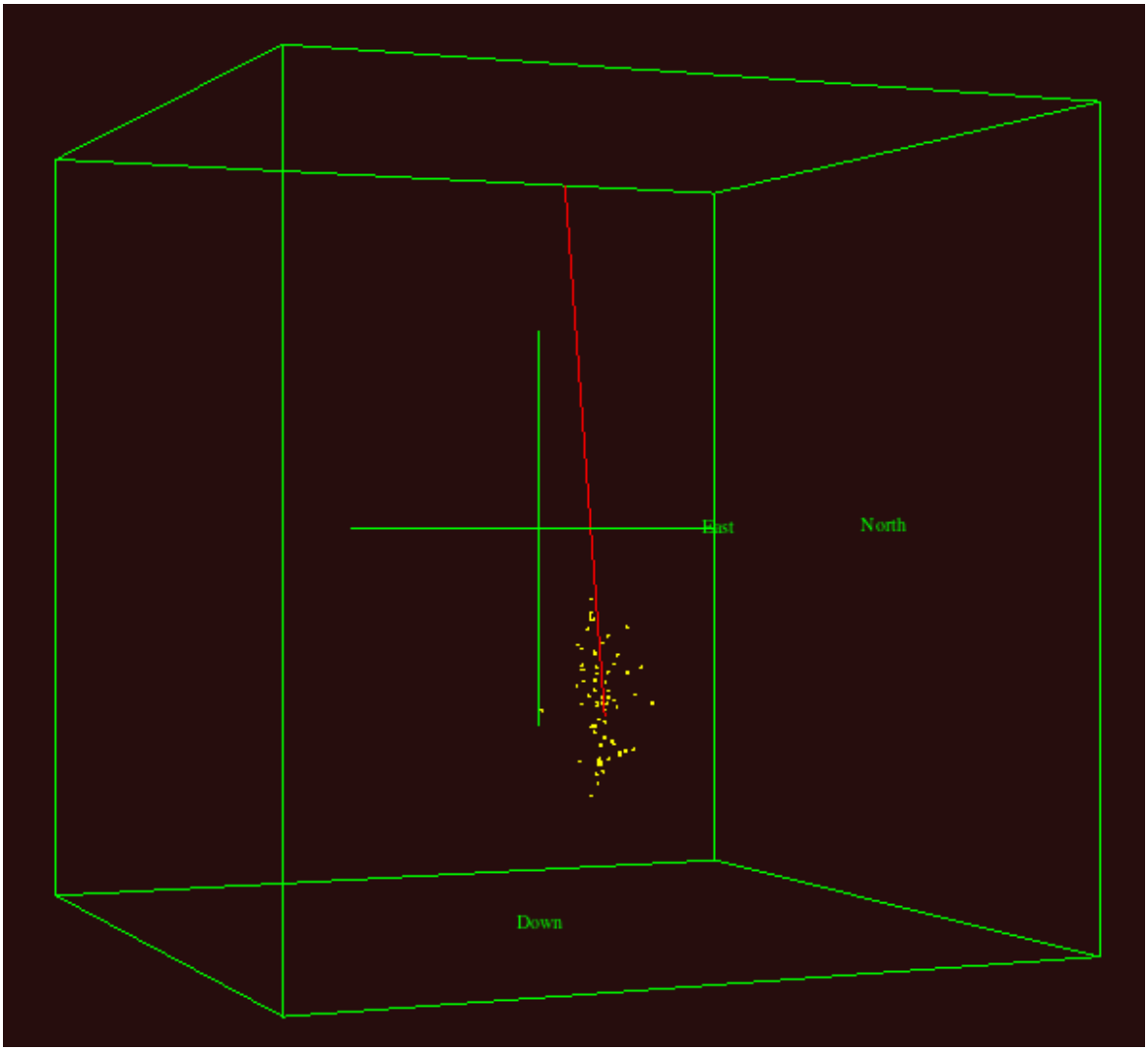


Figure 9: Same as

Figure 8 except looking along the strike of the epicentral trend, to the NW.

The northwesterly trending epicentral zone continues to be apparent. Perhaps the most striking difference between the earlier results and these, which contain earthquakes that occurred later in the sequence, is that the sharp separation between the two clusters is less obvious. It may be that the earthquakes that occurred after 29 October have partly filled in the gap between the two clusters.

Numerical data for these interim results have been provided to AltaRock by email attachment to Trenton Cladouhos.

5 Task 5 Moment tensor calculations

5.1 Instrument polarities and orientations

A quarry blast about 12 km southwest of the Newberry seismic network at about 21:10:20 UTC on Nov. 10, 2014 enabled us to check the polarities and orientations of the seismometers, information that is needed in order to use polarities and amplitude ratios to study source mechanisms. The quarry location is 43.652318° N, 121.423070° W (information provided by Trenton Cladouhos), which is 11.9 km southwest (azimuth 227°) of the 55-29 well head.

Vertical-component polarities: The vertical-component seismograms of the blast (Figure 10 to Figure 12) show clear upward first motions, as expected for an explosion, at all stations except NN17, NN08, and NN03, which appear to be dead. Waveforms from the functioning stations are similar to one another, except for NN21 and NN40, which are deficient in high frequencies, possibly indicating defects in the electronics or in the mechanical installation of the sensors.

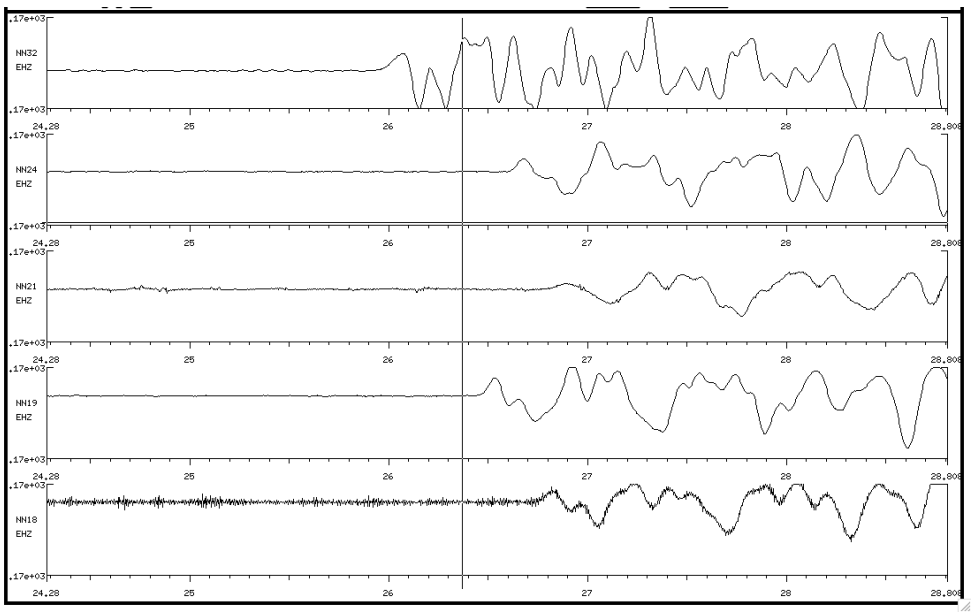


Figure 10: Vertical-component seismograms of the Nov. 10 quarry blast from stations NN32, NN24, NN21, NN19, and NN18. All first motions are upward, as expected.

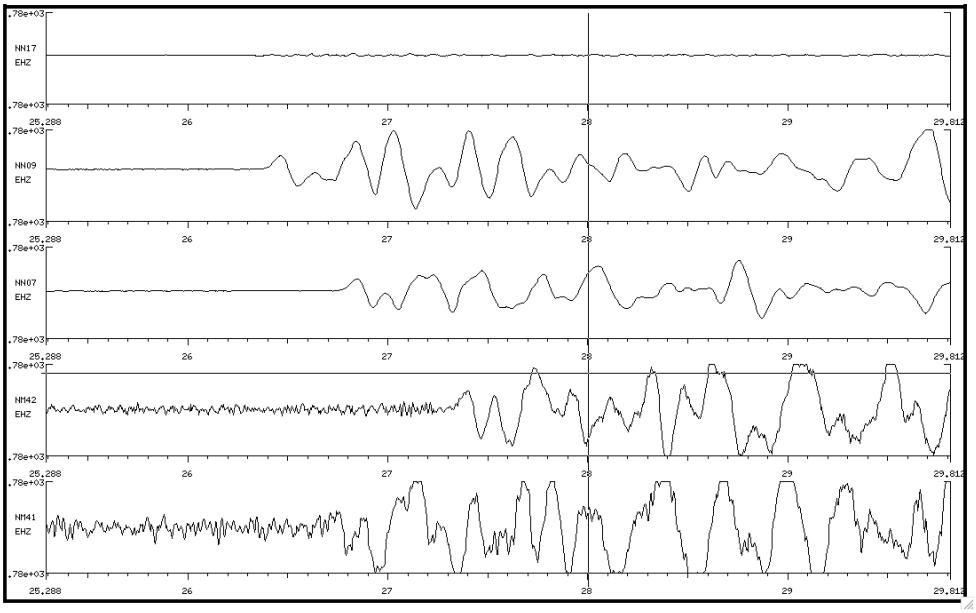


Figure 11: Vertical-component seismograms from stations NN17, NN09, NN07, NM42, and NM41. All except NN17 have upward first motions, as expected.

