Oklahoma Earthquake Summary Report 2014

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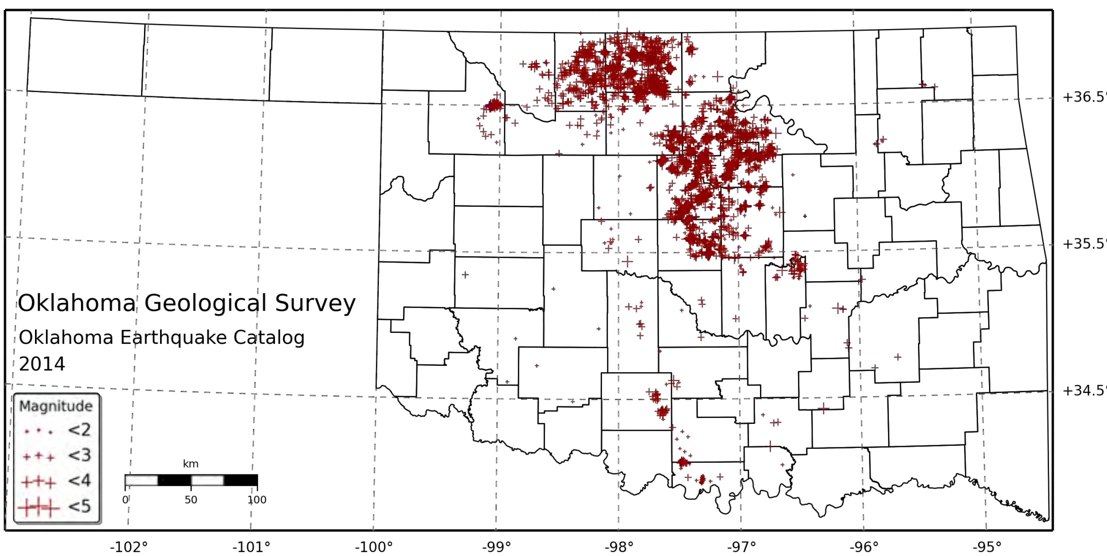

Oklahoma Geological Survey
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OKLAHOMA GEOLOGICAL SURVEY
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Appendix A

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Summary

The Oklahoma Geological Survey (OGS) located 5,417 earthquakes during 2014, throughout 40 counties in Oklahoma (Figure 1); this is the greatest number of earthquakes that have occurred in a single year in Oklahoma's recorded seismic history. Of the earthquakes reported in 2014, 967 were reported as felt to the OGS and/or the U.S. Geological Survey (USGS) (Figure 2), and 585 were of magnitude 3.0 or greater. Seismicity was concentrated in central and north-central Oklahoma with more than 43% of the earthquakes located within Grant and Logan Counties; a large format county map is located in Appendix B, Figure B9, for reference.

The OGS catalog is fairly complete to a minimum magnitude of 2.0 during the time that the OGS has operated a seismic monitoring network, 1977 to current. However, with the increased rate of earthquakes in 2014, analysis to that level of detection was not possible and our efforts focused on completeness for a minimum magnitude of 2.5. The seismicity rate for Oklahoma increased significantly in early 2014 and by the end of 2014 the daily rate of magnitude 3.0 or greater earthquakes was roughly equivalent to that of the annual average from 1980 to 2008. To help expand and prioritize analysis efforts the OGS developed and implemented an automatic processing and earthquake evaluation system and upgraded the existing data archiving, retrieval, and exchange processes.

Additions and upgrades to the OGS seismic monitoring network, during 2014, also dramatically improved earthquake location accuracies and analysis. As part of a two-year multidisciplinary grant, the OGS deployed a temporary seismic network, known as the OKRaH network, in central and north-central Oklahoma.

To meet with the demands of an expanding workload in all areas and to improve communication with the community the OGS added a new Research Seismologist and, later in the year, an Education & Outreach/Data Specialist to the team. The increased rate of seismicity in 2014 added to the potential risk to the public, therefore the OGS asserted that it was necessary and responsible to establish a more proactive stance on earthquake education and outreach efforts.

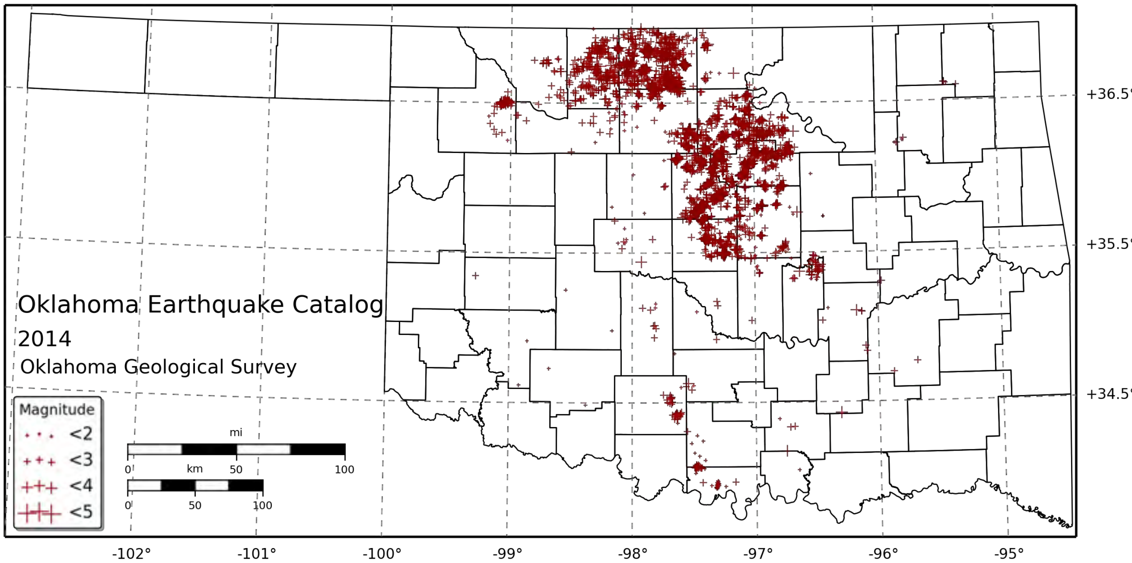

Figure 1. Earthquakes reported by the OGS in 2014.

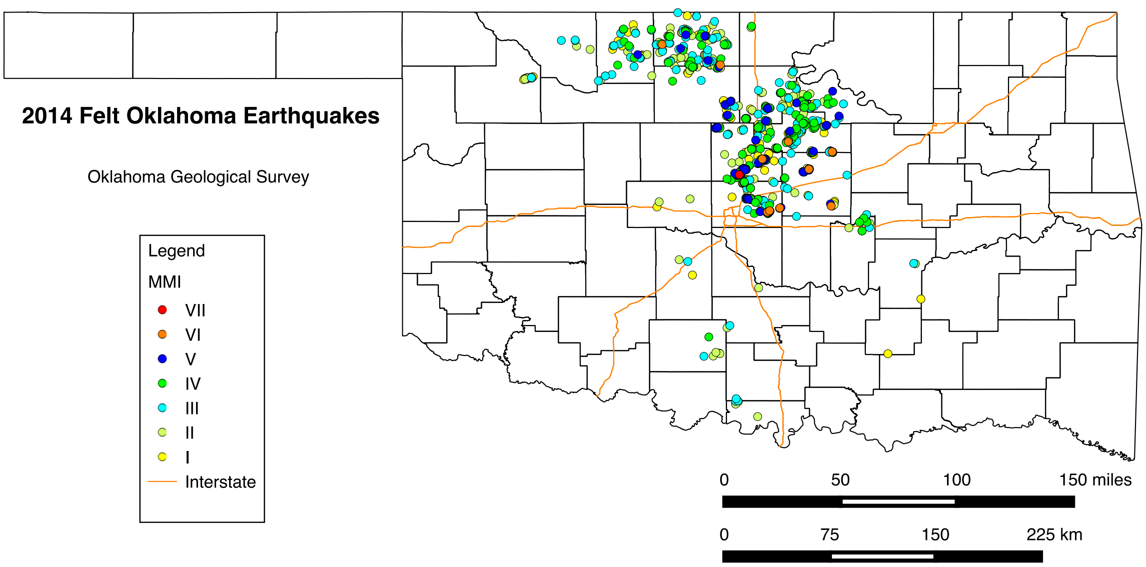

Figure 2. Earthquakes reported as felt by the public to the OGS or the "USGS Did You Feel It?" website, totaled 967 and color-coded by assigned maximum Modified Mercalli Intensity (MMI). Large format image in Appendix B, Figure B5.

First Quarter Oklahoma Earthquake Summary 2014

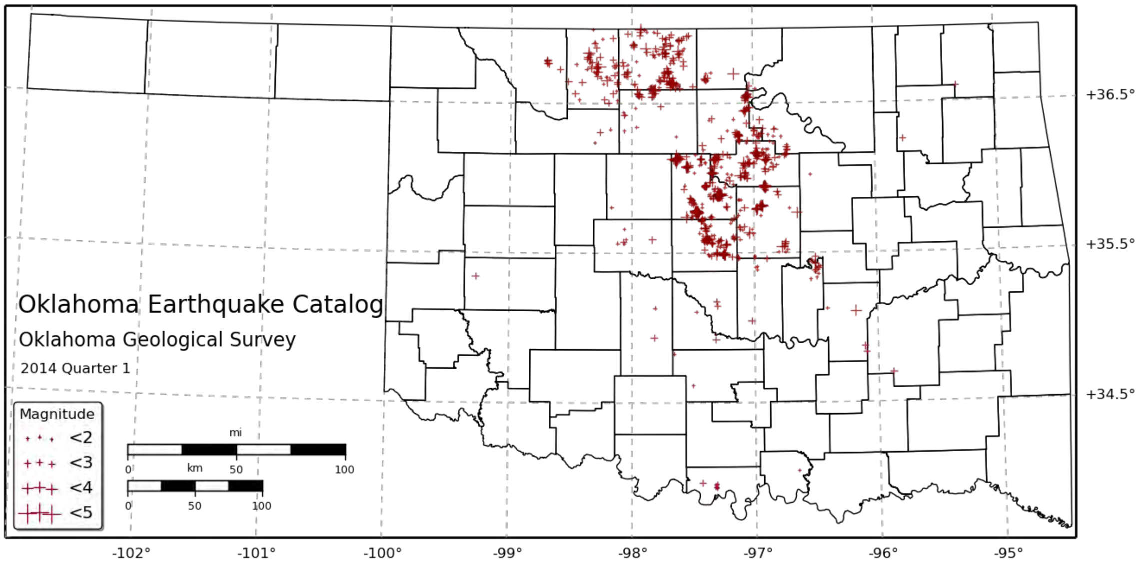

Figure 3. First Quarter Oklahoma earthquakes reported for January 1st through March 31st, 2014, located with four or more seismic stations.

The OGS located 1,249 earthquakes in the first quarter (January 1–March 31) of 2014 (Figure 3), with 248 of them reported as felt to the OGS and/or the USGS. One-third (33%) of this quarter's earthquakes occurred within Logan County. Earthquakes were located within 30 counties (Table 1), with a substantial number of earthquakes located in Logan (413), Oklahoma (190), Payne (171), and Grant (140). There were 94 earthquakes of magnitude 3.0 and greater during this quarter with the two largest both estimated at a moment magnitude 4.1. The first 4.1 occurred on February 6th outside of Cherokee in Alfalfa County, while the second occurred on March 30th south of Marshall in Logan County. All earthquakes reported in Oklahoma for the first quarter of 2014 can be seen in Figure 3 and events by county are listed in Table 1. Seismic activity continues to be concentrated in central and north-central Oklahoma.

Table 1. Number of earthquakes reported, listed by county for the first quarter of 2014.

#Eqs	County	Year	Quarter
58	ALFALFA	2014	QT1
6	CANADIAN	2014	QT1
2	CLEVELAND	2014	QT1
1	CRAIG	2014	QT1
1	CREEK	2014	QT1
26	GARFIELD	2014	QT1
2	GARVIN	2014	QT1
2	GRADY	2014	QT1
140	GRANT	2014	QT1
4	HUGHES	2014	QT1
9	KAY	2014	QT1
1	KINGFISHER	2014	QT1
75	LINCOLN	2014	QT1
413	LOGAN	2014	QT1
10	LOVE	2014	QT1
3	MAJOR	2014	QT1
1	MARSHALL	2014	QT1
2	MCCLAIN	2014	QT1
83	NOBLE	2014	QT1
4	OKFUSKEE	2014	QT1
190	OKLAHOMA	2014	QT1
2	OSAGE	2014	QT1
16	PAWNEE	2014	QT1
171	PAYNE	2014	QT1
1	PITTSBURG	2014	QT1
5	POTTAWATOMIE	2014	QT1
1	ROGERS	2014	QT1
12	SEMINOLE	2014	QT1
1	WASHITA	2014	QT1
7	WOODS	2014	QT1
#Eqs	Description	Year	Quarter
248	Felt	2014	QT1
1249	Cataloged	2014	QT1

Second Quarter Oklahoma Earthquake Summary 2014

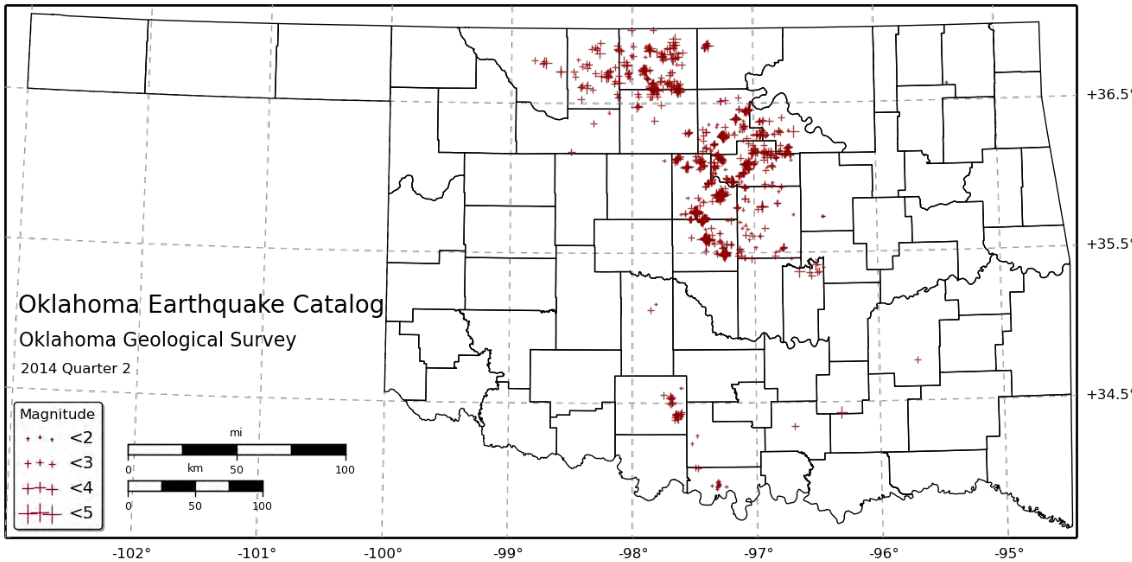

Figure 4. Second Quarter Oklahoma earthquakes reported for April 1st through June 30th, 2014, located with four or more seismic stations.

The OGS located 1,282 earthquakes in the second quarter (April1–June 30) of 2014 (Figure 4), with 255 of them reported as felt to the OGS and/or the USGS. One-fourth (25%) of this quarter's events occurred within Logan County. Earthquakes were located within 24 counties (Table 2), with a substantial number of earthquakes located in Logan (323), Oklahoma (190), Payne (184), Grant (154) and Noble (153). There were 144 earthquakes of magnitude 3.0 and greater during this quarter with the two largest estimated at a moment magnitude 4.1 and 4.0, which occurred on April 7th south of Langston in Logan County and on June 16th south of Arcadia Lake in Oklahoma County, respectively. All earthquakes reported in Oklahoma for the second quarter of 2014 can be seen in Figure 4 and events by county are listed in Table 2. Seismic activity continues to be concentrated in central and north-central Oklahoma.

Table 2. Number of earthquakes reported, listed by county for the second quarter of 2014.

#Eqs	Description	Year	Quarter
46	ALFALFA	2014	QT2
3	CARTER	2014	QT2
1	COAL	2014	QT2
1	CRAIG	2014	QT2
2	CREEK	2014	QT2
41	GARFIELD	2014	QT2
2	GRADY	2014	QT2
154	GRANT	2014	QT2
1	JOHNSTON	2014	QT2
12	KAY	2014	QT2
1	KINGFISHER	2014	QT2
54	LINCOLN	2014	QT2
323	LOGAN	2014	QT2
16	LOVE	2014	QT2
3	MAJOR	2014	QT2
153	NOBLE	2014	QT2
190	OKLAHOMA	2014	QT2
42	PAWNEE	2014	QT2
184	PAYNE	2014	QT2
1	PITTSBURG	2014	QT2
3	POTTAWATOMIE	2014	QT2
8	SEMINOLE	2014	QT2
34	STEPHENS	2014	QT2
7	WOODS	2014	QT2
#Eqs	County	Year	Quarter
255	Felt	2014	QT2
1282	Cataloged	2014	QT2

Third Quarter Oklahoma Earthquake Summary 2014

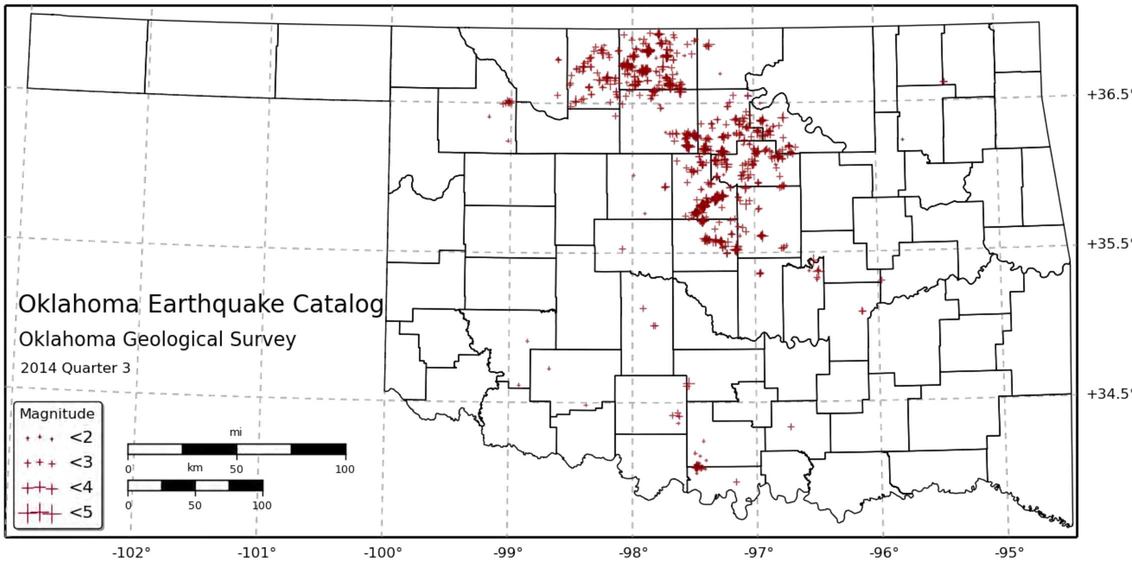

Figure 5. Third Quarter Oklahoma earthquakes reported for July 1st through September 30th, 2014, located with four or more seismic stations.

The OGS located 1,193 earthquakes in the third quarter (July 1–September 30) of 2014 (Figure 5), with 299 of them reported as felt to the OGS and/or the USGS. One-fourth (25%) of this quarter's events occurred within Logan County and 22% within Grant County. Earthquakes were located within 31 counties (Table 3), with a substantial number of earthquakes located in Logan (292), Grant (259), Noble (122) and Payne (100). There were 147 earthquakes of magnitude 3.0 and greater during this quarter with the two largest both estimated at a moment magnitude 4.1. The first 4.1 occurred on July 29th east of Medford in Grant County, and a second occurred on August 19th south of Liberty Lake in Logan County. All earthquakes reported in Oklahoma for the third quarter of 2014 can be seen in Figure 5 and events by county are listed in Table 3. Seismic activity continues to be concentrated in central and north-central Oklahoma.

Table 3. Number of earthquakes reported, listed by county for the third quarter of 2014.

#Eqs	County	Year	Quarter
67	ALFALFA	2014	QT3
1	CANADIAN	2014	QT3
21	CARTER	2014	QT3
2	COMANCHE	2014	QT3
2	CRAIG	2014	QT3
92	GARFIELD	2014	QT3
1	GARVIN	2014	QT3
3	GRADY	2014	QT3
259	GRANT	2014	QT3
2	HUGHES	2014	QT3
1	JOHNSTON	2014	QT3
6	KAY	2014	QT3
5	KINGFISHER	2014	QT3
2	KIOWA	2014	QT3
31	LINCOLN	2014	QT3
292	LOGAN	2014	QT3
15	LOVE	2014	QT3
1	MAJOR	2014	QT3
1	MCINTOSH	2014	QT3
122	NOBLE	2014	QT3
1	OKFUSKEE	2014	QT3
92	OKLAHOMA	2014	QT3
1	OSAGE	2014	QT3
41	PAWNEE	2014	QT3
100	PAYNE	2014	QT3
4	POTTAWATOMIE	2014	QT3
1	ROGERS	2014	QT3
6	SEMINOLE	2014	QT3
6	STEPHENS	2014	QT3
4	WOODS	2014	QT3
11	WOODWARD	2014	QT3
#Eqs	Description	Year	Quarter
299	Felt	2014	QT3
1193	Cataloged	2014	QT3

Fourth Quarter Oklahoma Earthquake Summary 2014

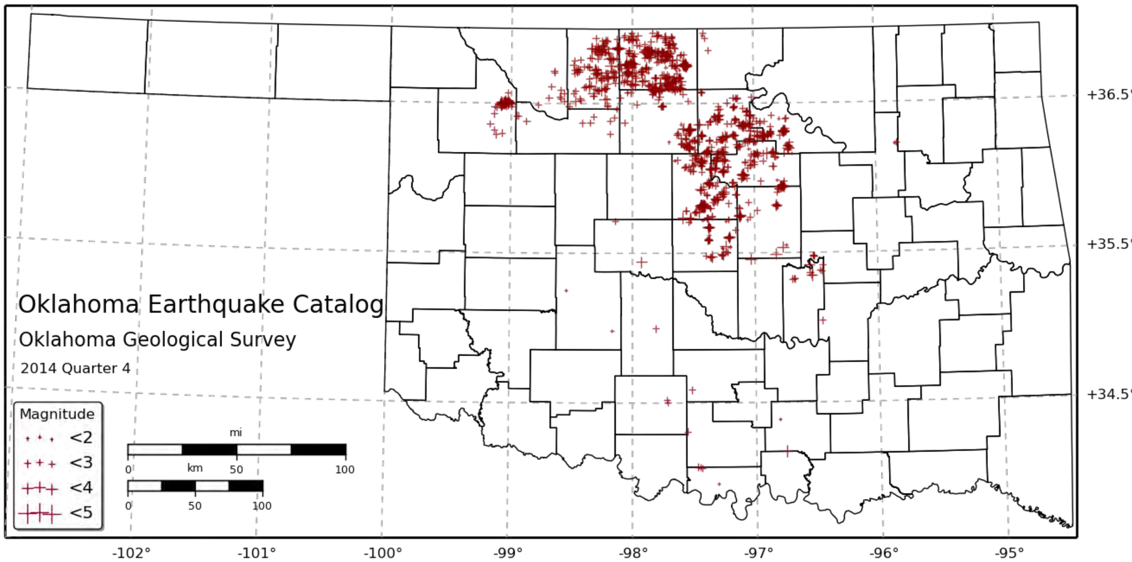

Figure 6. Fourth Quarter Oklahoma earthquakes reported for October 1st through December 31st, 2014, located with four or more seismic stations.

The OGS located 1,693 earthquakes in the third quarter (October 1–December 31) of 2014 (Figure 6), with 205 of them reported as felt to the OGS and/or the USGS. About one-third (31%) of this quarter's events occurred within Grant County. Earthquakes were located within 26 counties (Table 4), with a substantial number of earthquakes also located in Grant (526), Logan (230), Noble (187), Alfalfa (168), Payne (139) and Garfield (132). There were 200 earthquakes of magnitude 3.0 and greater during this quarter with the four largest estimated at a moment magnitude of 3.9 in Payne, Pawnee, Grant and Alfalfa Counties. All earthquakes reported in Oklahoma for the fourth quarter of 2014 can be seen in Figure 6 and events by county are listed in Table 4. Seismic activity continues to be concentrated in central and north-central Oklahoma.

Table 4. Number of earthquakes reported, listed by county for the fourth quarter of 2014.

#Eqs	County	Year	Quarter
168	ALFALFA	2014	QT4
2	CADDO	2014	QT4
2	CANADIAN	2014	QT4
2	CARTER	2014	QT4
132	GARFIELD	2014	QT4
1	GARVIN	2014	QT4
1	GRADY	2014	QT4
526	GRANT	2014	QT4
1	HUGHES	2014	QT4
2	JOHNSTON	2014	QT4
4	KAY	2014	QT4
48	LINCOLN	2014	QT4
230	LOGAN	2014	QT4
3	LOVE	2014	QT4
9	MAJOR	2014	QT4
187	NOBLE	2014	QT4
5	OKFUSKEE	2014	QT4
63	OKLAHOMA	2014	QT4
73	PAWNEE	2014	QT4
139	PAYNE	2014	QT4
1	POTTAWATOMIE	2014	QT4
10	SEMINOLE	2014	QT4
2	STEPHENS	2014	QT4
2	TULSA	2014	QT4
10	WOODS	2014	QT4
70	WOODWARD	2014	QT4
#Eqs	Description	Year	Quarter
205	Felt	2014	QT4
1693	Cataloged	2014	QT4

Oklahoma Earthquake Summary 2014

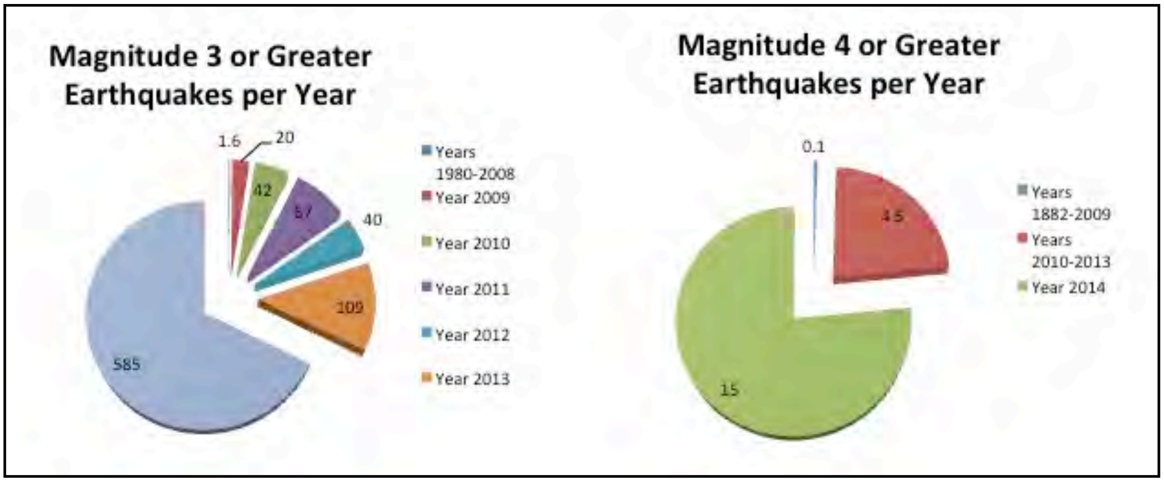

Figure 7. Chart showing magnitude 3.0 and greater (left) and magnitude 4.0 and greater (right) earthquakes in Oklahoma for 2014 compared to previous years.

In 2014, the Oklahoma Geologic Survey located 5,415 earthquakes while many more small earthquakes were left un-located because of the sheer number of earthquakes and limited resources. With the rate of seismicity in Oklahoma in 2014 we were, at a minimum, working hard to locate all events above a magnitude 2.5. The magnitude of completeness represents the minimum magnitude above which all events are reported for the region monitored. There are often earthquakes reported below a magnitude 2.5, but statistics should not be conducted for earthquakes below the magnitude of completeness, because not all such earthquakes are located. The magnitude of completeness for all of Oklahoma in 2014 is about 2.4 without further analysis and the Gutenberg-Richter relationship for the year normalized to a daily rate of earthquakes provides a relationship of a=3.215 ±0.241 b=1.217 ±0.022 (Figure 8) (Aki, 1965; Gutenberg and Richter, 1944). Among the 5,415 earthquakes located in 2014 (Figure 1), 585 were of a magnitude 3.0 or greater (Figure 7 and Figure 11) and 8 were of a magnitude 4.0 or greater (Figure 7 and Figure 12). Because 967 events were reported as felt they were assigned a maximum Modified Mercalli Intensity (MMI) value, by both the OGS and the USGS (Figure 9). The average depth of the 2014 earthquakes, where the depth were reliable and not fixed by an analyst due to uncertainty, was 5.43 km (3.37 miles) as shown in a histogram of hypocentral depths (Figure 10). Figures 13 and 14 show seismicity for 2014 plotted with historical seismicity from 1882 to 2013.