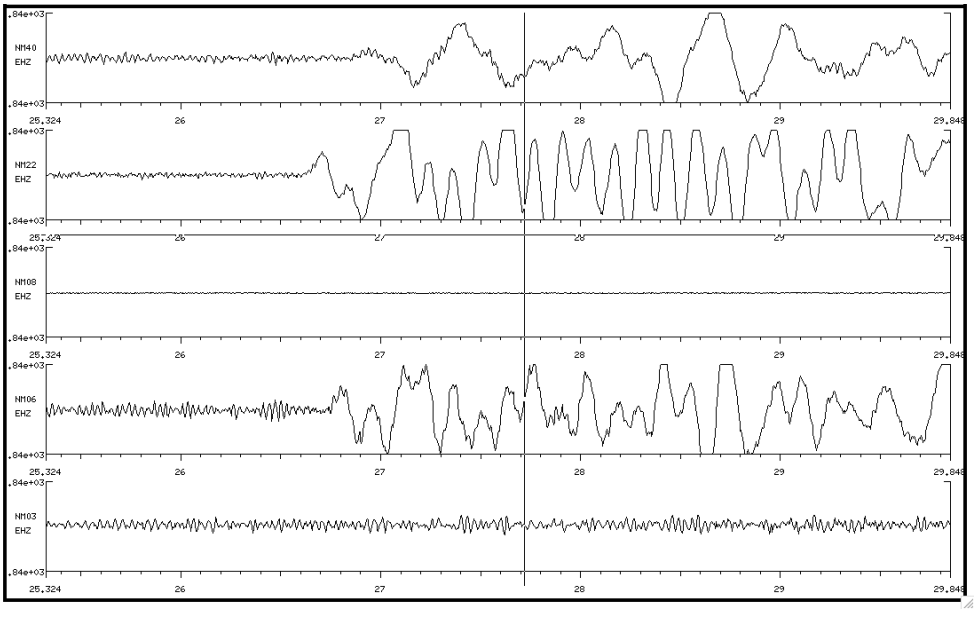


Figure 12: Vertical-component seismograms from stations NM40, NM22, NM08, NM06, and NM03. NM40, NM22, and NM06 have upward first motions, as expected.

Horizontal-component orientations and polarities: Regional signals such as those from quarry blasts are poorly suited for determining the polarities and orientations of horizontal-component sensors, because

P-phase signals involve weak horizontal motion. Nevertheless, we have been able to obtain useful information for most stations of the Newbery network.

P-phase first motions are expected to be away from an explosion, so for an event to the southwest first motions should be to the north and east. The north-component signals for 12 stations are in accord with this expectation; those for NM40,NM08, and NM06 cannot be determined reliably because of noise (Figure 13 to Figure 15).

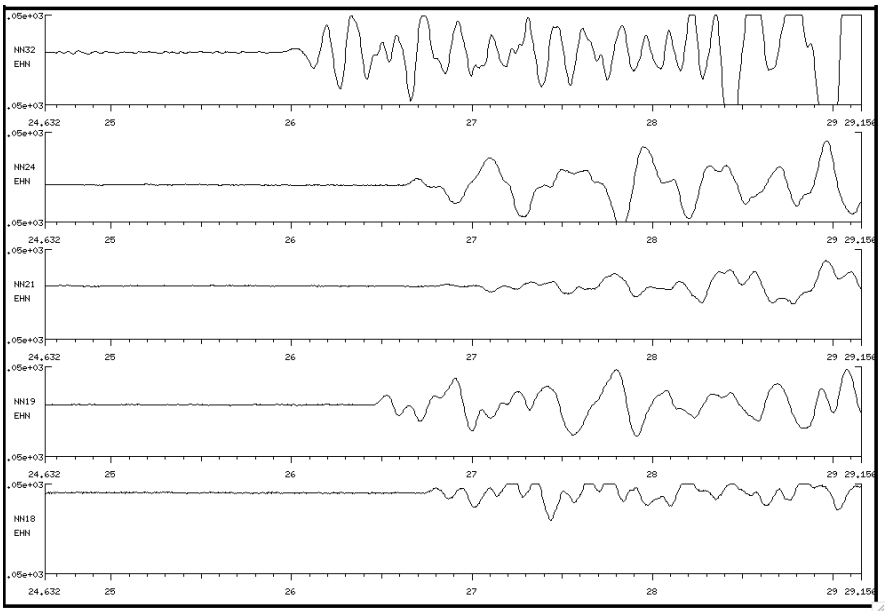


Figure 13: North-component seismograms of the Nov. 10 quarry blast from stations NN32, NN24, NN21, NN19, and NN18. All first motions are to the north, as expected.

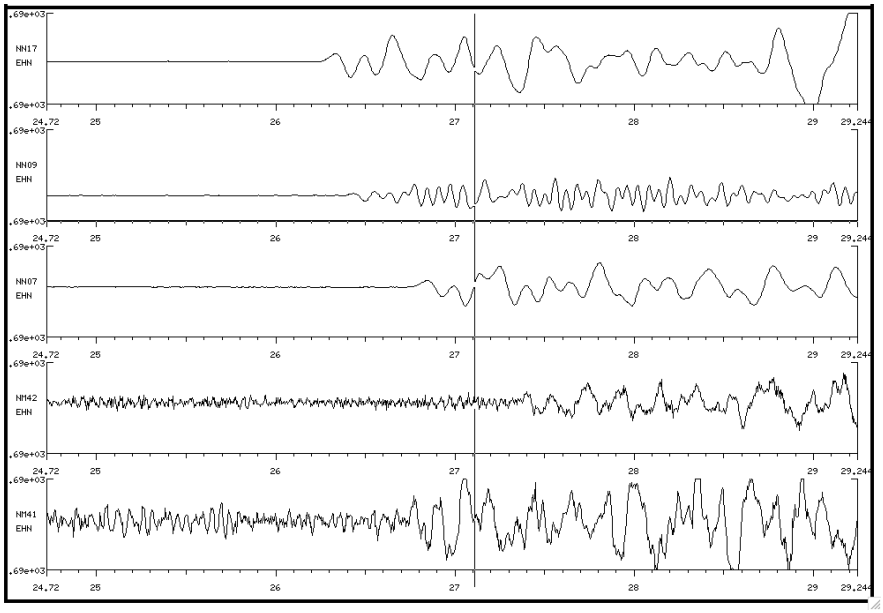


Figure 14: North-component seismograms of the Nov. 10 quarry blast from stations NN17, NN09, NN07, NM42, and NM41. All first motions are to the north, as expected.

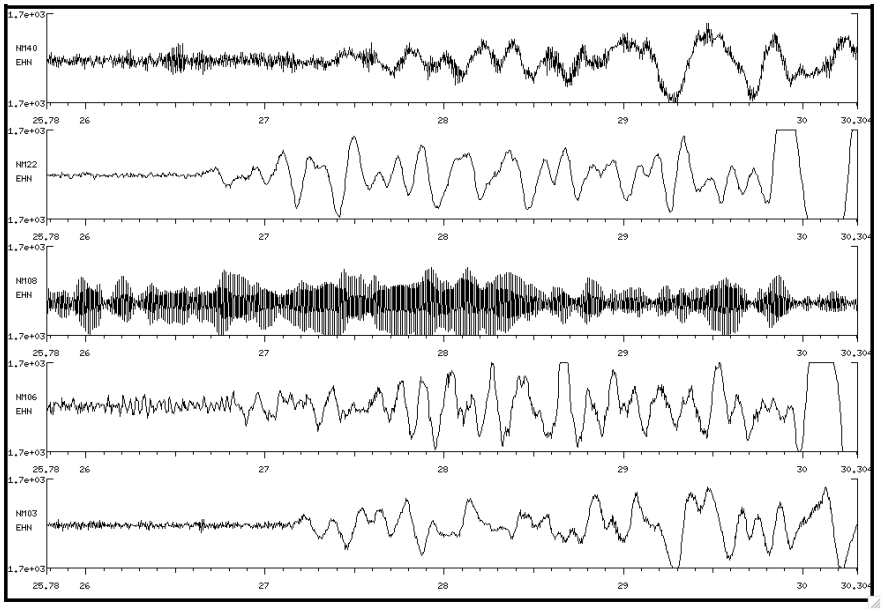


Figure 15: North-component seismograms of the Nov. 10 quarry blast from stations NM40, NM22, NM08, NM06, and NM03. First motions for NM22 and NM03 are to the north, as expected; signals from NM40, NM08, and NM06 are too noisy to be useful.

The east-component seismograms indicate that one station, NN09, has incorrect polarity. All the others appear to have correct polarity, although the signals are weak at NM42, NM41, NM40, NM06, and NM03 (Figure 16 to Figure 18).

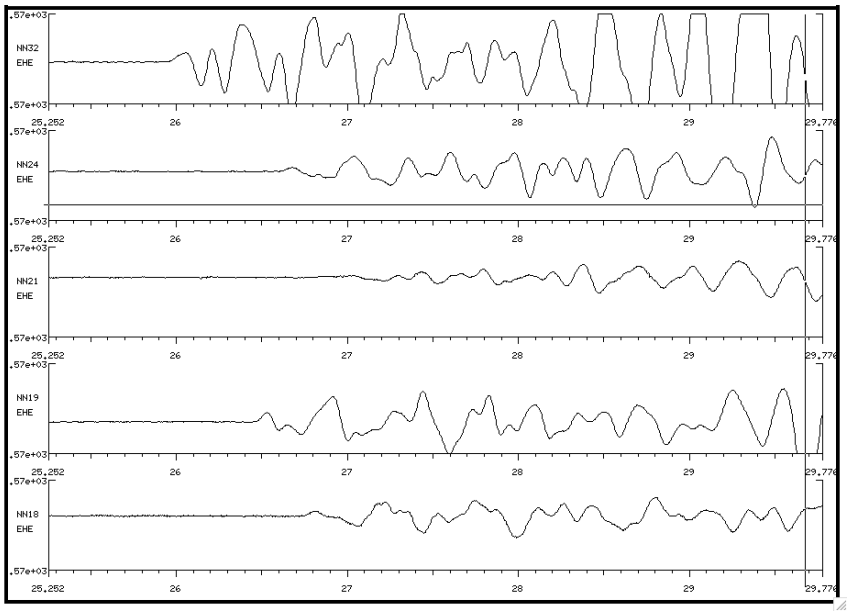


Figure 16: East-component seismograms of the Nov. 10 quarry blast from stations NN32, NN24, NN21, NN19, and NN18. All first motions are to the east, as expected.