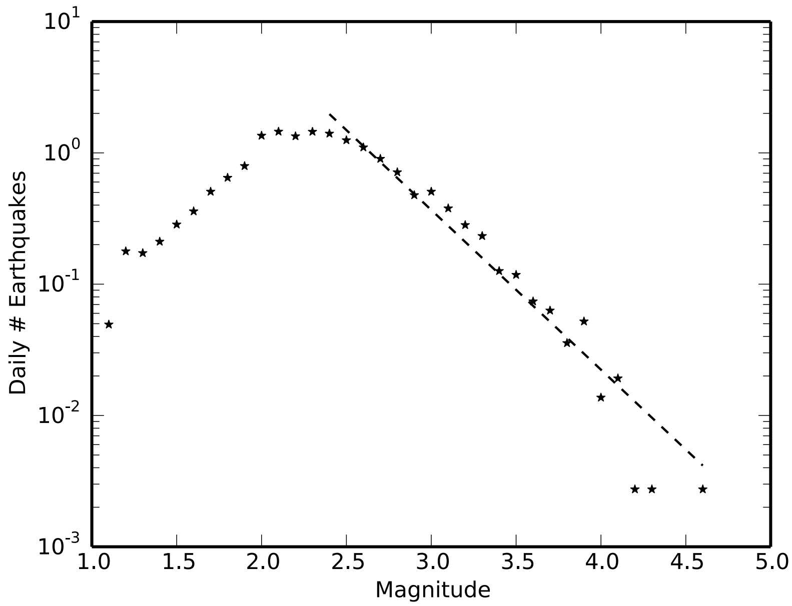

Figure 8. Plot showing number of earthquakes scaled to a daily rate of earthquakes by magnitude. The b-value for 2014 in Oklahoma is 1.217±0.022, determined using the maximum likelihood estimator of Aki (1965). The magnitude of completeness of 2.4 is inferred from the fall-off of the linear trend.

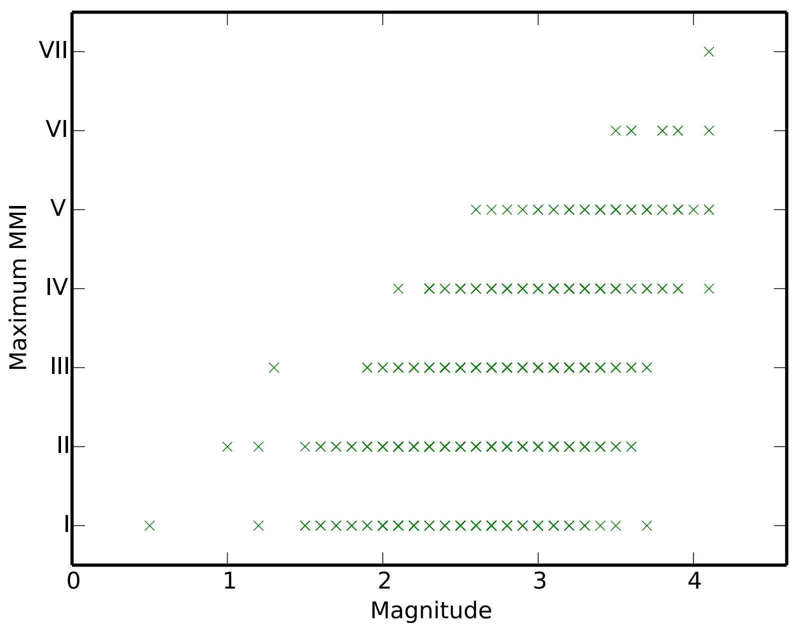

Figure 9. Plot of 967 earthquakes reported as felt by the public to the OGS or the "USGS Did You Feel It?" website, with assigned maximum Modified Mercalli Intensity (MMI) plotted against magnitude. Darker green x's indicate multiple events at that magnitude and maximum MMI.

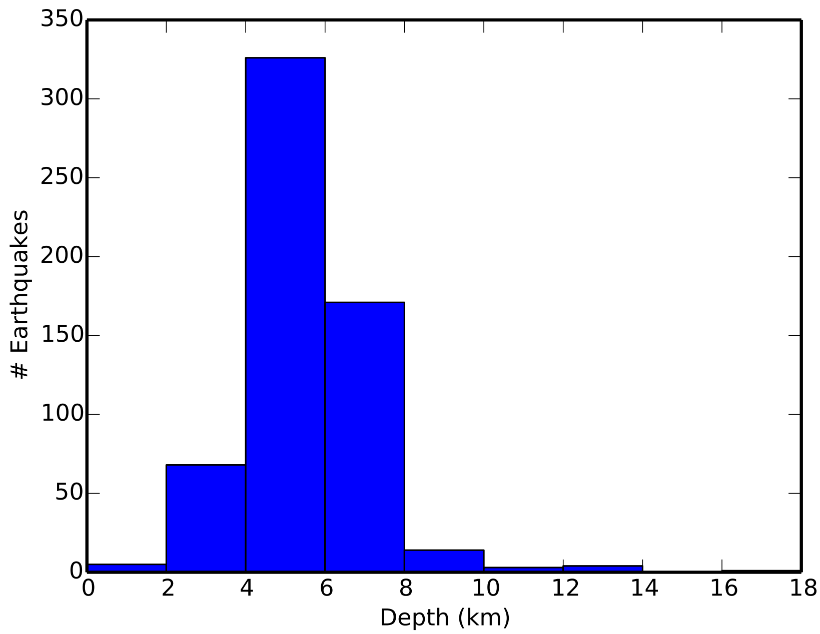

Figure 10. Histogram of hypocentral depths of 2014 earthquakes excluding events with fixed depths.

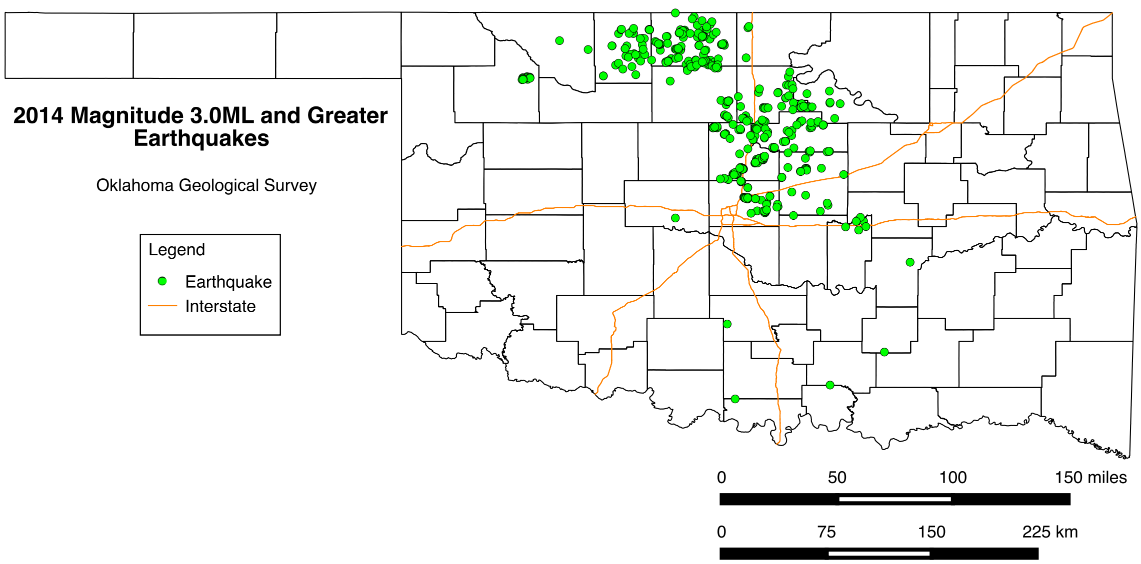

Figure 11. Map showing all cataloged earthquakes equal to and above a magnitude 3.0 (green dots) for 2014.

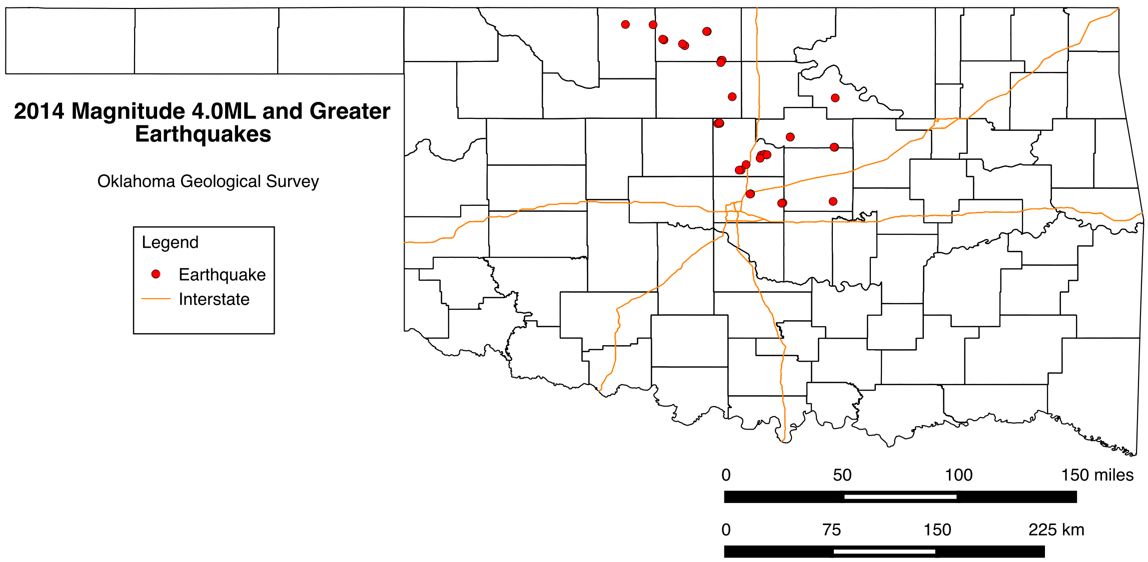

Figure 12. Map showing all cataloged earthquakes equal to and above a magnitude 4.0 (red dots) for 2014.

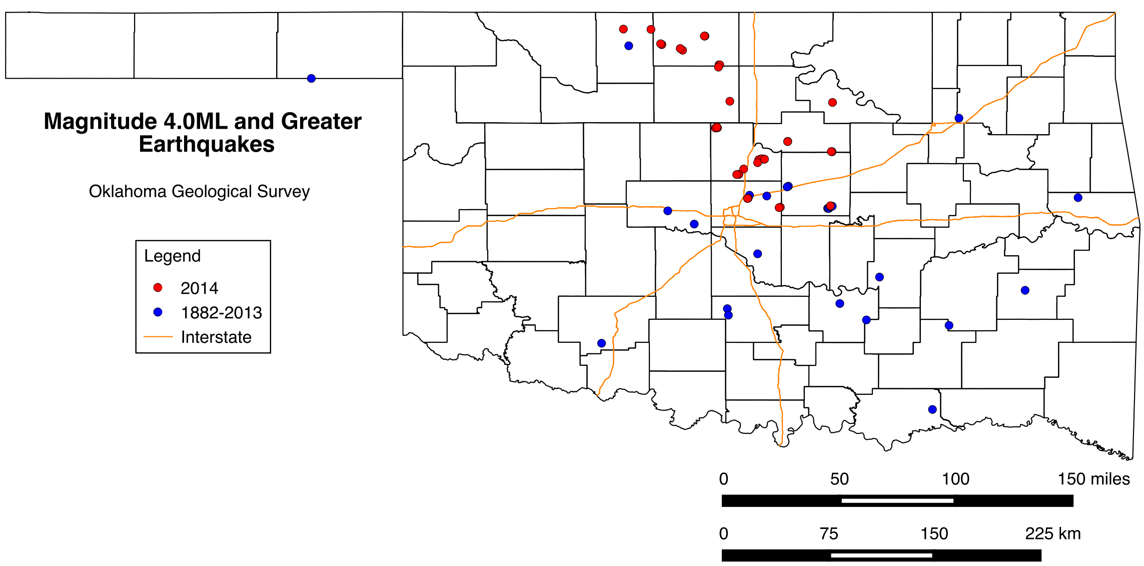

Figure 13. Map showing all cataloged earthquakes equal to and above a magnitude 4.0 in Oklahoma, highlighting 2014 (red dots) and historical to 1882 (blue dots). Large format image in Appendix B, Figure B5.

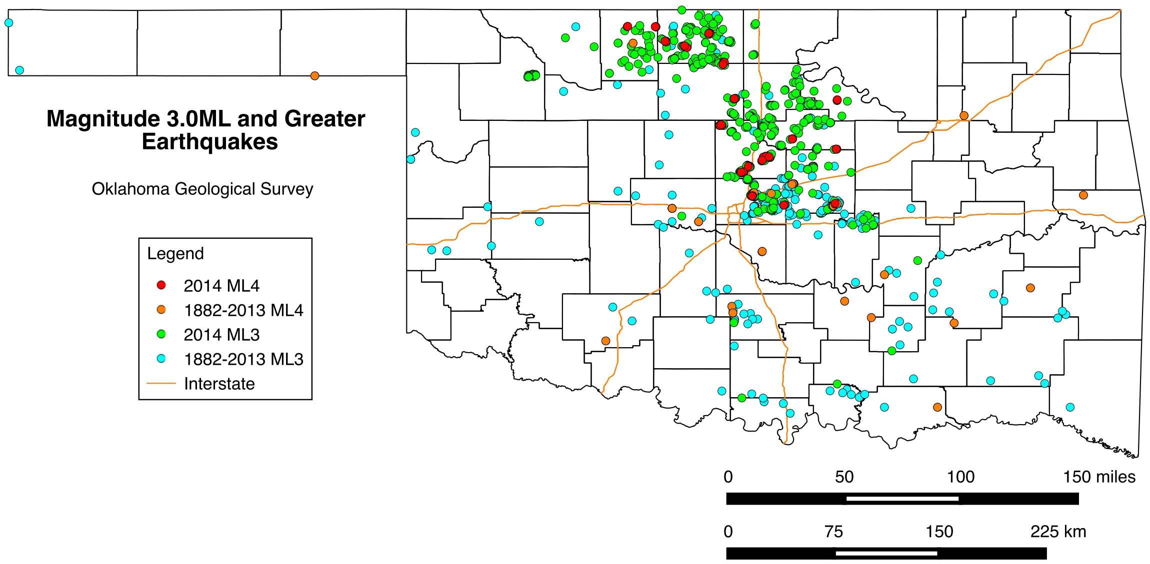

Figure 14. Map showing all cataloged earthquakes equal to and above a magnitude 3.0 in Oklahoma. Earthquakes in 2014 are highlighted for magnitudes equal to and greater than 3.0 (green dots) and equal to and greater than 4.0 (red dots), while all other earthquakes represented occurred from 1882 to 2013.

Oklahoma Earthquake Rates

Daily seismicity rates can be examined in a number of different ways. We calculate the raw rate of seismicity by selecting events of some minimum magnitude out of the OGS catalog, and then calculate the number of such earthquakes occurring during a specific timeframe. We also use the time between consecutive earthquakes to estimate the Poissonian rate of earthquakes at and above our minimum magnitude. This method is based on the maximum likelihood estimator (MLE) of the Poissonian rate following the method of Hainzl et al. (2006). We then apply a moving window of some specified time so that at each point in time we are using the previous *N* number of days to calculate the seismicity rate. We apply this to two different magnitude cutoff values, but both the seismicity rates can be seen to significantly increase in early 2014 (Figures 15 and 16). At the end of 2014 the daily rate of magnitude 3.0 or greater earthquakes is roughly that for the annual average from 1980 to 2008. The quasi-periodic nature of seismicity rates for magnitude 2.5 and greater earthquakes (Figure 16) were not evaluated to determine whether this behavior is an artifact of the earthquake catalog or if it represents a true periodic signal.

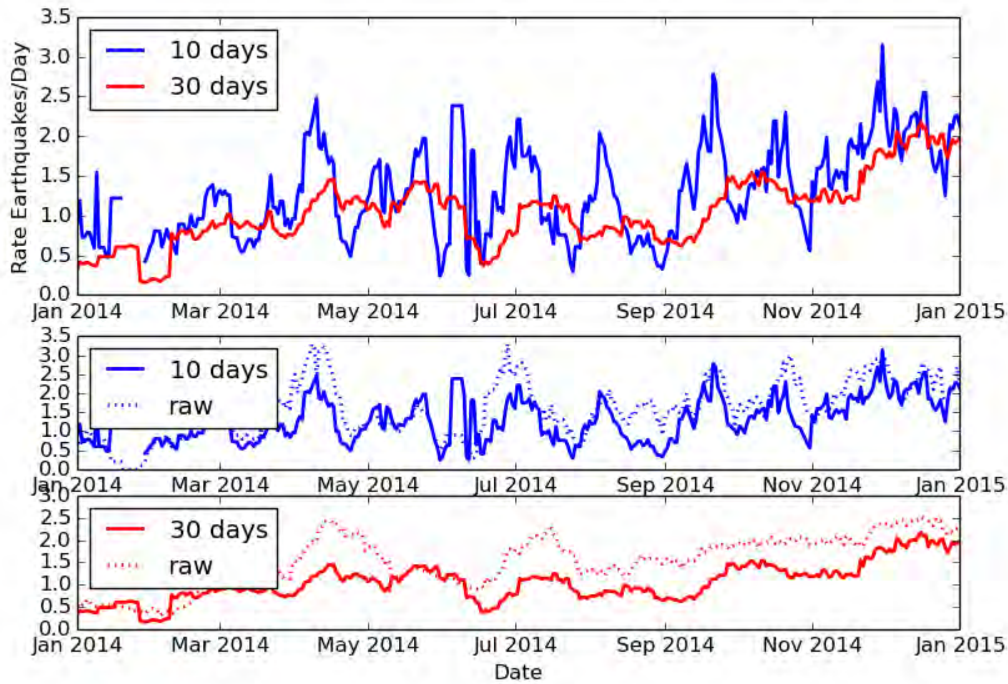

Figure 15. Daily seismicity rates for magnitude 3.0 or greater earthquakes calculated using a moving window of the specified number of days. Solid lines show the MLE of the Poissonian rate. The raw rate (dashed lines) is simply the number of earthquakes divided by the time interval in days. Each point is calculated using the previous time period and indicated by the number of days.

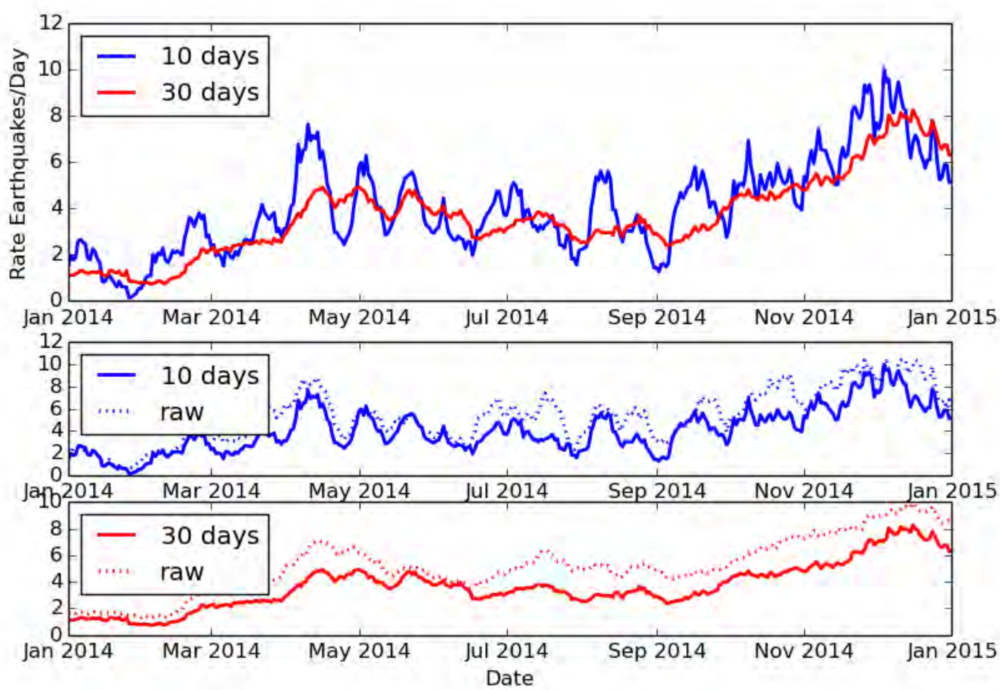

Figure 16. Daily seismicity rates for magnitude 2.5 or greater earthquakes calculated using a moving window of the specified number of days. Solid lines show the MLE of the Poissonian rate. The raw rate (dashed lines) is simply the number of earthquakes divided by the time interval in days. Each point is calculated using the previous time period indicated by the number of days.

Additional analyses documented in a separate report, but summarized here, documents a case where earthquakes were likely triggered by hydraulic fracturing in south-central Oklahoma (Darold et al., 2014), which creates an apparent earthquake rate increase in 2014. In the Darold et al. (2014) case, there was a strong temporal correlation between injection parameters and the occurrence of earthquakes that was clearly distinct from the background rate of seismicity. While south-central Oklahoma has a low level of background seismicity, about 10 located events per year, there were 43 earthquakes located in the area during 2014. Of the 2014 events, 29 coincide, in time and space, with the four-stage, 2-day hydraulic fracturing of the well while an additional 31 events were indicated through cross-correlation. The largest event located in this sequence was a magnitude 3.2; however, the majority of events that were manually located were under a magnitude 2.5. By plotting the pressures measured at the wellhead and the discharge rates through time, Darold et al. (2014) were able to see a strong correlation with the seismicity and hydraulic fracturing of this well (Figure 17). The strong temporal correlation between injection parameters and the occurrence of earthquakes, distinct from the background rate of seismicity, along with the relatively close spatial proximity to the well suggest a causal link.

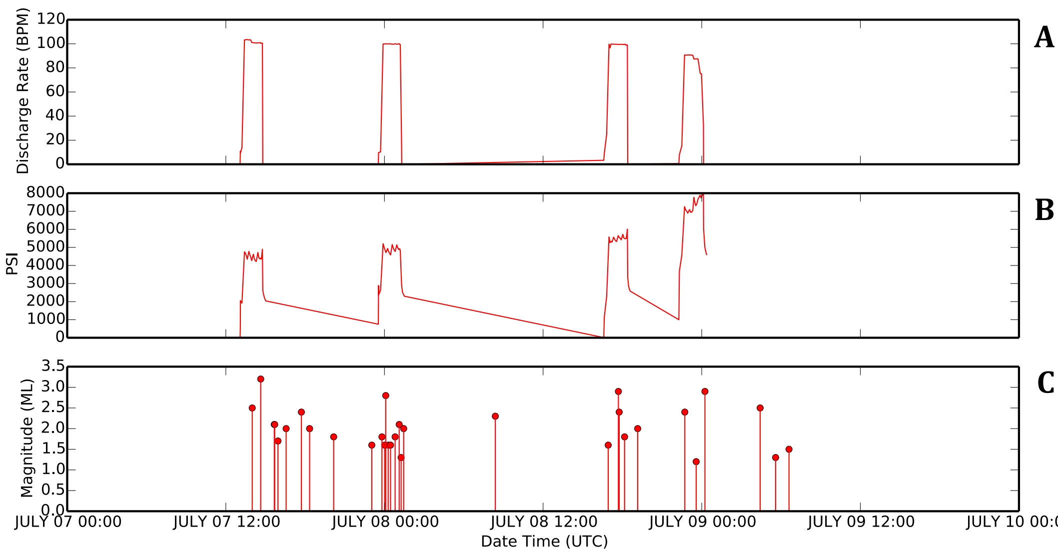

Figure 17. Plots span, in UTC time, the four-fracturing stages of the well in south-central Oklahoma between July 7th and July 9th 2014. Plot A shows the discharge rate in barrels per minute (BPM) through time, plot B shows the pressure in pounds per square inch (PSI) through time and plot C shows magnitude of earthquakes occurring within 7.0 km (4.35 miles) of the well through time.

Earthquake Processing and Analysis

The OGS has used the SEISAN (Havskov and Ottemoller, 1999) earthquake analysis package since 2010. The regional velocity model used to determine the location of earthquakes in Oklahoma is shown in Table 5. We currently use a Vp/Vs ratio of 1.73 for the regional velocity model. The regional model does a reasonably good job through most of the state of Oklahoma as illustrated by the travel-time curves for earthquakes in 2014 and the reported travel-time residuals (Figure 18). SEISAN also has the capability to calculate moment magnitude (MW) from the shape of the displacement spectra (Abercrombie, 1995; Brune, 1970). The OGS began routinely doing MW analysis in 2014 for earthquakes of an initial local magnitude (ML) of 3.8 or greater. There are many smaller earthquakes for which an MW has also been calculated. In general, MW's calculated by the OGS compare quite well to those determined by the USGS NEIC which generally are only determined for earthquakes of magnitude 4.0 or greater. The MW magnitudes tend to be smaller than the ML magnitudes calculated by the OGS. Both of these calculations are tracked in the earthquake reporting in the OGS catalog, which is available for 2014 in a variety of formats at http://www.okgeosurvey1.gov/pages/earthquakes/catalogs.php or directly at http://wichita.ogs.ou.edu/eq/catalog/2014/. The OGS earthquake catalog is preliminary and subject to change as further analysis occurs. The information in the catalog may change, and is always the most up-to-date at the above links. A static copy of the catalog at the time of preparation of this report is available at http://wichita.ogs.ou.edu/documents/2014/. For an earthquake to be reported in the OGS catalog, there must be identified phase arrivals from, at least, four seismic stations included in the location solution and must have occurred within Oklahoma. In addition, the OGS routinely relocates earthquakes using HYPODD (Waldhauser and Ellsworth, 2000). These relocations are in the static copy of the catalog, mentioned above, and shown in Figure B4 in Appendix B. A discussion of parameters used for the relocations and the reasons for these choices is beyond the scope of this paper, but we will provide this information to those that may be interested.

Table 5. Regional 1-D velocity model used in Oklahoma to determine the location of earthquakes

P-Velocity (km/s)	Depth (km)
2.700	0.0
2.950	0.3
4.150	1.0
5.800	1.5
6.270	8.0
6.410	21.0
7.90	42.0
8.15	50.0
8.5	80.0

a

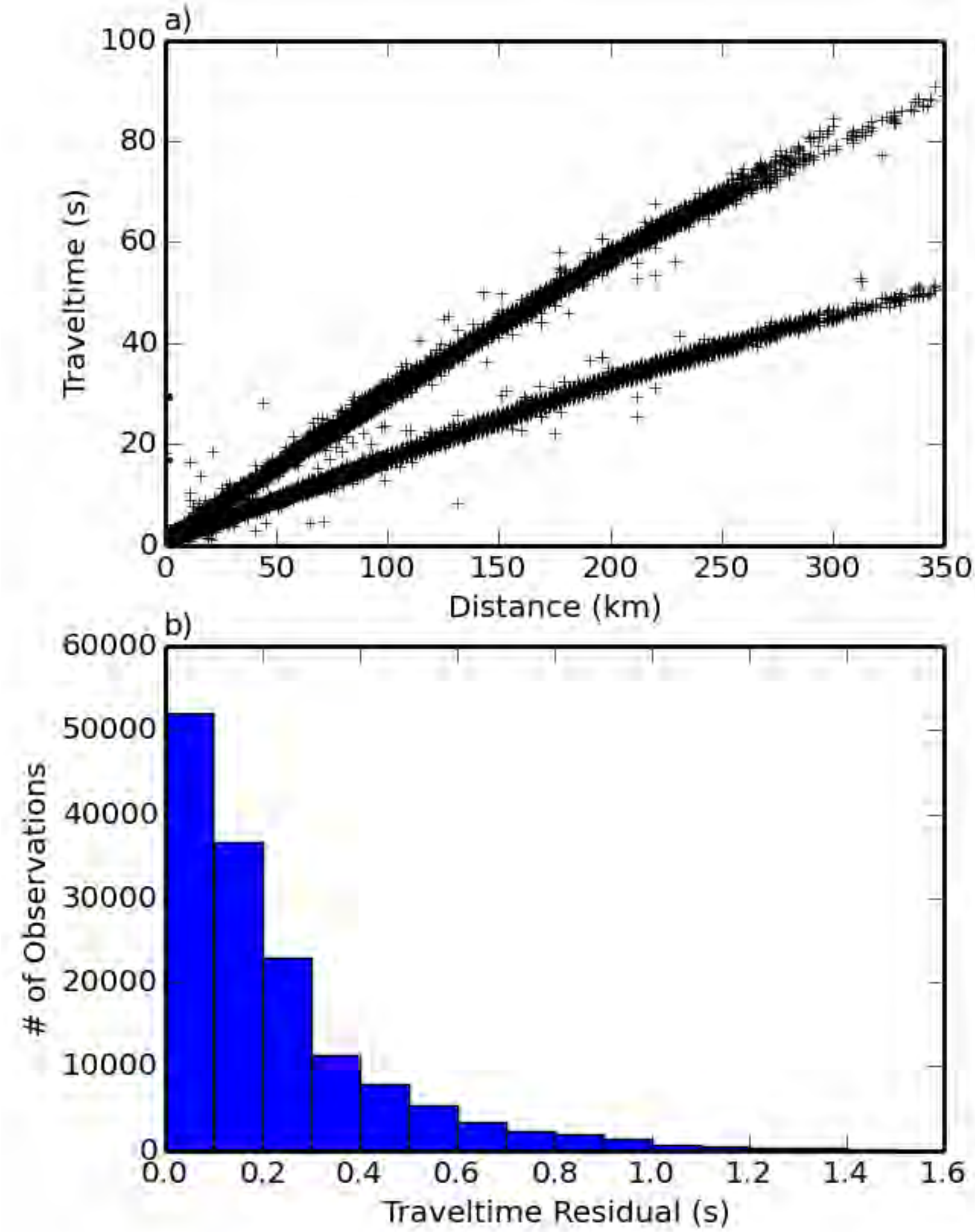

Figure 18. a) Phase travel-times shown by distance in kilometers; b) histogram of absolute value of travel-time residuals reported from SEISAN locations.