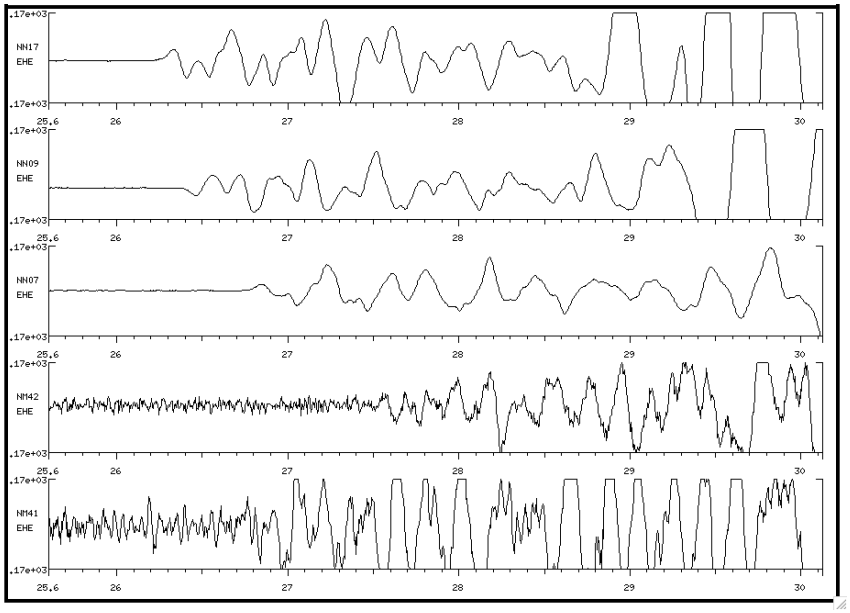


Figure 17: East-component seismograms of the Nov. 10 quarry blast from stations NN17, NN09, NN07, NM42, and NM41. First motions for NN17 and NN07 are to the east, as expected. Those for NM42 and NM41 are noisy, but probably to the east. The first motion for NN09 is to the west, indicating that the instrument is either wired incorrectly or installed incorrectly.

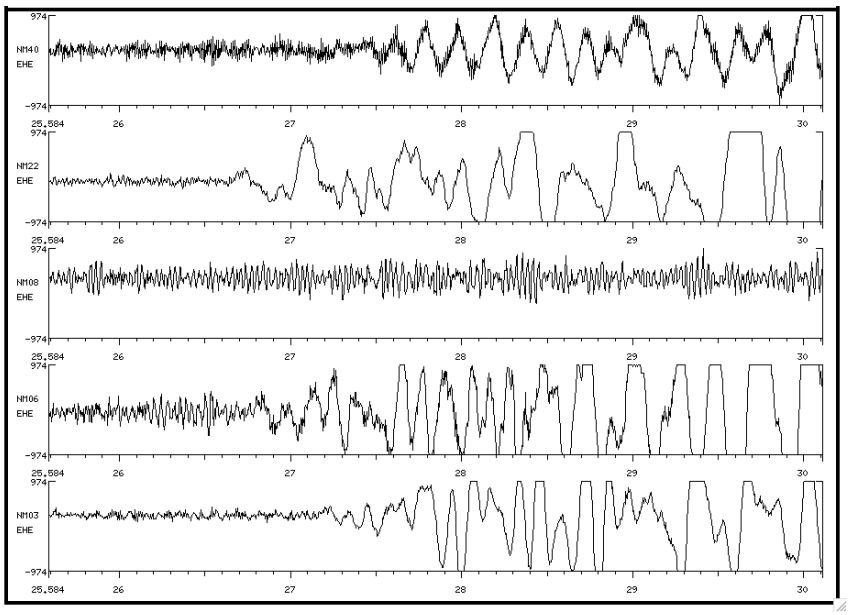


Figure 18: East-component seismograms of the Nov. 10 quarry blast from stations NM40, NM22, NM08, NM06, and NM03. The first motions for NM22 is to the east, as expected; those from NM40, NM06, and NM03 are noisy, but probably to the east. Station NM08 appears to be malfunctioning.

Table 1 summarizes the results of the polarity measurements made for this blast.

Table 1: Observed *P*-phase Polarities for Blast of 2014 Nov. 10, 21:10:20 UTC.

Station	V	N	E
NN32	+	+	+
NN24	+	+	+
NN21	+	+	+
NN19	+	+	+
NN18	+	+	+
NN17	BAD	+	+
NN09	+	+	–
NN07	+	+	+
NM42	+	+	+?
NM41	+	+	+?
NM40	+	?	+?
NM22	+	+	+
NM08	BAD	BAD	BAD
NM06	+	+?	+?
NM03	BAD	+	+?

5.2 Moment tensors

We continued to derive moment tensors using the procedure described in our Weekly Report #1. We report here an additional 11 moment tensors. The entire list of earthquakes processed to date is given in Appendix 1. The numerical results of the entire moment-tensor catalog, including the 10 new results obtained during the last week, are given in Appendix 2. Graphical results for the additional 10 events are given in Appendix 3. We have provided the locations and moment tensor decomposition data of these new moment tensors to Trenton Cladouhos of AltaRock electronically, by email attachment.

The source types for the entire 65-event set are shown in source-type space in Figure 19. The distribution remains similar to that reported earlier, i.e., source types ranging from +Dipole to -Dipole.

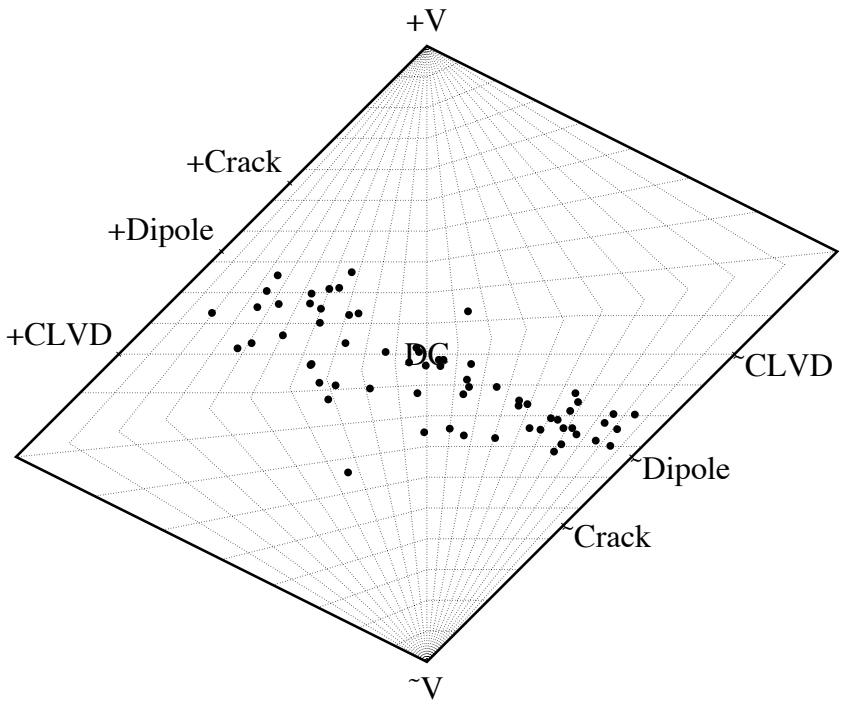


Figure 19: Source-type plot showing the 65 earthquakes for which moment tensors have been derived to date.

Figure 20 shows a plot of the P-, T- and I-axes, approximately corresponding to the directions of σ_1, σ_3 and σ_2. The addition of more earthquakes has strengthened the distribution seen earlier. Most T axes cluster systematically subhorizontally and to the S ± 20˚ or so. The orientations of the P-axes show some clustering in a sub-horizontal orientation to the NNE-ENE directions.

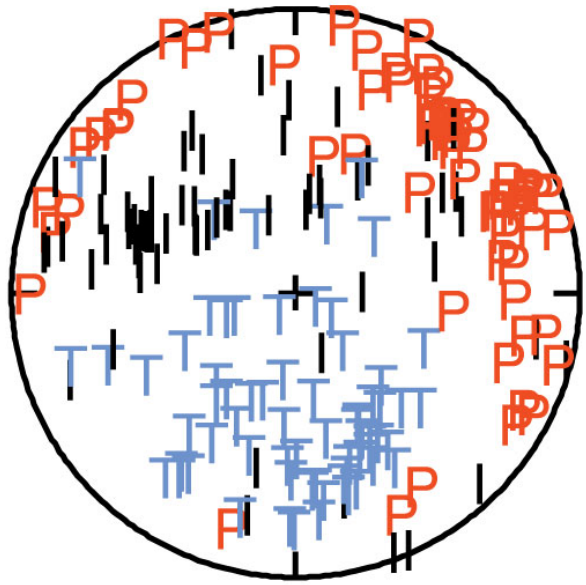


Figure 20: Plot of pressure (P ~ σ_1) and tension (T ~ σ_3) and intermediate (I ~ σ_2) axes for the 65 earthquakes for which moment tensors have been derived to date.

6 Brief summary statement

During the last week, vigorous earthquake activity has occurred in response to renewed injection. These earthquakes appear to be located slightly further to the NW than earlier earthquakes. They are restricted in time and the largest of them had a larger magnitude than any previous earthquake in the 8-week-long sequence.

Preliminary relative locations suggest that these later earthquakes may have partly filled the gap between the two earlier, separate seismogenic volumes. This result is preliminary and needs to be looked at more carefully in future, perhaps relative locating these later earthquakes separately from the earlier ones.

An additional 11 moment tensor results were obtained, including a result for the largest, M2.2 event. This event was complex and it proved difficult to either locate it or derive a moment tensor. Subsequent to our initial result, which showed a thrust mechanism, we obtained additional information on the calibration of the instruments. This moment tensor will be re-studied in the light of that new information. The general pattern of P- T- and I-axis orientations remains similar to what was observed earlier.

Appendix 1: The 65 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
321	11	17	4	41	53.061	43.7249	-121.31087	0.708	2.2

Appendix 2: Numerical moment tensor results for the 65 MEQs studied to date. N=North, E=East, D=Down.