SEISAN also allows the calculation of first focal mechanisms using a variety of techniques including FPFIT (Reasenberg and Oppenheimer, 1985), HASH (Hardebeck and Shearer, 2002), and FOCMEC (Snoke et al., 1984). All of these techniques were used to determine focal mechanisms for earthquakes in Oklahoma during 2014. During 2014, 324 focal mechanisms were determined mostly for earthquakes of magnitude 3.0 and greater. Because of the substantial number of focal mechanisms, Appendix A provides a table of focal mechanisms and Figure B1 in Appendix B illustrates the preliminary focal mechanisms in map view.

The OGS also implemented, with the support of the USGS, a continuous waveform buffer (CWB) that allows for the real-time exchange of data from our data server using SEEDLINK, which is now being used to send data to the Incorporated Research Institutions for Seismology's (IRIS) data management center (DMC). The OGS CWB allows for the continuous archiving of data and data retrieval for earthquake studies and analysis.

In addition, the OGS began operating a quasi-real-time automatic processing system called SeiProc. The SeiProc system regularly performs coincidence triggering on different subnets in Oklahoma. Once events are identified, the waveforms are processed by an automatic picker and associator algorithm (Chen and Holland, 2014). After an event has been automatically located using the SEISAN earthquake location algorithm, a ML is automatically determined for each earthquake. The SeiProc database contains about 12,800 located earthquakes for 2014, with some duplicate earthquakes. This indicates that there are many smaller earthquakes that have not yet been processed (i.e., less than 2.4ML). SeiProc allows analysts to prioritize their efforts by being able to identify and begin analysis on earthquakes with an automatically determined magnitude of 2.5 or greater. Furthermore, it reduces the effort required by analysts for manually locating very small earthquakes. Routinely, locations and magnitudes can change substantially upon re-evaluation by a trained analyst compared to the automatic system. Because the potential for problematic events from the automatic processing system, automatic earthquake solutions are not reported. Thus, in order to prevent confusion, these data are only used to guide and prioritize the analysis of earthquakes.

Earthquake Magnitudes

The state has seen an increased number of magnitude 4.0 or greater earthquakes in 2014 compared to years prior. However, after further analysis many have magnitudes below 4.0, this is often the case at both the USGS and the OGS. There are many different ways to calculate magnitude and the most reliable methods are usually done after the initial reporting of an earthquake and further analysis occurs. The more reliable methods for magnitude determination mostly affect the larger earthquakes and tend to reduce their magnitude slightly. The majority of Oklahoma earthquakes are located and reported with an initial ML and updated to a MW if further analysis is deemed necessary (i.e. the earthquake is estimated at a 3.8ML or greater). The method used by the OGS to calculate ML and the ML attenuation relationship used are documented in Darold et al. (2014). Local magnitudes often disagree slightly with other magnitude relationships as can be seen in Miao and Langston (2007), but are commonly used by regional networks. Magnitude measurements are estimates based off of recorded ground motions and have uncertainty that can be characterized (CEUS-SSC, 2012). The OGS uses the spectral shape in displacement of the P or S phase to determine the MW for earthquakes using functionality within SEISAN(Abercrombie, 1995; Brune, 1970; Caprio et al., 2011; Ottemoller and Havskov, 2003). The MW more accurately represents the area of the fault that ruptured and the total energy released (Hanks and Kanamori, 1979; Kanamori and Anderson, 1975), while the initial ML uses measured amplitudes and may more accurately represent the ground shaking of an earthquake experienced by those that feel it. The OGS initially reported 34 earthquakes at or above a magnitude 4.0 in 2014. However, after completing MW analysis and using the USGS MW calculations as the preferred magnitude the number of reported earthquakes at or above a magnitude 4.0 was reduced to 15. The comparison between OGS determined ML and MW with USGS National Earthquake Information Center (NEIC), determinations of Lg body-wave magnitude (mbLg) and MW for earthquakes with an ML of 4.0 or greater are shown in Table 6. From this table it can be seen that both mbLg and ML tend to overestimate magnitude compared to MW. The USGS and OGS MW calculations, while calculated using different methods, generally compare quite well with a few exceptions.

Table 6. OGS and USGS magnitude determinations for Oklahoma earthquakes occurring in 2014 with ML of 4.0 or greater. The highlighted event in the table shows the agreement between OGS and USGS MW for a larger event located in southern Kansas.

	OGS		USGS	
Origintime (UTC)	**ML**	**MW**	**mbLg**	**MW**
2/9/14 2:16	4.1	3.8	4.4	4.1
3/30/14 6:51	4.5	4.1	4.3	4.2
3/30/14 8:42	4.1	3.9	4.3	3.9
3/30/14 14:09	4.3	3.9	4.4	4.1
4/5/14 12:42	4.1	3.9	4.2	3.8
4/6/14 14:58	4.1	3.7	4	3.8
4/7/14 16:03	4.3	4.1		4.2
4/10/14 7:33	4.1	3.9	4.1	4
5/9/14 18:52	4	3.6		3.9
6/16/14 10:47	4.6	4		4.3
6/18/14 10:53	4.1	3.8	4.3	4.1
6/20/14 23:10	4	3.9	4.3	3.9
6/27/14 15:09	4.1	3.7	3.9	3.6
7/12/14 17:11	4.3	3.9	4.3	4
7/14/14 7:15	4.1	3.9	3.9	3.9
7/15/14 7:19	4.1	3.8	3.8	3.5
7/15/14 9:08	4	3.9	3.9	3.9
7/29/14 2:46	4.4	4.1	4	4.3
8/19/14 12:41	4.3	4.1	4.2	4.4
9/8/14 16:21	4.2	3.9	4.2	3.9
9/15/14 20:08	4.1	3.7	4.2	3.9
9/19/14 1:31	4	3.9	4	3.8
10/7/14 16:51	4	3.8	4.3	4
10/10/14 13:51	4.5	3.9	4.3	4.2
11/9/14 20:10	4.1	3.8	4.1	3.8
11/12/14 21:40	5.3	4.8		4.8
11/24/14 6:36	4	3.8	4	3.8
11/24/14 19:05	4.2	3.9	3.6	3.7
11/25/14 14:43	4	3.8	4	3.6
11/30/14 6:59	4.1	3.6	3.8	
11/30/14 10:24	4.3	3.9	4.2	4
12/5/14 3:54	4	3.7		3.7
12/11/14 7:53	4	3.7	4.1	3.8
12/14/14 9:14	4.2	3.8	4.3	3.9
12/14/14 21:18	4.2	3.9	4.1	4

Oklahoma Seismic Stations Operating in 2014

In the first few months of 2014, the OGS added four temporary stations, and one permanent station in response to several earthquake swarms within central and north-central Oklahoma. Instrumentation for three of these temporary stations are generously on loan from the USGS. We received instrumentation for the OKRaH network in August 2014 and installed 12 temporary stations in central and north-central Oklahoma. This instrumentation was borrowed from the IRIS PASSCAL, Portable Array Seismic Studies of the Continental Lithosphere, instrument center. Figure 19 shows all stations operating in 2014 and Table 7 lists times operated and locations of those stations.

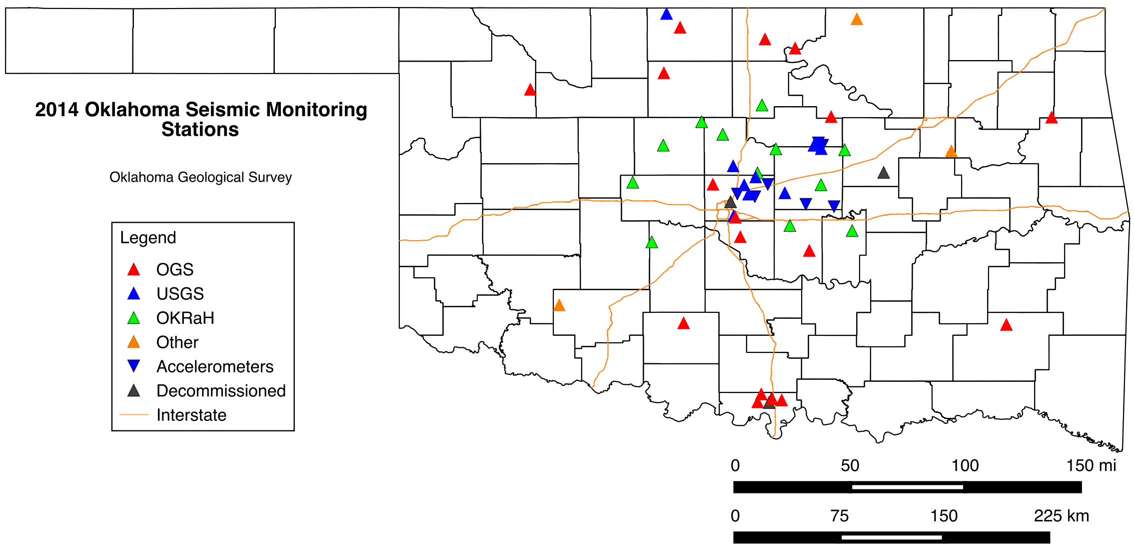

Figure 19. Map of Oklahoma showing all seismic stations operating in 2014. Including stations owned and operated by OGS (red triangles), stations owned by USGS (blue triangles), OKRaH stations owned by IRIS (green triangles), and additional stations in orange triangles. Large format image as Figure B7 in Appendix B.

Table 7. Stations operating in 2014 within Oklahoma. Stations with start times were installed in 2014, stations with stop times were decommissioned during 2014 and stations with neither value were installed prior to 2014 and operated throughout the entire year.

Station	Network	Start	Stop	Nearest town	State	County
LOV7	OK	1/30/14		Marietta	OK	Love
OK029	GS	2/13/14		Guthrie	OK	Logan
OK027	GS	2/14/14		Luther	OK	Oklahoma
OK028	GS	2/18/14		Harrah	OK	Lincoln
RLOK	OK	3/14/14		Rose Lookout	OK	Mayes
KAY1	OK	3/26/14		Blackwell	OK	Kay
QUOK	OK	3/27/14		Quay	OK	Pawnee
KAN14	GS	8/19/14		Manchester	OK	Grant
RH01	ZD	8/29/14		Drumright	OK	Creek
RH02	ZD	9/02/14		Shawnee	OK	Pottawatomie
RH03	ZD	9/02/14		Chandler	OK	Lincoln
RH04	ZD	9/04/14		Seminole	OK	Seminole
RH05	ZD	9/26/14		Pocasset	OK	Grady
RH06	ZD	10/01/14		Crescent	OK	Logan
RH07	ZD	10/02/14		Perkins	OK	Lincoln
RH08	ZD	10/06/14		Calumet	OK	Canadian
RH09	ZD	10/08/14		Dover	OK	Kingfisher
OK915	NQ	10/11/14		Cushing	OK	Payne
OK914	NQ	10/12/14		Cushing	OK	Payne
OK31	GS	10/15/14		Cushing	OK	Payne
OK30	GS	10/16/14		Cushing	OK	Payne
RH10	ZD	10/17/14		Meridian	OK	Logan
GC02	OK	11/05/14		Medford	OK	Grant
RH11	ZD	11/26/14		Perry	OK	Noble
ADOK	GS			Arcadia	OK	Oklahoma
OK001	GS			Jones	OK	Oklahoma
OK005	GS			Luther	OK	Oklahoma
OK009	GS			Massey's Lake	OK	Oklahoma
OK011	GS			Prague	OK	Lincoln
OK012	GS			Meeker	OK	Lincoln
OK025	GS			Jones	OK	Oklahoma
OK026	GS			Valley Brook	OK	Oklahoma
T35B	N4			Foraker	OK	Osage
BCOK	OK			Bluff Creek	OK	Oklahoma
CDOK	OK		3/21/14	Marietta	OK	Love
CROK	OK			Carrier	OK	Garfield
FNO	OK			Norman	OK	Cleveland
KNG1	OK			Marshall	OK	Kingfisher
LOV1	OK			Marietta	OK	Love
LOV3	OK			Marietta	OK	Love
LOV4	OK		1/30/14	Marietta	OK	Love
LOV5	OK			Marietta	OK	Love
OCO	OK		2/20/14	Oklahoma City	OK	Oklahoma
OKCSW	OK			Dell City	OK	Oklahoma
PCO	OK			Ponca City	OK	Kay
SIO	OK		4/01/14	Slick	OK	Creek
U32A	OK			Mooreland	OK	Woodward
X34A	OK			Bray	OK	Stephens
X37A	OK			Tuskahoma	OK	Pushmataha
TUL1	TA			Leonard	OK	Tulsa
W35A	OK			Maud	OK	Pottawatomie
WMOK	US			Indiahoma	OK	Comanche

Oklahoma Risk and Hazard (OKRaH) Network

Oklahoma Risk and Hazard (OKRaH) network consists of a set of temporary seismic stations deployed as part of a two-year project titled “4D Integrated Study Using Geology, Geophysics, Reservoir Modeling & Rock Mechanics to Develop Assessment Models for Potential Induced Seismicity Risk”. The project is funded by the Research Partnership to Secure Energy for America (RPSEA) with cost shares from the state of Oklahoma, the University of Oklahoma, and Oklahoma oil and gas operators. This project includes multidisciplinary research in the University of Oklahoma Mewbourne College of Earth and Energy and the OGS.

For this project, 12 temporary seismic stations are operated in central and north-central Oklahoma within the existing seismic monitoring network operated by the OGS (Figure 20). Each station consists of a sensitive seismometer, a recording device, batteries and a solar panel. Three of these stations feed immediately into the OGS seismic monitoring system while the other nine record data locally. The locally recorded data are retrieved regularly and are incorporated into routine earthquake analysis within Oklahoma or in support of other research efforts. The data are also archived at the IRIS DMC (www.iris.edu) and will be made available to other researchers after the project has been completed. One station (KNG1) is being provided as open data and is available at the IRIS DMC.

The recordings from these instruments, along with the Oklahoma Seismic Network, will be used to improve our understanding of active faults and subsurface rock properties, along with the surface ground motions observed in Oklahoma. Ultimately, we hope to gain a better understanding of potential changes that may be causing some of the earthquakes within Oklahoma. Further, current, information on the OKRaH network and the RPSEA grant are available on the OGS seismic monitoring website.