NN	NE	EE	ND	ED	DD	Year	Mo	Day	Hr	min	Sec	Quality
1.91E-01	-1.22E-01	-8.47E-02	1.94E-01	2.39E-02	4.51E-02	2014	9	29	9	57	54.158	excellent
5.00E-02	-1.93E-01	-1.24E-01	1.75E-01	2.48E-02	3.99E-02	2014	9	29	18	3	37.66	excellent
6.49E-02	-9.50E-02	-2.84E-01	6.74E-02	1.45E-01	-3.58E-02	2014	9	30	9	23	48.626	good
-2.67E-01	1.32E-01	-6.40E-02	6.06E-02	1.03E-01	7.79E-02	2014	9	30	21	30	43.503	excellent
-1.78E-01	-1.05E-01	-1.51E-01	7.11E-02	1.06E-01	1.06E-01	2014	10	1	1	3	14.49	excellent
1.48E-01	-1.18E-01	-1.49E-01	1.58E-01	-3.13E-02	9.55E-02	2014	10	1	8	8	57.998	excellent
-3.26E-02	2.22E-01	-3.37E-01	1.64E-02	7.16E-02	9.88E-03	2014	10	1	10	50	55.107	excellent
2.00E-01	-1.41E-01	-1.46E-01	1.40E-01	-8.71E-03	7.41E-02	2014	10	1	12	3	16.94	good
1.58E-01	3.47E-02	6.67E-02	2.48E-01	6.32E-02	8.34E-02	2014	10	1	14	53	5.23	excellent
-1.04E-01	1.46E-01	-2.54E-01	1.25E-01	-1.33E-02	7.34E-02	2014	10	1	15	1	54.95	excellent
-2.21E-01	-8.13E-02	-2.19E-02	-1.52E-01	3.52E-02	2.20E-01	2014	10	1	16	56	11.343	good
2.17E-01	-3.67E-02	-6.42E-02	2.35E-01	7.20E-02	3.18E-02	2014	10	1	19	5	16.54	excellent
3.03E-02	-1.92E-01	-9.50E-02	1.99E-01	1.07E-02	7.11E-02	2014	10	1	20	47	39.521	excellent
1.28E-01	1.27E-01	-6.92E-02	8.79E-02	1.45E-01	-8.42E-02	2014	10	1	22	13	54.151	good
1.62E-01	4.20E-02	-2.04E-01	2.16E-01	-2.04E-02	7.76E-02	2014	10	2	6	39	2.998	excellent
-1.46E-02	9.64E-02	-3.98E-01	2.60E-02	1.69E-01	-4.69E-03	2014	10	2	6	47	52.94	excellent
-1.17E-01	1.71E-01	-1.99E-01	1.39E-01	-2.43E-02	1.64E-02	2014	10	2	7	7	4.16	excellent
3.77E-01	-1.27E-02	-1.42E-01	1.29E-01	8.11E-02	3.59E-02	2014	10	2	7	22	3.575	good
5.18E-02	-1.72E-01	-2.48E-02	2.09E-01	-2.97E-02	1.02E-01	2014	10	2	9	4	8.647	good
2.41E-01	-7.30E-02	-9.79E-02	1.73E-01	4.30E-02	8.35E-02	2014	10	2	11	1	42.38	excellent
-6.57E-02	-1.85E-01	-1.14E-01	1.69E-01	4.18E-02	2.83E-02	2014	10	2	12	39	24.317	good
-2.17E-01	-2.31E-01	4.01E-02	5.04E-02	7.21E-02	3.58E-02	2014	10	2	16	12	35.315	weak
2.31E-03	-1.80E-01	-9.21E-02	2.20E-01	-4.35E-03	9.59E-02	2014	10	2	18	54	3.152	good
1.42E-01	-1.37E-01	-1.64E-01	1.72E-01	1.08E-02	5.38E-02	2014	10	2	20	37	6.043	good
6.07E-03	-2.23E-01	-9.16E-02	1.94E-01	3.37E-02	-6.18E-04	2014	10	3	6	6	22.76	excellent
2.45E-01	-8.11E-02	-1.97E-01	1.74E-01	1.62E-02	1.51E-02	2014	10	3	15	27	57.661	good
-5.77E-02	-1.66E-01	-1.43E-01	1.46E-01	7.81E-02	-1.95E-02	2014	10	3	18	54	53.93	fair
1.68E-01	-3.35E-02	-9.83E-03	2.95E-01	3.54E-02	9.35E-02	2014	10	4	5	29	8.258	fair
-1.03E-01	1.33E-01	-1.19E-01	1.48E-01	5.51E-02	1.07E-01	2014	10	4	17	32	52.76	excellent
8.71E-02	1.26E-01	-4.19E-02	1.81E-01	8.43E-02	8.72E-02	2014	10	4	18	51	12	excellent
-4.16E-01	-1.86E-04	4.65E-02	1.89E-01	-7.14E-02	1.64E-02	2014	10	4	21	29	47.537	moderate
-1.37E-01	-1.84E-01	-5.91E-02	1.61E-01	-1.12E-02	9.22E-02	2014	10	5	2	6	16.967	excellent
-2.45E-02	-1.88E-01	-1.23E-01	1.69E-01	9.68E-03	1.19E-01	2014	10	5	2	14	37.168	excellent
5.30E-02	6.78E-02	-1.18E-01	1.62E-01	7.51E-02	2.21E-01	2014	10	5	4	7	20	excellent
-2.29E-01	1.61E-01	-7.21E-02	-9.28E-02	8.01E-02	-3.22E-02	2014	10	5	15	55	21.007	good
2.87E-01	-3.71E-02	-1.79E-01	9.26E-02	1.26E-01	2.27E-02	2014	10	5	16	7	32.777	excellent
-1.87E-01	9.00E-02	-9.47E-02	-1.45E-01	-2.49E-02	1.99E-01	2014	10	5	23	22	16.499	good

-8.06E-02	-9.30E-02	-2.67E-01	6.01E-02	1.63E-01	-2.04E-02	2014	10	6	4	2	55.789	good
-3.56E-01	1.59E-01	1.19E-01	5.15E-02	2.88E-02	4.70E-02	2014	10	6	6	13	48.626	excellent
1.32E-01	1.00E-01	-3.87E-01	3.12E-02	9.89E-02	1.91E-02	2014	10	7	6	12	8.593	good
2.45E-01	-1.19E-01	-1.14E-01	1.67E-01	-1.16E-02	4.69E-02	2014	10	7	7	26	23.18	good
4.38E-02	2.44E-01	-1.80E-01	4.37E-02	9.99E-02	-2.18E-05	2014	10	7	10	47	20.916	good
2.55E-02	1.51E-01	-2.81E-01	1.69E-02	1.79E-01	-4.14E-04	2014	10	8	7	5	5.941	weak
-7.82E-03	2.19E-01	-2.87E-01	2.80E-02	1.01E-01	-8.51E-03	2014	10	8	19	8	20.619	excellent
-1.75E-01	-2.00E-01	-6.44E-02	1.28E-01	-1.70E-02	6.96E-02	2014	10	8	21	16	58.2	good
2.44E-02	7.10E-02	-2.43E-02	-8.64E-02	-1.62E-01	3.13E-01	2014	10	9	6	24	33.418	excellent
7.44E-02	8.69E-02	-6.60E-02	-1.45E-01	-9.86E-02	1.98E-01	2014	10	9	10	16	9.945	moderate
-1.43E-01	-1.36E-01	3.35E-03	1.56E-01	-5.83E-02	1.55E-01	2014	10	11	3	29	5.667	good
3.71E-03	3.87E-02	-3.57E-01	5.61E-02	2.09E-01	2.16E-02	2014	10	11	10	53	26.502	good
-1.35E-01	-1.17E-01	-4.10E-02	2.00E-01	-5.35E-02	8.30E-02	2014	10	12	10	12	29	good
-4.88E-01	-1.02E-01	5.62E-02	5.97E-02	-1.84E-03	1.29E-01	2014	10	12	16	37	43.287	excellent
4.02E-02	-1.23E-01	-2.57E-01	1.61E-01	1.97E-02	9.60E-02	2014	10	12	16	47	1.137	excellent
2.03E-01	-2.42E-02	-3.05E-01	1.71E-01	-4.33E-02	1.58E-02	2014	10	12	18	33	4.693	moderate
-2.21E-01	1.54E-01	4.96E-02	9.04E-02	8.19E-02	7.60E-02	2014	10	12	21	10	23.311	good
-5.87E-02	-1.25E-01	-2.80E-01	6.12E-02	1.41E-01	6.33E-03	2014	10	13	0	57	6.717	good
2.61E-02	-1.18E-01	-2.89E-01	8.03E-02	1.23E-01	4.15E-02	2014	10	13	4	12	29.126	excellent
-1.16E-01	-1.39E-01	-1.17E-01	1.51E-01	5.54E-02	7.56E-02	2014	10	13	10	22	29.084	excellent
-1.13E-01	-2.73E-02	-2.41E-01	5.66E-02	5.18E-02	3.75E-01	2014	10	14	5	46	13.914	exellent
-1.27E-01	-1.70E-01	3.34E-02	1.57E-01	-5.42E-02	7.86E-02	2014	10	15	15	3	44.602	excellent
-5.10E-02	-1.76E-01	-8.51E-02	1.95E-01	1.28E-03	1.20E-01	2014	10	15	15	37	25.945	excellent
-4.01E-01	-1.33E-01	-3.89E-03	1.17E-01	1.60E-02	6.35E-02	2014	10	16	16	53	27.374	good
-4.20E-02	-1.46E-01	-3.20E-01	-5.38E-04	1.43E-01	5.83E-02	2014	10	18	23	57	3.695	good
-1.86E-01	8.58E-02	-2.76E-01	1.40E-01	-1.35E-02	6.01E-02	2014	10	19	9	7	50.325	good
-1.40E-02	-2.15E-01	-6.15E-02	2.27E-01	1.12E-03	3.93E-02	2014	10	23	21	2	22.252	good
-2.49E-01	-8.81E-02	-1.12E-01	3.18E-02	-3.71E-02	3.26E-01	2014	11	17	4	41	52.962	excellent

Appendix 3: The additional 11 moment tensors derived over the reporting week.

/Users/foulger/SeismicProcessing/Newberry/Data/2014/10/04/20141004212937.or

2014 Oct 4 21:29:47.537 UTC
Lat: 43.7275 Lon: -121.306 Depth: 0.955
43:43.65 N 121:18.3792 W

Solve

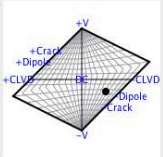
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NM22	0.33	220	171	EHT	SH	0.042	☐ +			
2	NN07	3.06	330	117	EHU	P	0.051	☑ −		☑ -3.15e+01	1.78e+01
3	NN09	2.21	287	129	EHU	P	0.005	☑ −		☑ -2.19e+01	1.92e+01
4	NN09	2.21	287	129	EHR	SV	-0.040	☑ +	0.021	☑ 1.29e+02	2.13e+01
5	NN09	2.21	287	129	EHT	SH	-0.010	☐ +		☑ 1.20e+02	1.76e+01
6	NN17	1.87	246	135	EHU	P	-0.020	☑ +		☑ 5.45e+00	2.92e+01
7	NN17	1.87	246	135	EHR	SV	-0.049	☑ +		☑ 1.11e+02	2.42e+01
8	NN17	1.87	246	135	EHT	SH	-0.058	☑ −		☑ -1.25e+02	1.47e+01
9	NN18	1.17	17	150	EHU	P	0.043	☑ −		☑ -2.77e+01	1.74e+01
10	NN18	1.17	17	150	EHT	SH	0.043	☑ +		☑ 9.97e+01	1.64e+01
11	NN19	1.02	183	153	EHU	P	-0.005	☑ +		☑ 7.63e+01	1.70e+01
12	NN19	1.02	183	153	EHR	SV	0.034	☑ +		☑ 2.90e+02	1.67e+01
13	NN19	1.02	183	153	EHT	SH	0.011	☑ −		☑ -2.84e+02	1.55e+01
14	NN21	1.47	65	144	EHZ	P	-0.049				
15	NN24	0.55	338	165	EHU	P	-0.002	☑ −		☑ -2.61e+01	1.81e+01
16	NN24	0.55	338	165	EHR	SV	-0.029	☑ +		☑ 2.41e+02	2.13e+01

	Sta	Type	Penalty
1	NN09	☑ P:SV	0.125
2	NN09	☐ P:SH	
3	NN09	☐ SV:SH	
4	NN17	☑ P:SV	
5	NN17	☑ P:SH	
6	NN17	☑ SV:SH	
7	NN18	☑ P:SH	
8	NN19	☑ P:SV	
9	NN19	☑ P:SH	
10	NN19	☑ SV:SH	
11	NN24	☑ P:SV	0.014
12	NN24	☐ P:SH	
13	NN24	☐ SV:SH	

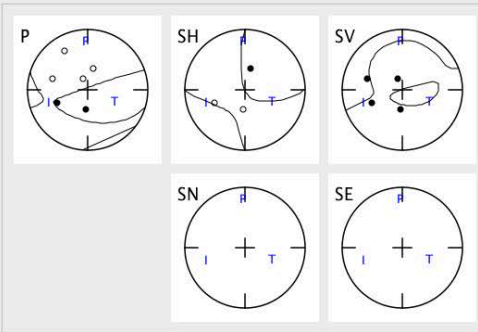
	North	East	Down
North	-4.16e-01	-1.86e-04	1.89e-01
East	-1.86e-04	4.65e-02	-7.14e-02
Down	1.89e-01	-7.14e-02	1.64e-02

Scalar M0 = 3.585e-01
T = 0.623 k = -0.241

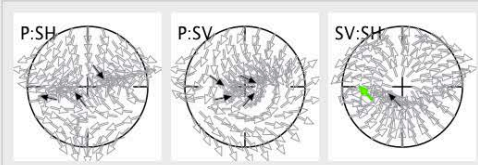
Total Penalty = 0.160



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/10/23/20141023210222.03.or

2014 Oct 23 21: 2:22.252 UTC
Lat: 43.725 Lon: -121.31 Depth: 0.601
43:43.5012 N 121:18.5988 W

Solve

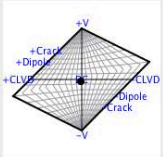
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NN07	3.18	338	107	EHU	P	0.000	✓ −	0.004	✓ -7.40e+00	1.75e+01
2	NN07	3.18	338	107	EHT	SH	0.036	☐ +		✓ 6.64e+01	1.24e+01
3	NN09	2.03	296	123	EHU	P	0.007	✓ +		✓ 3.10e+00	2.20e+01
4	NN09	2.03	296	123	EHR	SV	-0.010	✓ −		✓ -2.68e+02	1.46e+01
5	NN09	2.03	296	123	EHT	SH	-0.002	✓ +		✓ 5.34e+01	2.12e+01
6	NN17	1.49	251	135	EHU	P	-0.003	✓ +		✓ 2.34e+00	3.69e+01
7	NN17	1.49	251	135	EHT	SH	-0.009	✓ −		✓ -1.32e+02	1.33e+01
8	NN18	1.53	24	135	EHU	P	0.004	✓ −		✓ -4.96e+00	1.80e+01
9	NN19	0.78	162	155	EHU	P	0.001	✓ +		✓ 3.61e+01	1.23e+01
10	NN19	0.78	162	155	EHT	SH	0.095	✓ −		✓ -1.71e+02	1.57e+01
11	NN24	0.79	7	155	EHU	P	-0.004	✓ −		✓ -2.78e+01	2.46e+01
12	NN24	0.79	7	155	EHR	SV	-0.036	✓ +		✓ 1.56e+02	1.93e+01
13	NN24	0.79	7	155	EHT	SH	-0.043	✓ −		✓ -5.70e+01	1.98e+01
14	NN32	2.74	211	112	EHU	P	-0.010	✓ −		✓ -1.24e+01	1.56e+01
15	NN32	2.74	211	112	EHR	SV	0.053	☐ −		✓ -1.33e+02	1.46e+01
16	NN32	2.74	211	112	EHT	SH	0.058	✓ −		✓ -4.61e+01	1.63e+01

	Sta	Type	Penalty
1	NN07	☐ P:SH	
2	NN09	✓ P:SV	
3	NN09	✓ P:SH	
4	NN09	✓ SV:SH	
5	NN17	✓ P:SH	0.004
6	NN19	☐ P:SH	
7	NN24	✓ P:SV	
8	NN24	✓ P:SH	
9	NN24	✓ SV:SH	
10	NN32	☐ P:SV	
11	NN32	☐ P:SH	
12	NN32	☐ SV:SH	

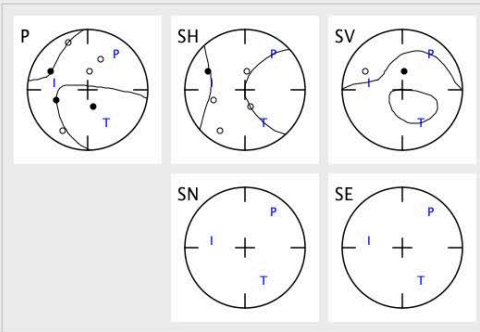
	North	East	Down
North	-1.40e-02	-2.15e-01	2.26e-01
East	-2.15e-01	-6.15e-02	1.12e-03
Down	2.26e-01	1.12e-03	3.93e-02

Scalar M0 = 3.167e-01
T = -0.004 k = -0.037

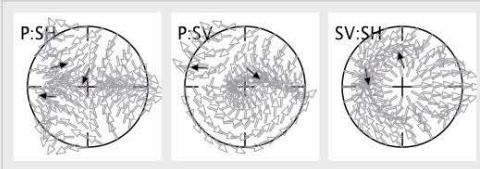
Total Penalty = 0.008



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/10/01/20141001221344.or

2014 Oct 1 22:13:54.151 UTC
Lat: 43.7265 Lon: -121.308 Depth: 0.955
43:43.5888 N 121:18.4872 W

Solve

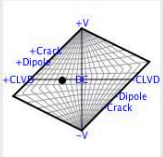
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NM22	0.15	206	176	EHT	SH	0.097	☑ +		☑ 5.76e+02	1.38e+01
2	NM42	3.55	41	115	EHU	P	0.008	☑ −		☑ -5.57e+01	1.58e+01
3	NN07	3.10	334	117	EHU	P	-0.001	☑ −		☑ -9.94e+00	1.88e+01
4	NN07	3.10	334	117	EHR	SV	-0.024	☑ −		☑ -5.07e+01	1.09e+01
5	NN09	2.10	291	130	EHU	P	0.010	☑ −		☑ -3.94e+00	2.04e+01
6	NN09	2.10	291	130	EHR	SV	0.003	☑ +		☑ 6.21e+01	2.79e+01
7	NN09	2.10	291	130	EHT	SH	0.043	☐ +		☑ 6.08e+01	2.64e+01
8	NN17	1.69	248	138	EHU	P	-0.009	☑ +		☑ 3.11e+00	2.90e+01
9	NN17	1.69	248	138	EHR	SV	0.024	☐ +		☑ 5.92e+01	1.66e+01
10	NN17	1.69	248	138	EHT	SH	-0.001	☑ −		☑ -2.83e+01	1.94e+01
11	NN18	1.32	21	146	EHU	P	-0.002	☑ −		☑ -3.40e+01	1.85e+01
12	NN18	1.32	21	146	EHR	SV	0.041	☑ −		☑ -9.81e+01	1.32e+01
13	NN19	0.91	174	156	EHU	P	0.003	☑ +		☑ 3.36e+01	1.77e+01
14	NN19	0.91	174	156	EHR	SV	0.001	☑ −		☑ -1.08e+02	1.40e+01
15	NN24	0.62	355	163	EHU	P	-0.009	☑ −		☑ -2.70e+01	1.92e+01
16	NN24	0.62	355	163	EHR	SV	-0.018	☑ +		☑ 1.25e+02	2.54e+01

	Sta	Type	Penalty
1	NN07	☑ P:SV	
2	NN09	☑ P:SV	0.001
3	NN09	☑ P:SH	0.036
4	NN09	☐ SV:SH	
5	NN17	☐ P:SV	
6	NN17	☑ P:SH	0.074
7	NN17	☐ SV:SH	
8	NN18	☑ P:SV	
9	NN19	☐ P:SV	
10	NN24	☐ P:SV	
11	NN24	☑ P:SH	
12	NN24	☐ SV:SH	
13	NN32	☑ SV:SH	0.017

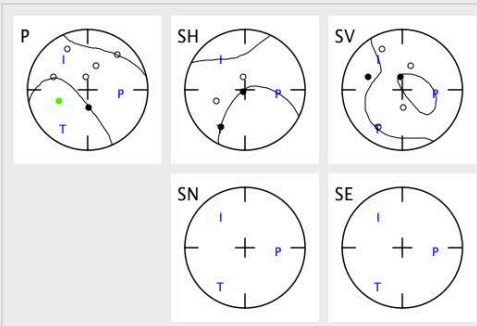
	North	East	Down
North	1.28e-01	1.27e-01	8.79e-02
East	1.27e-01	-6.92e-02	1.45e-01
Down	8.79e-02	1.45e-01	-8.41e-02