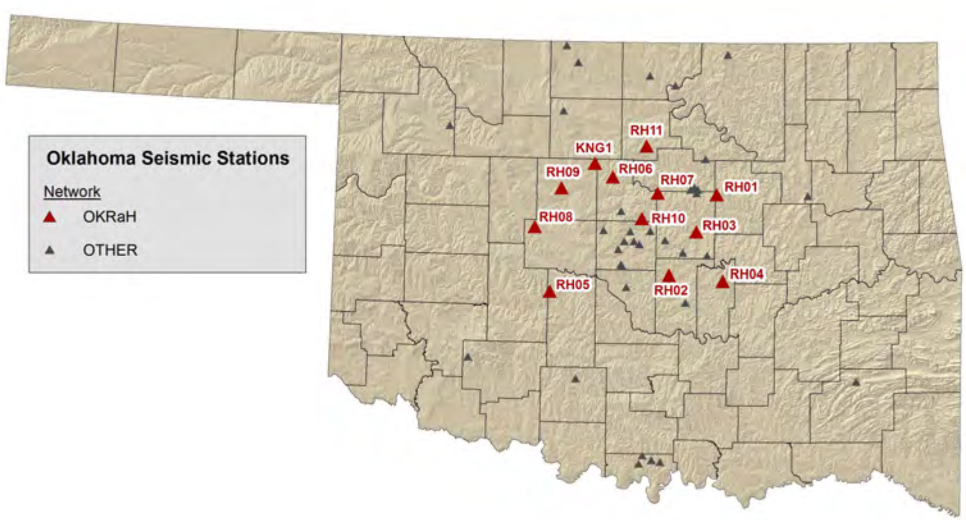

Figure 20. Map of Oklahoma seismic stations highlighting the OKRaH seismic stations with (red triangles), and other seismic stations (gray triangles).

OGS Outreach and Education Efforts

The increased rate of seismicity in Oklahoma in 2014 added to the potential future risk to the public, therefore the OGS sought to establish a more proactive stance on earthquake education and outreach efforts (Figure 21). This multidimensional approach encompassed presentations to the Federal Emergency Management Agency, local and state emergency management groups in addition to other civic organizations, a strong online presence, active engagement and open dialogue within the academic community, media interviews/statements, and the production of hard copy preparedness materials. It is through these rigorous undertakings that the OGS stayed consistently visible and informative to the public.

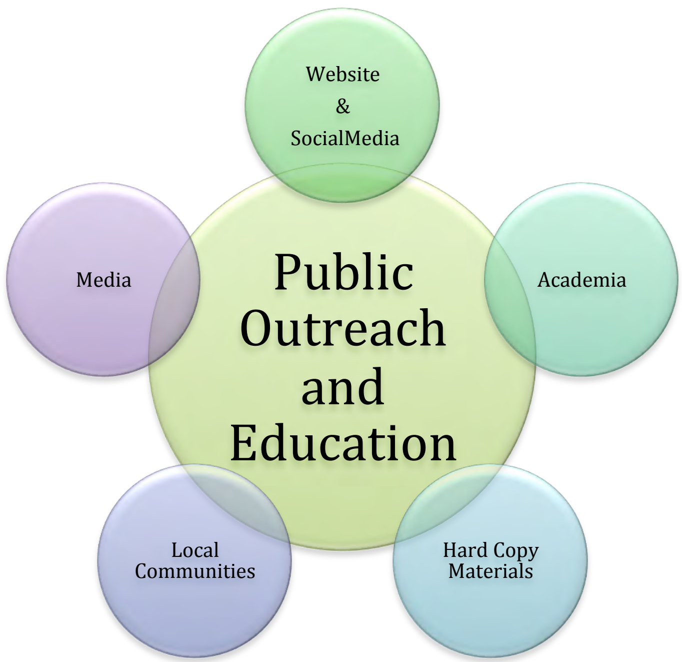

Figure 21. OGS Public Outreach and Education Avenues Diagram

Website and Social Media

The OGS has an exclusive website for information regarding Oklahoma earthquakes: http://www.okgeosurvey1.gov/. In 2014, this website posted current earthquakes on the home page, maps of the seismic monitoring network, earthquake catalogues, current and past research publications, and earthquake preparedness/education material. Moreover, the website allowed for the external reporting of earthquakes by the public (Report Feeling an Oklahoma Earthquake), asking seismologists questions (Ask a seismologist) and the posting of frequently asked questions with replies (OK Earthquake FAQ). The homepage displays a direct link to our twitter account.

Two social media accounts, Twitter's @OKearthquakes and Facebook's Oklahoma Geological Survey –Earthquake Notices, post the latest information on Oklahoma earthquakes as they are located and updated by analysts. The communication includes the date, time, magnitude, closest town, latitude/longitude, and depth of each earthquake (Figure 22).

Figure 22. Example of a Tweet

The number of social media posts generally coincides with the number of earthquakes greater than magnitude 2.4. As a result of analyst hours residing primarily within work days and working hours (8am-5pm), tweets and Facebook posts occur mainly around these times. For magnitude greater than 3.0, analysts are on-call and update earthquake locations as soon as possible, including weekends and holidays. The average tweet-posting rate was 12.2 posts per day (Figure 23).

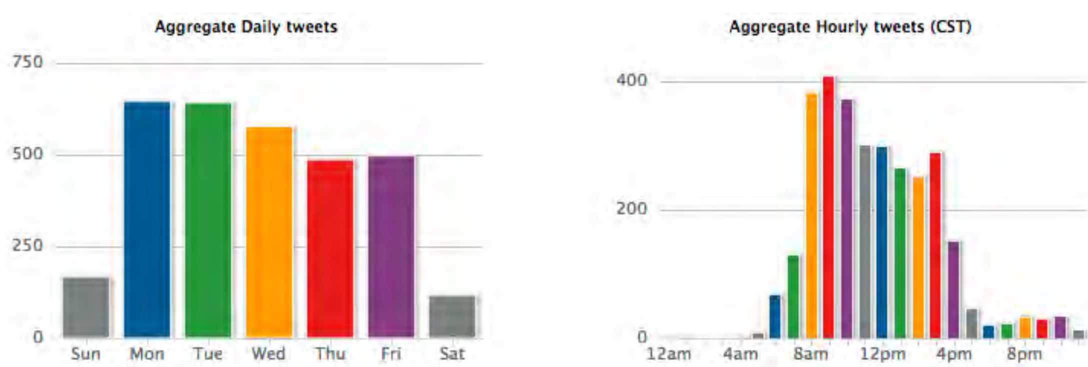

Figure 23. Aggregate daily/hourly Tweets

Altogether, with social media posting, the OGS reached well over 1500 followers and potentially more with follower re-tweets. At the end of 2014, the OGS had 1,725 followers on Twitter (Figure 24).

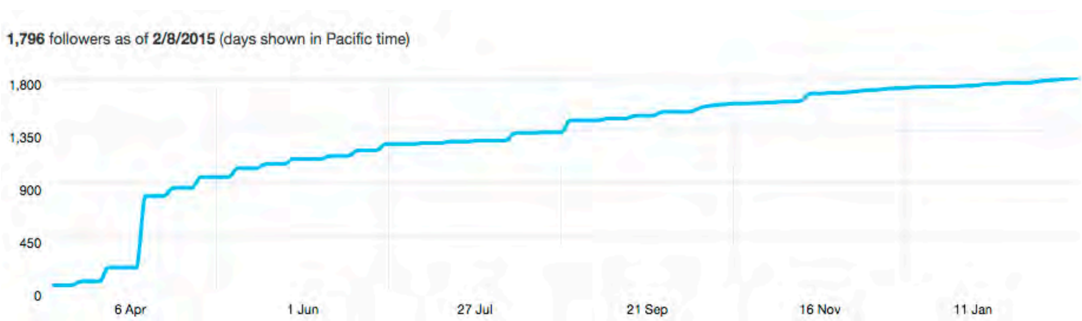

Figure 24. March 2014 through February 2015 graph of Twitter follower increase over time.

Academia

From the most basic to the most advanced levels of education, the OGS seismic group strives to extend itself and its knowledge to students and scholars in all areas concerning Oklahoma earthquake education and on-going research. The OGS worked with multiple primary, secondary, and post-secondary institutions last year as well as partnered with the United States Geological Survey (USGS) to hold a three-day Seismic Hazards workshop, which included a number of presentations and question and answer sessions for all stakeholders. The function was well attended with over one hundred participants.

At the primary and secondary levels of education, the OGS accepted several local public school invitations to teach and/or give presentations about earthquakes. Along with these invitations, level-appropriate materials were created to scaffold learning for young students and preparedness brochures were provided to students, teachers, and parents. Additionally, tours and presentations were held for students at the OGS facilities both in Norman, Oklahoma and Leonard, Oklahoma.

Since the main offices for the OGS are situated at the University of Oklahoma and because educational outreach is highly valued, the OGS employs undergraduate and graduate students in an attempt to create mutually beneficial relationships of innovation and development. These student-employees help with the maintenance of catalogs, databases, and even employ their own original research at times. In turn, their education and research receives input from professionals and practical experience. Student work may be found in many of the OGS endeavors.

Employees of the OGS seismic group published a number of papers in 2014 and attended numerous conferences in order to share and receive input for recent seismic findings in Oklahoma. They collaborated often with institutions and researchers nation-wide and participated in the USGS Powell Center Working Group on Induced Seismicity. Their publications can be found on the website or in the list provided at the end of this report.

Local Communities

Representatives from the OGS seismic monitoring program gave numerous presentations to community organizations all over the state. These presentations provided general, factual information on the increase of Oklahoma earthquakes and vital information about Oklahoma earthquake hazard and preparedness. By sharing this information with civic-minded community organizations, it is the OGS's expectation that community leaders (members of these organizations) will further disseminate it, ultimately establishing more public awareness.

Further community awareness building was created by the OGS's participation in the Pottawatomie County Local Emergency Planning Committee's Prepare Fair and the Great Central U.S. ShakeOut Earthquake Drill. At the Prepare Fair, hardcopies of the *Hazard and Preparedness* brochures were distributed and a table was set up displaying maps of Oklahoma's areas of increased seismic activity. Also, a seismologist was present to answer questions and give a presentation. The Great Central U.S. Shakeout Earthquake Drill (Figure 25) for Oklahoma was aided by the OGS and covered by the media at Fogarty Elementary School in Guthrie, Oklahoma. The drill was concurrently tweeted on the OGS Twitter page.

Figure 25. Advertisement for The Great Central ShakeOut of 2014

Media

The OGS seismic group offered several interview and media coverage opportunities to local, national and global media. Through media exposure, the OGS gained yet another method of communication and transparency with the public.

Hardcopy Educational Materials

Two documents were created in the last six months of 2014. One was the Earthquakes Hazard and Preparedness brochure and the other was the Seismic Monitoring handout.

Hazard and Preparedness Brochure

This brochure is handed out at any event concerning seismicity in Oklahoma. It contains general information on earthquakes, Oklahoma faults, Oklahoma's increase in earthquakes, the USGS Hazard map of Oklahoma, preparation information in the event of an earthquake, earthquake kit checklist, list of important websites, and contact/reporting information.

Seismic Monitoring Handout

This handout is used to inform the general public (and landowners whom host seismic equipment) of the OGS seismic monitoring network and monitoring process. It details a purpose, short history, current seismic network information and map, as well as a step-by-step procedure of the seismic monitoring process from installation to the reporting of earthquakes.

Publications 2014

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Concluding Remarks

Earthquakes are not predictable and we do not know what the future holds, therefore, it is not possible to know whether we are going to see an increase or a decrease in 2015 or beyond. However, the 2014 increase in earthquakes of a magnitude 4.0 and greater increases the probability that we could have a damaging earthquake in Oklahoma. It is important for Oklahomans to understand how to prepare and what to do during an earthquake. Our website has related information and links at http://www.okgeosurvey1.gov/pages/prepare.php.

Download 2014 quarterly earthquake file and complete list of felt earthquakes (CSV):
http://www.okgeosurvey1.gov/media/quarterlies/2014_qt1.csv
http://www.okgeosurvey1.gov/media/quarterlies/2014_qt1_felt.csv
http://www.okgeosurvey1.gov/media/quarterlies/2014_qt2.csv
http://www.okgeosurvey1.gov/media/quarterlies/2014_qt2_felt.csv
http://www.okgeosurvey1.gov/media/quarterlies/2014_qt3.csv
http://www.okgeosurvey1.gov/media/quarterlies/2014_qt3_felt.csv
http://www.okgeosurvey1.gov/media/quarterlies/2014_qt4.csv
http://www.okgeosurvey1.gov/media/quarterlies/2014_qt4_felt.csv

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Appendix A – Oklahoma Focal Mechanisms during 2014

The OGS calculated 324 focal mechanisms throughout Oklahoma in 2014. These focal mechanisms are dominated by strike-slip motion on steeply dipping faults (Figure A1). It is possible with available data to determine many more focal mechanisms for earthquakes in Oklahoma during 2014. The ones presented in Table A.1 are those earthquakes for which focal mechanisms were calculated at the time of preparation of this report. Focal mechanisms can be used to approximate the maximum horizontal stress (shmax) following the method of Zoback (1992). A statistical summary of the estimated shmax for focal mechanisms with a defined shmax can be seen in Figure A1. The calculated shmax is 81.7±20.7° with 297 defined values with a median of 78.1° a 25th percentile of 69.0° and a 75th percentile of 97.1°. A map of the focal mechanisms and associated maximum horizontal stress can be seen in Appendix B, Figure B1, and Figure B2, respectively.