Scalar M0 = 2.426e-01
T = -0.362 k = -0.031

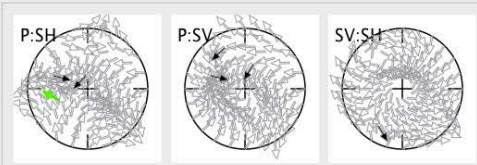
Total Penalty = 0.128



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/10/01/20141001204729.or

2014 Oct 1 20:47:39.521 UTC
Lat: 43.7266 Lon: -121.309 Depth: 0.876
43:43.5936 N 121:18.5358 W

Solve

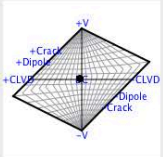
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NM06	0.74	107	160	EHT	SH	0.069	✓ +		✓ 9.02e+01	1.22e+01
2	NM22	0.15	181	176	EHT	SH	-0.004	✓ +	0.006	✓ 1.79e+02	2.18e+01
3	NN07	3.06	335	116	EHU	P	0.009	✓ −		✓ -1.84e+01	1.62e+01
4	NN09	2.04	291	130	EHU	P	0.005	✓ +	0.002	✓ 4.21e+00	1.58e+01
5	NN09	2.04	291	130	EHR	SV	-0.024	✓ +		✓ 9.55e+01	2.76e+01
6	NN09	2.04	291	130	EHT	SH	0.011	✓ +		✓ 8.63e+01	2.80e+01
7	NN17	1.63	247	138	EHU	P	-0.006	✓ +		✓ 4.28e+00	2.85e+01
8	NN17	1.63	247	138	EHR	SV	0.007	✓ +		✓ 7.28e+01	2.75e+01
9	NN17	1.63	247	138	EHT	SH	0.003	✓ −		✓ -4.63e+01	2.30e+01
10	NN18	1.34	24	145	EHU	P	0.001	✓ −		✓ -2.66e+01	1.49e+01
11	NN18	1.34	24	145	EHR	SV	0.022	☐ −		✓ -1.32e+02	1.27e+01
12	NN18	1.34	24	145	EHT	SH	0.066	✓ −		✓ -7.39e+01	2.29e+01
13	NN19	0.93	170	155	EHU	P	0.005	✓ +		✓ 3.28e+01	1.64e+01
14	NN19	0.93	170	155	EHT	SH	0.049	✓ −		✓ -2.28e+02	1.91e+01
15	NN21	1.70	64	138	EHU	P	-0.003	✓ −		✓ -2.19e+00	1.39e+01

	Sta	Type	Penalty
1	NN09	✓ P:SV	0.002
2	NN09	✓ P:SH	0.006
3	NN09	✓ SV:SH	0.022
4	NN17	✓ P:SV	
5	NN17	✓ P:SH	
6	NN17	✓ SV:SH	
7	NN18	☐ P:SV	
8	NN18	✓ P:SH	0.110
9	NN18	☐ SV:SH	
10	NN19	☐ P:SH	
11	NN24	✓ P:SV	0.026
12	NN24	✓ P:SH	0.026
13	NN24	✓ SV:SH	
14	NN32	☐ P:SH	

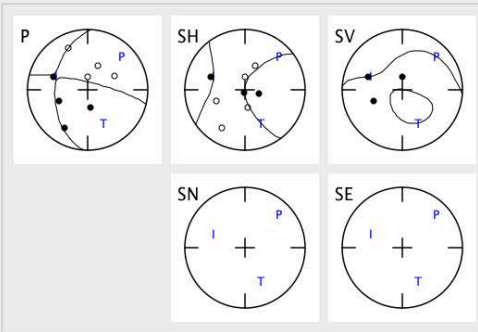
	North	East	Down
North	3.03e-02	-1.92e-01	1.99e-01
East	-1.92e-01	-9.50e-02	1.07e-02
Down	1.99e-01	1.07e-02	7.11e-02

Scalar M0 = 2.900e-01
T = -0.025 k = 0.007

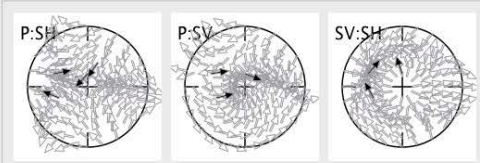
Total Penalty = 0.200



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/10/07/20141007072613.or

2014 Oct 7 7:26:23.180 UTC
Lat: 43.7251 Lon: -121.308 Depth: 1.23
43:43.5042 N 121:18.4896 W

Solve

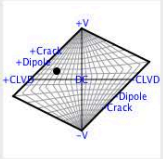
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
12	NN17	1.63	253	144	EHU	P	-0.012	✓ +		✓ 3.92e+00	1.90e+01
13	NN17	1.63	253	144	EHR	SV	0.008	✓ +		✓ 8.30e+01	2.40e+01
14	NN17	1.63	253	144	EHT	SH	0.007	☐ +		✓ 2.22e+02	9.67e+00
15	NN18	1.47	19	147	EHU	P	-0.008	✓ −		✓ -1.99e+01	1.86e+01
16	NN18	1.47	19	147	EHR	SV	-0.017	☐ −		✓ -1.91e+02	1.46e+01
17	NN19	0.76	173	162	EHU	P	0.010	✓ +		✓ 3.82e+01	1.53e+01
18	NN19	0.76	173	162	EHT	SH	0.073	✓ −		✓ -1.44e+02	1.87e+01
19	NN21	1.73	59	143	EHU	P	-0.017	✓ −		✓ -8.20e+00	1.62e+01
20	NN24	0.78	356	162	EHU	P	-0.018	✓ −		✓ -2.36e+01	2.07e+01
21	NN24	0.78	356	162	EHR	SV	-0.052	✓ +		✓ 2.40e+02	1.96e+01
22	NN24	0.78	356	162	EHT	SH	-0.060	✓ −		✓ -9.85e+01	1.74e+01
23	NN32	2.83	213	125	EHU	P	-0.012	✓ +		✓ 1.05e+01	1.26e+01
24	NN32	2.83	213	125	EHR	SV	0.039	☐ −		✓ -1.75e+02	1.31e+01
25	NN32	2.83	213	125	EHT	SH	0.041	✓ −		✓ -5.15e+01	2.87e+01

	Sta	Type	Penalty
3	NN09	✓ P:SV	0.037
4	NN09	✓ P:SH	0.033
5	NN09	✓ SV:SH	0.053
6	NN17	✓ P:SV	0.000
7	NN17	☐ P:SH	
8	NN17	☐ SV:SH	
9	NN18	☐ P:SV	
10	NN19	☐ P:SH	
11	NN24	✓ P:SV	
12	NN24	✓ P:SH	
13	NN24	✓ SV:SH	
14	NN32	☐ P:SV	
15	NN32	✓ P:SH	
16	NN32	☐ SV:SH	

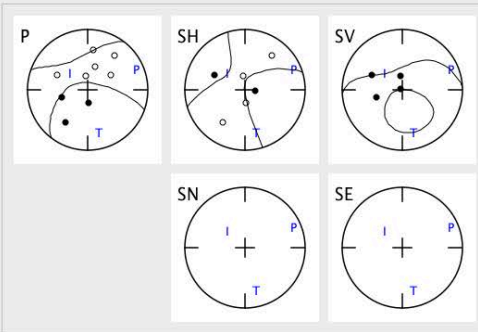
	North	East	Down
North	2.45e-01	-1.19e-01	1.67e-01
East	-1.19e-01	-1.14e-01	-1.16e-02
Down	1.67e-01	-1.16e-02	4.69e-02

Scalar M0 = 2.822e-01
T = -0.574 k = 0.162

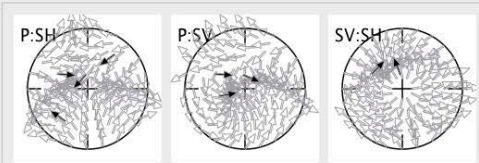
Total Penalty = 0.139



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/10/02/20141002072138.or

2014 Oct 2 7:22: 3.575 UTC
Lat: 43.7266 Lon: -121.309 Depth: 1.003
43:43.5984 N 121:18.5478 W

Solve

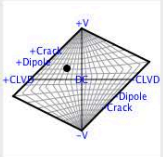
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NM03	2.91	11	122	EHU	P	0.024	☑ +		☑ 1.49e+01	2.06e+01
2	NM06	0.76	108	161	EHU	P	0.039	☑ −		☑ -1.10e+02	1.06e+01
3	NM22	0.16	175	176	EHE	SE	0.065				
4	NM42	3.59	42	115	EHZ	P	-0.010	☑ −			
5	NN07	3.05	335	118	EHZ	P	-0.003	☐ −			
6	NN09	2.02	291	133	EHU	P	0.025	☑ +		☑ 7.53e+00	2.08e+01
7	NN09	2.02	291	133	EHR	SV	0.009	☑ +		☑ 1.49e+02	2.58e+01
8	NN09	2.02	291	133	EHT	SH	0.047	☑ +		☑ 8.98e+01	2.90e+01
9	NN17	1.62	246	140	EHU	P	-0.009	☑ +		☑ 4.58e+00	3.04e+01
10	NN17	1.62	246	140	EHR	SV	0.018	☑ +		☑ 7.18e+01	1.91e+01
11	NN17	1.62	246	140	EHE	SE	-0.001				
12	NN18	1.34	25	147	EHU	P	-0.016	☑ −		☑ -1.48e+01	1.80e+01
13	NN18	1.34	25	147	EHR	SV	0.004	☑ −		☑ -1.79e+02	1.50e+01
14	NN19	0.94	169	156	EHU	P	-0.009	☑ +			
15	NN24	0.60	2	164	EHU	P	-0.013	☑ −		☑ -1.09e+01	2.59e+01
16	NN24	0.60	2	164	EHR	SV	-0.028	☑ +		☑ 1.37e+02	1.72e+01
17	NN24	0.60	2	164	EHT	SH	-0.052	☑ −		☑ -7.79e+01	1.68e+01
18	NN32	2.93	210	120	EHU	P	-0.045	☑ +		☑ 3.73e+00	1.50e+01

	Sta	Type	Penalty
1	NN09	☑ P:SV	
2	NN09	☑ P:SH	
3	NN09	☑ SV:SH	
4	NN17	☑ P:SV	0.110
5	NN18	☑ P:SV	0.013
6	NN24	☑ P:SV	
7	NN24	☑ P:SH	0.047
8	NN24	☐ SV:SH	
9	NN32	☐ P:SV	
10	NN32	☐ P:SH	
11	NN32	☐ SV:SH	