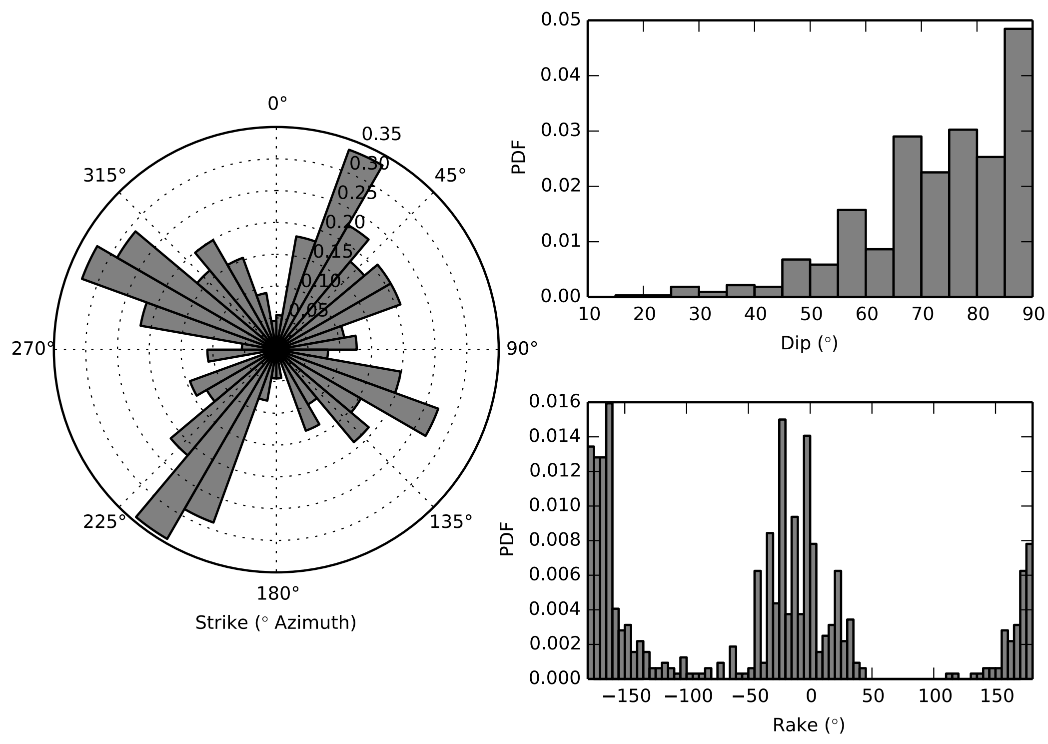

Figure A1. Focal mechanism statistics normalized to a probability distribution function (PDF) for both possible nodal planes from each focal mechanism following the method of Holland (2013) showing strike, dip, and rake.

Table A1. Focal mechanisms for earthquakes in Oklahoma during 2014.

origintime	longitude	latitude	depth	magnitude	type	strike	dip	rake	P-trend	P-plunge	T-trend	T-plunge
1/9/14 3:26	-96.77302	35.54209	3.21	3.4	MW	55.1	83.9	-151.1	282.2	24.5	185	15.3
1/18/14 16:20	-97.68843	36.6506	4.47	2.4	ML	189.4	48.6	-3.1	153.8	29.8	47.6	26
1/26/14 6:38	-96.17922	35.10973	2.54	3.1	ML	56.4	59.4	-160.5	272.6	34.3	8.8	9
1/28/14 15:05	-97.38941	35.59954	6.27	3	ML	25	88	-168	250.4	9.9	159.2	7
2/1/14 9:08	-96.90718	35.95056	5	3.7	MW	-61	90	22	71.8	15.4	166.2	15.4
2/9/14 2:16	-97.29112	35.89266	5	3.8	MW	101	68	-25	60.7	32.8	151.1	0.7
2/9/14 2:24	-97.30614	35.88955	5	2.8	ML	31	55	-154	243.3	41.3	341	8.7
2/10/14 23:37	-96.93239	35.81616	5	3.6	MW	23.9	87.6	158.8	71.3	13.1	337.4	16.6
2/15/14 0:19	-97.48073	35.78179	5	3.1	ML	33.6	81.4	-169.1	258	13.8	167.6	1.5
2/15/14 1:15	-97.47593	35.77693	5	2.6	ML	24.3	61.2	170.1	248.5	13.5	345.4	26.6
2/16/14 1:51	-97.47701	35.78091	5	3.3	ML	35.8	83.8	-172.4	260.5	9.7	170.3	1
2/17/14 4:54	-97.46925	35.77573	7.36	3.7	MW	-58	90	22	74.8	15.4	169.2	15.4
2/17/14 5:02	-97.46552	35.77724	5.39	3.2	ML	34	90	-171	259.4	6.4	168.6	6.4
2/17/14 5:31	-97.4642	35.77062	5.03	2.5	ML	117	78	-22	72.8	24	165.7	6.4
2/17/14 5:37	-97.47745	35.77602	5	2.9	ML	309.1	69.6	33.3	75.6	6.7	170.8	37.6
2/17/14 8:24	-97.4597	35.77026	4.55	2.7	ML	28	88	-168	253.4	9.9	162.2	7
2/18/14 2:44	-97.46168	35.77133	5	2.5	ML	210.2	75.1	163.2	257.6	0.9	167.2	22.3
2/18/14 3:11	-97.47345	35.77521	4.83	2.6	ML	24.6	78.7	-162.4	248.6	20.4	157.1	4.1
2/18/14 3:59	-97.46277	35.77156	4.72	2.5	ML	-60	90	22	72.8	15.4	167.2	15.4
2/18/14 11:53	-97.46733	35.77652	5.03	3.4	ML	-59	90	22	73.8	15.4	168.2	15.4
2/18/14 12:16	-97.45854	35.76963	5.14	3.2	ML	-60	90	22	72.8	15.4	167.2	15.4
2/18/14 12:29	-97.46864	35.77537	5	2.7	ML	206.7	73	173.1	71.7	7.2	163.8	16.7
2/18/14 15:17	-97.45766	35.77204	4.81	2.8	ML	205	65.5	173.4	69	12.7	164	21.5
2/19/14 16:44	-97.46564	35.77709	5	3.1	ML	44	87	-180	269	2.1	359	2.1
2/21/14 21:38	-97.47451	35.78099	5.17	3.1	ML	44.1	80.2	170.6	269.9	0.4	360	13.5
2/22/14 12:45	-97.38024	35.58928	6.44	2	ML	28	78	-164	251.8	19.7	160.9	2.5
2/22/14 14:06	-96.98981	36.16985	4.65	2.7	ML	88	38	-113	252.3	73.3	14.2	9
2/24/14 0:11	-96.97858	36.17099	5	3.1	ML	238.2	63.6	155.5	108.1	3	200.2	35.2
2/24/14 11:20	-97.34251	35.56497	4.17	2.9	ML	202.1	62.5	-170.5	61.5	25.5	157.8	12.9
2/24/14 11:22	-97.34837	35.56818	5	2.7	ML	11	68	-162	231.5	27.9	323.4	3.6
2/24/14 16:44	-96.94263	35.81733	4.31	3.2	ML	28	58	-180	248.3	22	347.7	22
2/27/14 0:19	-97.07355	36.44764	0	3.2	ML	45	64	-162	263.8	30.4	357.6	6.5
2/28/14 10:40	-97.41673	35.70174	4.96	1.9	ML	266.8	67.5	-11.2	225.9	23.4	132.3	8.3
3/2/14 4:21	-97.04103	35.63574	4.39	3.5	ML	245.7	79.5	173.3	111	2.7	201.6	12.1
3/2/14 19:23	-96.92464	35.94695	2.86	2.5	ML	-41	90	22	91.8	15.4	186.2	15.4
3/3/14 2:53	-97.47083	35.78139	5.39	2.4	ML	202.9	72.8	172.3	68	6.8	160.2	17.4
3/5/14 14:17	-97.3834	35.59251	6.43	3.3	MW	18	85.3	-176	242.8	6.1	332.9	0.5
3/8/14 1:29	-97.28426	35.88874	4.61	3	ML	66	81	-146	293.4	30.1	193.6	16.3
3/8/14 21:50	-96.97575	35.79551	4.69	3.3	ML	-70	90	22	62.8	15.4	157.2	15.4
3/9/14 0:05	-97.24594	35.4939	7.34	2.9	ML	229.4	89.8	-172.1	94.7	5.7	4.1	5.4

origintime	longitude	latitude	depth	magnitude	type	strike	dip	rake	P-trend	P-plunge	T-trend	T-plunge
3/9/14 17:05	-97.2474	35.49192	7.29	3	ML	47.8	86	168.6	93.7	5.2	2.7	10.9
3/11/14 12:55	-97.28226	35.88961	4.89	3.5	MW	61	78	-162	284.9	21.1	193.4	3.8
3/12/14 18:09	-97.66911	36.6255	5	2.4	ML	46.4	51.5	-143.8	253.6	50.1	351.5	6.5
3/15/14 0:37	-97.67059	36.63768	2.77	2.9	ML	73.8	90	-178.6	298.8	1	208.8	1
3/15/14 3:50	-97.67868	36.63067	5.32	2.9	ML	71.3	77.2	-176.1	295.2	11.7	26.5	6.3
3/15/14 18:48	-97.66875	36.63132	5	2.9	ML	233.4	71.5	174.5	97.9	9.2	190.7	16.8
3/15/14 19:12	-97.66861	36.63725	4.83	2.8	ML	243.8	80.3	-166.5	108	16.4	17.3	2.5
3/15/14 19:15	-97.679	36.63605	6.67	2.9	ML	66.1	85.7	170.3	111.8	3.8	21.1	9.9
3/15/14 19:27	-97.66923	36.63211	5	3	ML	63	85	-162	288.5	16.2	195.9	9
3/18/14 15:44	-97.28684	35.89488	2.76	2.3	ML	101.6	46.7	-120.7	296.7	68	32.8	2.4
3/19/14 8:54	-97.5495	36.07649	3.75	3.1	ML	78.5	78	154.1	128.4	8.9	33.9	26.7
3/19/14 11:23	-97.55015	36.07906	3.71	3.1	ML	261	88.7	173.1	306.3	3.9	215.9	5.8
3/19/14 20:15	-96.91794	35.9487	0.05	3.4	MW	18	50	158	245.4	14.6	348.5	41.1
3/20/14 5:12	-97.6716	36.63762	6.71	3.1	ML	238.4	68.1	-172.8	100	20.2	193.9	10.5
3/20/14 14:39	-97.27538	35.89143	5.14	3.3	ML	152	89	18	285.4	11.9	18.3	13.3
3/20/14 16:48	-97.27505	35.89474	4.31	2.8	ML	50	68	-164	270.6	26.5	3	4.8
3/20/14 22:42	-97.8247	36.56745	5	3.3	ML	242.9	71.2	165.1	109.7	3.2	201.1	23.6
3/22/14 3:01	-97.27876	35.89153	5	3	ML	235	89.4	155.7	282.8	16.5	187.5	17.4
3/22/14 3:02	-97.29017	35.88816	4.47	3.1	ML	118.5	41.7	3.1	83.3	30.2	330.5	33.6
3/22/14 3:05	-97.29901	35.88808	2.94	3.7	MW	76	66	-62	26.3	59.1	145.8	16.4
3/25/14 14:01	-97.55585	35.74271	6.11	3	MW	28	69.4	175.5	252	11.4	345.7	17.5
3/28/14 17:56	-97.63287	36.12566	5	3.1	ML	-66	90	25	66.2	17.4	161.8	17.4
3/28/14 23:16	-96.98195	36.16731	6.99	3.2	ML	13.6	80.1	-164.6	237.9	17.9	146.7	3.6
3/30/14 3:08	-97.24782	35.49142	7.01	3.5	MW	54.3	85.8	174.8	99.5	0.7	9.5	6.6
3/30/14 3:55	-97.64378	36.12885	0	3.5	MW	33	90	-175	258.1	3.5	167.9	3.5
3/30/14 5:49	-97.24645	35.49106	7.46	3	ML	137	86	-22	90.7	18.3	184.8	12.4
3/30/14 6:37	-97.64044	36.12881	4.64	3.3	ML	30.5	90	-179.2	255.5	0.6	165.5	0.6
3/30/14 6:51	-97.63563	36.12851	4.86	4.1	MW	226.5	64.5	-165.5	85.9	27.7	180.3	8.3
3/30/14 6:59	-97.64408	36.12529	5	3.3	ML	214.5	82.6	172.8	79.9	0.2	170	10.3
3/30/14 8:07	-97.62403	36.1371	0.08	3.3	MW	215.7	75.6	178.1	80	8.8	171.8	11.5
3/30/14 8:10	-97.62802	36.13174	0.37	3.3	MW	213.7	61.2	173.3	76.9	15.6	174.2	24.4
3/30/14 8:42	-97.62784	36.13359	0.01	3.9	MW	29.6	86.3	170.6	75.2	4	344.6	9.3
3/30/14 9:06	-97.63937	36.12663	3.08	2.9	ML	34.5	66.9	-172.9	255.8	21	350.2	11.4
3/30/14 12:49	-97.63586	36.12996	5	3.4	ML	37	68	-176	259.1	18.1	353.3	12.7
3/30/14 14:09	-97.63687	36.12593	3.9	3.9	MW	210.5	77	168.7	76.6	1.4	167	17.1
3/31/14 17:17	-96.97733	35.79335	3.41	3.2	ML	231	73.1	170	96.6	5.1	188.4	18.8
3/31/14 23:45	-97.26743	35.8882	4.9	2.9	ML	47.6	85.8	-153.5	274.7	21.5	178.6	15.2
3/31/14 23:59	-97.26208	35.88696	5	3	ML	237.3	51.7	179.3	95.7	25.6	199.4	26.4
4/1/14 17:07	-97.28497	35.88417	5	3.2	ML	340.9	49.3	-13.1	308.8	35.6	203.8	19.9
4/2/14 0:56	-97.63475	36.62214	5	3.3	ML	225.9	60.9	-173.8	85.5	24.2	182.9	16.1