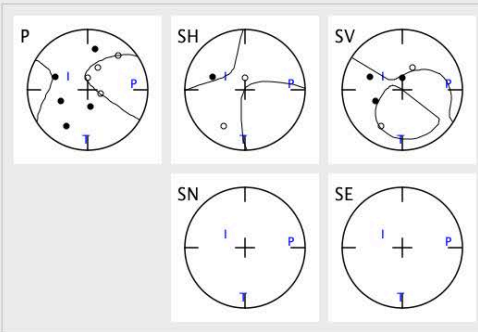
	North	East	Down
North	3.77e-01	-1.27e-02	1.29e-01
East	-1.27e-02	-1.42e-01	8.11e-02
Down	1.29e-01	8.11e-02	3.59e-02

Scalar M0 = 3.242e-01
T = -0.361 k = 0.215

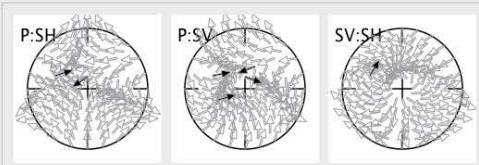
Total Penalty = 0.170



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/10/02/20141002090353.or

2014 Oct 2 9: 4: 8.647 UTC
Lat: 43.7254 Lon: -121.308 Depth: 1.063
43:43.5216 N 121:18.4602 W

Solve

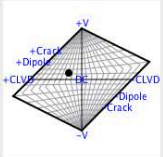
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NM03	3.03	8	122	EHU	P	0.027	☑ –			
2	NM42	3.62	39	116	EHU	P	-0.002	☑ –		☑ -2.34e+01	1.22e+01
3	NN07	3.22	334	118	EHU	P	-0.008	☑ –		☑ -8.18e+00	1.82e+01
4	NN09	2.19	293	131	EHU	P	0.002	☑ +	0.001	☑ 7.77e-01	2.81e+01
5	NN09	2.19	293	131	EHR	SV	-0.027	☑ +	0.019	☑ 8.56e+01	2.51e+01
6	NN09	2.19	293	131	EHT	SH	0.013	☑ +	0.007	☑ 3.86e+01	1.92e+01
7	NN17	1.68	252	140	EHU	P	-0.001	☑ +		☑ 4.13e+00	2.95e+01
8	NN17	1.68	252	140	EHE	SE	0.013				
9	NN18	1.43	18	146	EHZ	P	-0.004	☑ –			
10	NN19	0.79	176	160	EHZ	P	0.008	☑ +			
11	NN21	1.68	59	141	EHZ	P	-0.007	☑ –			
12	NN24	0.75	353	161	EHU	P	-0.002	☑ –		☑ -7.60e+00	2.57e+01
13	NN24	0.75	353	161	EHR	SV	-0.016	☑ +		☑ 9.38e+01	6.81e+01
14	NN24	0.75	353	161	EHT	SH	-0.019	☑ –		☑ -5.76e+01	1.94e+01
15	NN32	2.88	214	121	EHU	P	-0.013	☑ +		☑ 3.78e+00	1.46e+01
16	NN32	2.88	214	121	EHR	SV	0.032	☐ –		☑ -7.85e+01	1.61e+01
17	NN32	2.88	214	121	EHT	SH	0.032	☑ –		☑ -3.22e+01	2.67e+01

	Sta	Type	Penalty
1	NN09	☑ P:SV	
2	NN09	☑ P:SH	
3	NN09	☑ SV:SH	
4	NN24	☑ P:SV	
5	NN24	☑ P:SH	
6	NN24	☑ SV:SH	
7	NN32	☐ P:SV	
8	NN32	☑ P:SH	
9	NN32	☐ SV:SH	

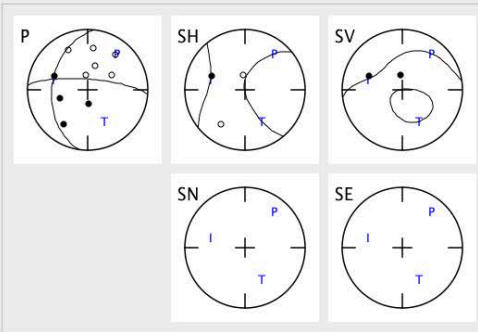
	North	East	Down
North	5.18e-02	-1.72e-01	2.09e-01
East	-1.72e-01	-2.48e-02	-2.97e-02
Down	2.09e-01	-2.97e-02	1.02e-01

Scalar M0 = 2.846e-01
T = -0.289 k = 0.126

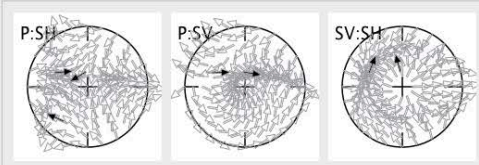
Total Penalty = 0.028



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/10/08/20141008070456.or

2014 Oct 8 7: 5: 5.941 UTC
Lat: 43.7272 Lon: -121.308 Depth: 1.396
43:43.635 N 121:18.4878 W

Solve

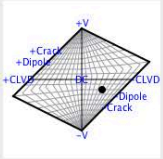
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NM06	0.71	115	165	EHU	P	0.046	✓ –		✓ -3.61e+01	8.42e+00
2	NM06	0.71	115	165	EHT	SH	0.062	☐ –		✓ -4.37e+02	1.69e+01
3	NM42	3.49	42	123	EHU	P	-0.049	✓ –		✓ -1.76e+02	9.97e+00
4	NN09	2.08	289	138	EHU	P	0.028	✓ +		✓ 7.55e-01	2.02e+01
5	NN09	2.08	289	138	EHR	SV	-0.043	✓ +		✓ 3.40e+01	2.63e+01
6	NN09	2.08	289	138	EHT	SH	-0.010	☐ +		✓ 4.46e+01	9.56e+00
7	NN17	1.72	245	144	EHU	P	-0.009	✓ +		✓ 3.01e+00	3.22e+01
8	NN17	1.72	245	144	EHR	SV	-0.064	✓ +		✓ 5.44e+01	1.58e+01
9	NN17	1.72	245	144	EHT	SH	-0.084	✓ –		✓ -9.72e+01	1.68e+01
10	NN18	1.25	23	153	EHU	P	0.017	✓ –		✓ -1.16e+01	1.93e+01
11	NN19	1.00	175	158	EHU	P	-0.020	✓ +		✓ 3.10e+01	1.79e+01
12	NN19	1.00	175	158	EHR	SV	-0.064	✓ +		✓ 8.10e+01	1.89e+01
13	NN19	1.00	175	158	EHT	SH	-0.060	☐ –		✓ -1.67e+02	1.19e+01
14	NN21	1.61	66	147	EHT	SH	0.026	✓ –		✓ -8.58e+01	1.23e+01
15	NN24	0.54	354	168	EHU	P	-0.015	✓ –		✓ -7.09e+00	2.68e+01
16	NN24	0.54	354	168	EHR	SV	-0.113	✓ +		✓ 1.12e+02	2.13e+01
17	NN32	3.03	211	125	EHR	SV	-0.021	✓ –		✓ -1.16e+02	1.61e+01

	Sta	Type	Penalty
1	NM06	☐ P:SH	
2	NN09	✓ P:SV	0.003
3	NN09	☐ P:SH	
4	NN09	☐ SV:SH	
5	NN17	☐ P:SV	
6	NN17	✓ P:SH	0.111
7	NN17	☐ SV:SH	
8	NN19	✓ P:SV	
9	NN19	☐ P:SH	
10	NN19	☐ SV:SH	
11	NN24	✓ P:SV	

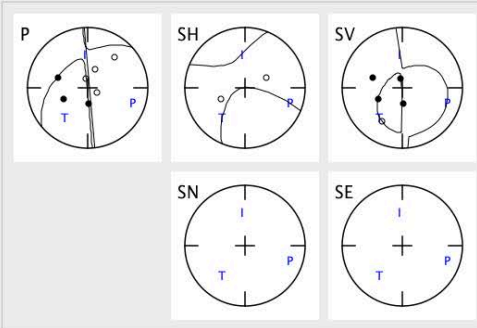
	North	East	Down
North	2.55e-02	1.51e-01	1.69e-02
East	1.51e-01	-2.81e-01	1.79e-01
Down	1.69e-02	1.79e-01	-4.14e-04

Scalar M0 = 3.079e-01
T = 0.511 k = -0.209

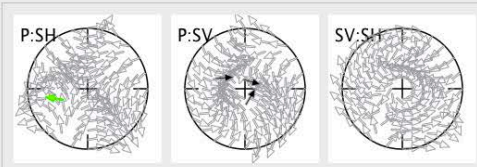
Total Penalty = 0.113



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/10/08/20141008190820.or

2014 Oct 8 19: 8:20.619 UTC
Lat: 43.7257 Lon: -121.308 Depth: 0.964
43:43.5408 N 121:18.465 W

Solve

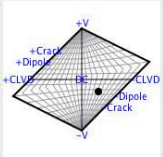
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NM03	3.00	9	120	EHU	P	0.055	☑ +		☑ 8.25e+00	5.03e+01
2	NM22	0.11	243	177	EHT	SH	0.101	☑ +		☑ 5.97e+02	1.36e+01
3	NN07	3.19	334	116	EHU	P	-0.015	☑ −		☑ -1.54e+01	1.68e+01
4	NN07	3.19	334	116	EHR	SV	0.031	☑ +		☑ 1.12e+02	1.46e+01
5	NN09	2.17	293	129	EHU	P	0.006	☑ −		☑ -2.26e+01	2.14e+01
6	NN09	2.17	293	129	EHR	SV	-0.011	☑ +		☑ 9.50e+01	2.77e+01
7	NN09	2.17	293	129	EHT	SH	0.026	☐ +		☑ 7.23e+01	2.58e+01
8	NN17	1.68	251	139	EHU	P	-0.006	☑ +		☑ 4.09e+00	2.81e+01
9	NN17	1.68	251	139	EHT	SH	-0.002	☑ −		☑ -7.25e+01	1.87e+01
10	NN18	1.40	19	145	EHU	P	-0.007	☑ −		☑ -3.69e+01	1.73e+01
11	NN19	0.82	175	158	EHU	P	0.017	☑ +	0.001	☑ 3.74e+01	1.70e+01
12	NN19	0.82	175	158	EHR	SV	0.024	☑ −		☑ -1.55e+02	1.96e+01
13	NN19	0.82	175	158	EHT	SH	0.094	☐ −		☑ -2.17e+02	1.48e+01
14	NN21	1.67	60	140	EHU	P	-0.017	☑ −		☑ -2.68e+01	1.58e+01
15	NN24	0.71	353	161	EHU	P	-0.010	☑ −		☑ -3.02e+01	1.80e+01

	Sta	Type	Penalty
1	NN07	☑ P:SV	0.114
2	NN09	☑ P:SV	0.021
3	NN09	☐ P:SH	
4	NN09	☐ SV:SH	
5	NN17	☑ P:SH	0.002
6	NN19	☑ P:SV	0.001
7	NN19	☐ P:SH	
8	NN19	☐ SV:SH	
9	NN24	☑ P:SV	
10	NN24	☑ P:SH	
11	NN24	☑ SV:SH	
12	NN32	☐ P:SV	
13	NN32	☐ P:SH	
14	NN32	☑ SV:SH	0.008

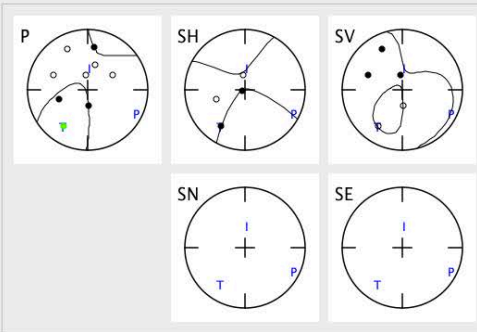
	North	East	Down
North	-7.82e-03	2.19e-01	2.80e-02
East	2.19e-01	-2.87e-01	1.01e-01
Down	2.80e-02	1.01e-01	-8.51e-03

Scalar M0 = 3.168e-01
T = 0.439 k = -0.240

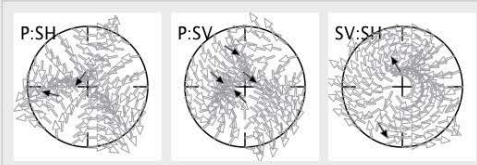
Total Penalty = 0.147



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/10/08/20141008211648.or

2014 Oct 8 21:16:58.200 UTC
Lat: 43.7264 Lon: -121.309 Depth: 1.034
43:43.5858 N 121:18.537 W

Solve

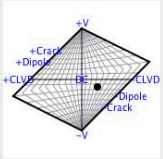
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
2	NM06	0.74	106	162	EHR	SV	0.122	☑ –		☑ -7.54e+02	1.31e+01
3	NM06	0.74	106	162	EHT	SH	0.114	☐ –		☑ -4.81e+02	1.79e+01
4	NM22	0.13	180	177	EHU	P	-0.019	☑ +		☑ 1.22e+02	1.69e+01
5	NN07	3.07	335	119	EHU	P	0.014	☑ –		☑ -3.42e+01	1.59e+01
6	NN09	2.04	292	133	EHU	P	0.029	☑ +		☑ 1.65e+01	8.84e+00
7	NN09	2.04	292	133	EHR	SV	-0.046	☑ +		☑ 1.17e+02	2.49e+01
8	NN09	2.04	292	133	EHT	SH	-0.010	☑ +		☑ 8.24e+01	3.08e+01
9	NN17	1.62	247	141	EHU	P	-0.014	☑ +	0.014	☑ 5.02e+00	2.84e+01
10	NN17	1.62	247	141	EHT	SH	-0.028	☑ –	0.016	☑ -1.49e+02	1.84e+01
11	NN18	1.36	24	147	EHU	P	-0.004	☑ –		☑ -2.23e+01	1.85e+01
12	NN18	1.36	24	147	EHR	SV	-0.012	☐ –		☑ -2.19e+02	1.46e+01
13	NN19	0.92	170	157	EHU	P	0.003	☑ +		☑ 5.43e+01	1.84e+01
14	NN19	0.92	170	157	EHT	SH	0.021	☑ –		☑ -1.42e+02	1.54e+01
15	NN21	1.71	64	140	EHU	P	-0.016	☐ +		☑ 4.98e+00	2.05e+01
16	NN24	0.63	1	164	EHU	P	-0.013	☑ –		☑ -4.79e+00	3.94e+01
17	NN24	0.63	1	164	EHR	SV	-0.066	☑ +		☑ 2.12e+02	2.66e+01
18	NN32	2.92	211	120	EHU	P	-0.009	☑ –		☑ -1.98e+01	1.43e+01
19	NN32	2.92	211	120	EHT	SH	0.034	☑ –		☑ -4.54e+01	2.29e+01

	Sta	Type	Penalty
1	NM06	☑ P:SV	0.078
2	NM06	☐ P:SH	
3	NM06	☐ SV:SH	
4	NN09	☑ P:SV	
5	NN09	☑ P:SH	
6	NN09	☑ SV:SH	
7	NN17	☑ P:SH	0.011
8	NN18	☐ P:SV	
9	NN19	☑ P:SH	
10	NN24	☑ P:SV	
11	NN32	☑ P:SH	

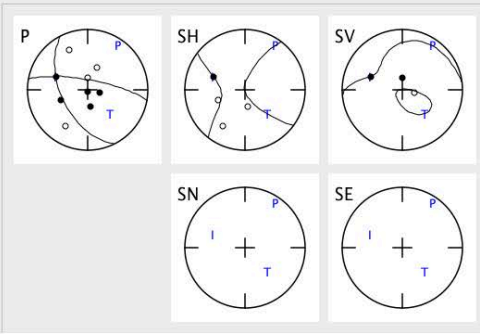
	North	East	Down
North	-1.75e-01	-2.00e-01	1.28e-01
East	-2.00e-01	-6.44e-02	-1.70e-02
Down	1.28e-01	-1.70e-02	6.96e-02

Scalar M0 = 2.769e-01
T = 0.391 k = -0.162

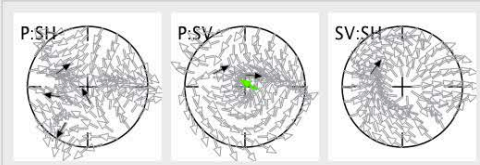
Total Penalty = 0.119



POLARITIES



AMPLITUDE RATIOS



/Users/foulger/SeismicProcessing/Newberry/Data/2014/11/17/20141117044153.05.or

2014 Nov 17 4:41:52.962 UTC
Lat: 43.727 Lon: -121.311 Depth: 0.428
43:43.6176 N 121:18.687 W

Solve

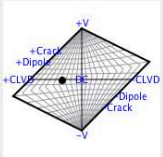
	Sta	Dist	Az	i	Chan	Phase	Resid	Polarity	Penalty	Amp	Freq
1	NM03	2.92	15	106	EHU	P	-0.001	✓ –		✓ -4.93e+02	1.27e+01
2	NM06	0.95	106	149	EHU	P	0.024	✓ +		✓ 4.26e+03	1.16e+01
3	NM08	2.98	167	105	EHZ	P	0.046				
4	NM22	0.28	134	170	EHU	P	-0.021	✓ +		✓ 6.65e+03	1.11e+01
5	NM40	2.74	111	109	EHU	P	0.029	✓ +		✓ 1.70e+02	1.60e+01
6	NM41	2.44	138	113	EHU	P	-0.046	✓ –		✓ -2.11e+02	1.20e+01
7	NM42	3.70	45	99	EHU	P	-0.026	✓ –		✓ -1.09e+03	1.00e+01
8	NN07	2.94	338	103	EHU	P	0.016	✓ –		✓ -1.16e+03	1.37e+01
9	NN09	1.84	292	122	EHU	P	0.007	✓ –		✓ -6.31e+01	1.48e+01
10	NN09	1.84	292	122	EHR	SV	0.009	✓ +		✓ 9.06e+03	1.48e+01
11	NN09	1.84	292	122	EHT	SH	0.034	✓ +		✓ 3.88e+03	2.32e+01
12	NN17	1.47	242	131	EHU	P	-0.003	✓ +		✓ 1.70e+03	1.49e+01
13	NN17	1.47	242	131	EHR	SV	0.067	☐ –		✓ -6.10e+03	1.41e+01
14	NN18	1.40	32	134	EHU	P	0.004	✓ –		✓ -1.56e+03	1.38e+01
15	NN19	1.03	159	145	EHU	P	0.002	✓ +		✓ 2.67e+03	1.41e+01
16	NN21	1.87	68	123	EHU	P	-0.013	✓ –		✓ -4.69e+02	1.24e+01
17	NN24	0.60	20	159	EHU	P	0.000	✓ +		✓ 4.90e+00	4.35e+01
18	NN32	2.88	207	104	EHU	P	-0.041	✓ –		✓ -7.01e+02	1.10e+01
19	NN32	2.88	207	104	EHR	SV	0.055	☐ –		✓ -2.40e+04	6.56e+00

	Sta	Type	Penalty
1	NN09	✓ P:SV	0.005
2	NN09	✓ P:SH	
3	NN09	☐ SV:SH	
4	NN17	☐ P:SV	
5	NN32	☐ P:SV	

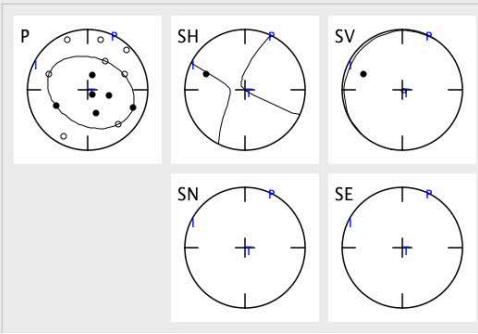
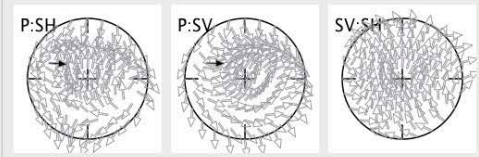
	North	East	Down
North	-2.49e-01	-8.81e-02	3.18e-02
East	-8.81e-02	-1.12e-01	-3.71e-02
Down	3.18e-02	-3.71e-02	3.26e-01

Scalar M0 = 3.167e-01
T = -0.365 k = -0.033

Total Penalty = 0.005



POLARITIES



AMPLITUDE RATIOS