origintime	longitude	latitude	depth	magnitude	type	strike	dip	rake	P-trend	P-plunge	T-trend	T-plunge
4/2/14 7:10	-97.25034	35.495	7.37	3	ML	48	78	-180	272.4	8.5	3.6	8.5
4/3/14 16:56	-97.27035	35.89052	4.8	3.3	ML	226.5	66.9	178.2	89.5	14.9	184.3	17.3
4/3/14 20:33	-97.06834	36.4478	5	3.1	ML	36	88	-142	267.1	27.4	163.7	24.2
4/3/14 20:58	-98.21693	36.68054	5	3.1	ML	15.2	68.2	162.6	242.6	3.8	334.6	27.3
4/4/14 1:18	-97.24204	35.49249	7.2	2.9	ML	130	68	-22	89.7	30.7	359	1.1
4/4/14 2:23	-97.26819	35.89414	5.22	3.5	ML	46	88	-165	271.7	12	179.8	9.1
4/4/14 3:15	-97.27338	35.89126	5	3.1	ML	224.7	81.6	-176.1	89.2	8.7	179.7	3.2
4/4/14 6:42	-97.26801	35.89491	4.18	3	ML	225.7	59.6	-165.8	83	30.5	180.2	12
4/4/14 18:54	-97.28371	35.88871	5	3.1	MW	71	68	-162	291.5	27.9	23.4	3.6
4/5/14 10:54	-97.54615	36.07881	4	3	ML	86	90	-180	311	0	221	0
4/5/14 12:42	-97.63078	36.13124	2.17	3.8	MW	37	88	-162	263.1	14.1	170.3	11.2
4/6/14 14:25	-97.26764	35.89279	5.01	3	ML	45	90	-165	271	10.5	179	10.5
4/6/14 14:58	-97.26633	35.89217	5.08	3.7	MW	51.1	89.6	-167.3	276.8	9.2	185.3	8.7
4/7/14 1:01	-97.27064	35.88934	5	3.1	ML	67.7	69.8	146.4	121.3	7.1	25.8	37.7
4/7/14 3:25	-98.26942	36.83704	5	3.5	MW	60	38	-2	29.5	34.9	272.8	32.8
4/7/14 5:59	-96.98055	36.28531	2.97	3	ML	19	90	-162	245.4	12.6	152.6	12.6
4/7/14 16:03	-97.27438	35.8911	5.16	4.1	MW	54	78	-162	277.9	21.1	186.4	3.8
4/9/14 3:36	-97.29263	35.89375	4.67	3.2	ML	88	42	-43	75.5	58	326.1	11.7
4/10/14 7:33	-97.48165	35.7754	6.8	3.9	MW	23	88	-180	248	1.4	338	1.4
4/10/14 7:35	-97.48271	35.77723	6.84	3.2	ML	214.5	46.4	-176.2	68.7	31.4	176.8	27
4/10/14 7:37	-97.4873	35.77637	6.94	3	ML	212	46.5	-176.7	66.5	31.1	174.5	27.2
4/10/14 8:19	-97.48133	35.7712	5.54	3.5	MW	28	90	-171	253.4	6.4	162.6	6.4
4/10/14 9:29	-97.48424	35.77388	6.33	2.4	ML	34	68	-167	254.9	24.4	347.9	6.7
4/10/14 13:18	-97.48006	35.77079	5.77	2.9	ML	117	68	-2	74.6	16.7	340.3	14
4/10/14 16:53	-96.951	36.28881	8.02	3.1	ML	0	58	-176	219.1	24.6	318.4	19.4
4/10/14 18:00	-96.95202	36.28936	8.13	3.7	ML	106	59	-22	70.4	36.2	334.6	7.9
4/10/14 18:18	-96.95393	36.2889	7.95	3.1	ML	358.9	56.8	168.2	223	15.4	322.4	30.5
4/11/14 0:35	-97.28775	35.88668	5	2.7	ML	73	68	-175	294.9	18.8	29.1	12
4/12/14 5:32	-97.24889	36.27795	5	3.6	MW	56	58	178	276.9	20.7	16.3	23.3
4/12/14 9:00	-97.24931	36.28192	5	2.7	ML	58	58	-167	274.8	30.6	13.2	13.9
4/13/14 17:00	-97.47926	35.76982	5.82	3.4	ML	211.5	73.8	175.5	76.1	8.3	168.2	14.5
4/13/14 20:02	-97.48315	35.77116	6.14	3.5	ML	28	90	-167	253.7	9.2	162.3	9.2
4/16/14 0:36	-97.63004	36.13445	4.95	2.8	ML	307	81.5	12.4	80.7	2.6	171.4	14.8
4/17/14 11:50	-98.21701	36.6797	5	3.6	ML	199.5	56.4	166.2	64.3	14.5	163.7	32.1
4/19/14 8:07	-97.87652	36.66537	5	2.9	ML	222.1	60.3	164.6	88.2	10.8	184.7	30.9
4/19/14 10:43	-97.25041	36.27606	4.16	3.6	MW	138.4	69.3	-22.2	97.5	30	187.5	0
4/20/14 19:07	-97.48206	35.77398	6.72	3.7	MW	202.2	50.7	165.1	66.3	17.9	169.9	36.1
4/20/14 19:13	-97.48286	35.77166	6.18	3	ML	27	68	-175	248.9	18.8	343.1	12
4/20/14 19:31	-97.47185	35.77244	7.19	3.3	ML	119	82	-22	73.7	21.1	167.3	9.4
4/21/14 18:16	-97.84215	36.60329	5	3.2	ML	66	90	-173	291.2	4.9	200.8	4.9

origintime	longitude	latitude	depth	magnitude	type	strike	dip	rake	P-trend	P-plunge	T-trend	T-plunge
4/22/14 8:04	-97.28914	35.88654	4.52	2.9	ML	74	68	-173	295.6	20.2	29.6	10.7
4/22/14 9:57	-97.37949	35.59348	5.91	3.3	ML	130.9	79.7	-22.9	86.1	23.4	179.7	8.3
4/22/14 21:02	-97.81955	36.59116	5	2.8	ML	59	78	154	109	9	14.4	26.8
4/23/14 15:35	-98.59226	36.71328	5	3.1	ML	73	29	-11	55.1	43.1	286.6	33.6
4/24/14 17:46	-98.71504	36.76763	5	3.2	ML	246.4	29.4	39.1	193.1	23.4	62.1	56.6
4/25/14 7:38	-97.82709	36.5989	6.18	3.2	ML	80	58	-173	298.3	26.6	37.4	17.6
4/25/14 23:54	-97.29486	36.1521	5	3	ML	136	69	-42	93	44	193.7	10.9
4/27/14 0:22	-97.55791	36.07523	4.63	3	ML	68	78	-168	291.7	16.9	21.8	0.2
4/27/14 16:46	-97.22496	35.99561	5.9	2.8	ML	58	88	-166	283.6	11.3	191.9	8.4
4/28/14 2:26	-97.04431	36.10568	7.04	3.2	ML	44	77	-169	267.5	16.9	358	1.6
4/30/14 7:48	-97.83421	36.60368	5	3.1	ML	154	67	-2	111.8	17.4	17.1	14.7
4/30/14 8:06	-98.07295	36.77637	5	3	ML	223.1	58.2	178.8	83.8	21.1	183.1	22.7
4/30/14 19:46	-97.68068	36.59706	5	3.4	ML	58	71	-162	279.6	25.9	10.3	1.4
4/30/14 21:26	-97.04744	36.06557	5	3.1	ML	110	58	32	56.9	3.3	323.8	43.8
5/1/14 10:04	-96.93607	35.81124	5	3.4	MW	26	58	-173	244.3	26.6	343.4	17.6
5/1/14 19:07	-97.25211	36.27571	3.99	3.1	ML	38	58	-168	255	30	353.6	14.5
5/2/14 5:46	-97.55154	36.07756	4.67	3.2	ML	77	71.9	-173.2	299.6	17.4	32.2	8.1
5/2/14 10:29	-97.29884	35.87598	5.98	3	ML	218.8	69.8	164.5	85.7	3.8	177.5	24.9
5/2/14 19:44	-97.3994	35.59033	5	3.2	MW	10	76	-180	234.1	9.8	325.9	9.8
5/3/14 9:39	-97.83673	36.60387	5	3.6	ML	246.3	53.7	178.5	105.7	23.8	208	25.7
5/6/14 6:08	-97.26452	35.90391	4.78	3.2	ML	355.7	89.4	-172.9	220.9	5.4	130.4	4.6
5/7/14 18:57	-97.15172	36.39055	4.76	3.2	ML	60.3	88.5	177.6	105.3	0.6	15.3	2.8
5/7/14 18:59	-97.1461	36.39351	5	2.5	ML	330.8	26.8	8.2	300.5	35.9	168.9	42.6
5/8/14 4:32	-97.82803	36.63067	5	3.2	ML	247.3	53.3	-177.6	105.2	26.5	207.7	23.5
5/8/14 15:08	-97.04323	36.45309	5	3	ML	-70	90	22	62.8	15.4	157.2	15.4
5/8/14 20:40	-97.62714	36.57732	5	3.5	MW	61	90	-162	287.4	12.6	194.6	12.6
5/9/14 18:52	-97.61885	36.58289	5	3.6	MW	83	68	-170	304.2	22.3	37.8	8.7
5/11/14 7:50	-97.61008	36.58307	5.79	3	ML	55	58	-165	271.4	32	9.4	12.7
5/11/14 19:29	-97.66244	36.90732	5	3	ML	26	58	-162	241.7	34.1	339.2	10.9
5/12/14 0:13	-96.67453	36.30899	5	3	ML	260	53.1	-9.1	224.5	30.9	122.2	19.6
5/15/14 0:28	-97.6599	36.79809	5	3.3	ML	51	90	-164	277.1	11.2	184.9	11.2
5/15/14 20:23	-97.47855	35.77625	6.99	3.4	MW	21	88	-172	246.1	7.1	155.6	4.2
5/16/14 20:00	-96.8595	36.16096	7.81	3.1	ML	34	58	178	254.9	20.7	354.3	23.3
5/17/14 10:47	-97.26117	36.27942	5	3.1	ML	38	88	-162	264.1	14.1	171.3	11.2
5/17/14 20:54	-97.07021	36.09457	1.04	3.2	ML	58	68	-162	278.5	27.9	10.4	3.6
5/18/14 8:29	-96.9371	35.80802	5	3.2	ML	23	58	173	245.6	17.6	344.7	26.6
5/18/14 18:53	-97.7994	36.59225	5	3	ML	237.4	88.6	167.1	283.3	8.1	191.8	10.1
5/19/14 4:16	-97.44503	36.10958	5	3.2	ML	30.9	68.8	157.1	80.3	0	350.2	30.8
5/19/14 6:29	-97.06868	36.09146	4.2	3	ML	58	78	-162	281.9	21.1	190.4	3.8
5/20/14 3:58	-97.25446	35.48547	7.6	3.2	ML	78	58	-164	294.1	32.7	32	12.1

origintime	longitude	latitude	depth	magnitude	type	strike	dip	rake	P-trend	P-plunge	T-trend	T-plunge
5/20/14 7:30	-97.24585	35.49016	7.48	3.4	MW	264.2	73.3	-130.8	132.8	45.7	23.3	18
5/22/14 2:46	-97.46793	35.77772	6.98	3.5	MW	110	89.1	4.9	244.9	2.9	335.1	4.1
5/31/14 10:18	-97.25196	35.49096	7.09	3.5	MW	60	88	-179	285	2.1	15	0.7
6/1/14 5:50	-96.50572	35.41846	2.82	3.1	ML	142	48	-22	114	42.1	9	16
6/1/14 19:54	-97.23606	35.50324	5	3.6	MW	73	88	-180	298	1.4	28	1.4
6/2/14 17:38	-97.25755	35.49427	6.12	3.2	ML	40.5	61.9	160.3	268.4	7.1	3	32.9
6/2/14 22:35	-97.42666	35.71815	5.28	3.2	ML	133	65	-42	93	46.7	191	7.5
6/2/14 23:08	-97.42442	35.71875	5.3	3.1	ML	240.8	71.4	-178.3	104	14.2	197	11.9
6/10/14 7:19	-97.42818	35.71684	5	3.1	ML	133	68	-42	90.7	44.7	190.8	10
6/10/14 15:13	-97.42879	35.71553	5.22	3.1	ML	143	78	10	97.2	1.5	6.7	15.5
6/11/14 9:42	-97.64949	36.92929	9.14	3	ML	204.9	81.8	179.3	69.7	5.3	160.2	6.3
6/14/14 22:55	-97.62338	36.60373	5	3.3	ML	83	68	-168	304	23.7	37.2	7.4
6/15/14 13:51	-97.8567	36.86635	5.25	3	ML	112	48	-26	85.4	44.7	341.1	14.1
6/15/14 17:33	-97.63914	36.83257	1.89	3	ML	-35	90	-35	274.3	23.9	15.7	23.9
6/16/14 10:31	-97.40271	35.59249	6.67	3.5	MW	11	78	-180	235.4	8.5	326.6	8.5
6/16/14 10:47	-97.39877	35.59236	5	4	MW	200	85.1	-159.9	65.8	17.6	332.5	10.5
6/16/14 11:25	-97.38017	35.5859	6.59	3.3	ML	66	90	-172	291.3	5.6	200.7	5.6
6/17/14 16:29	-97.37399	35.59076	5.05	3	ML	58	88	158	105.5	13.9	11.2	16.8
6/18/14 7:08	-97.18349	35.97718	5.57	3.4	ML	169.3	67	161.6	37	4.1	129.3	28.8
6/18/14 10:30	-97.40008	35.59744	5.31	3	ML	123	79	-2	78.7	9.2	347.7	6.4
6/18/14 10:53	-97.39558	35.5927	5	3.8	MW	204.5	84.2	-179	69.3	4.8	159.6	3.4
6/18/14 14:08	-97.17578	35.9758	5.97	3.2	MW	171.6	61.6	174.3	34.6	15.9	131.7	23.5
6/18/14 18:42	-97.18977	35.97725	5	3.2	ML	64	78	-22	19.8	24	112.7	6.4
6/18/14 19:11	-97.90056	36.72304	4.4	3.6	ML	85	58	-102	322.8	74	183.7	12.2
6/20/14 12:46	-97.40929	35.59939	4.64	3.1	ML	181.9	75.1	-169.9	45	17.6	136.1	3.6
6/20/14 14:46	-97.17788	35.975	6.7	3.4	MW	0	78	-176	224	11.3	315.1	5.7
6/20/14 23:10	-97.90533	36.72596	5	3.9	MW	82	67	-102	330.9	65.9	181.1	21.1
6/21/14 1:57	-97.88427	36.7197	5	3	ML	32	58	-162	247.7	34.1	345.2	10.9
6/23/14 7:42	-97.47852	35.77388	5.4	3.2	ML	-58	90	22	74.8	15.4	169.2	15.4
6/23/14 9:48	-97.85948	36.85341	6.07	3.3	ML	28	58	-164	244.1	32.7	342	12.1
6/23/14 13:44	-97.856	36.85119	5.49	3.4	MW	28	58	-164	244.1	32.7	342	12.1
6/24/14 14:15	-97.61364	36.59932	5.54	3	ML	49	88	-162	275.1	14.1	182.3	11.2
6/24/14 16:57	-97.37732	36.88396	6.1	3.2	ML	88	69	-89	359.7	66	177.2	24
6/24/14 17:38	-97.69402	36.87104	5	3	ML	95	88	-62	30.9	40.4	160.5	36.8
6/25/14 13:09	-98.10728	36.63835	5	3.3	ML	219.5	63.7	-149.9	77.4	39.1	347.2	0.3
6/26/14 5:26	-97.49104	35.77156	5	3.6	MW	13	68	-171	234.3	21.6	328.1	9.3
6/26/14 5:38	-97.48453	35.76834	5.56	3.5	MW	24	78	-175	247.9	12	339	5
6/26/14 5:41	-97.47623	35.76736	6.55	3.1	ML	35	58	-173	253.3	26.6	352.4	17.6
6/26/14 6:13	-97.49125	35.7749	6.17	3.3	MW	105	86	-2	60.1	4.2	330	1.4
6/26/14 7:45	-98.04694	36.75504	5.77	3.2	ML	219.8	72.5	-170.3	82.3	19	174.3	5.7

origintime	longitude	latitude	depth	magnitude	type	strike	dip	rake	P-trend	P-plunge	T-trend	T-plunge
6/26/14 7:57	-98.0499	36.75778	5.72	3	ML	135	62	-2	94.1	20.7	357	18.1
6/26/14 14:02	-97.68814	36.86823	1.46	3.2	MW	68	38	-102	211.3	79.4	346.5	7.5
6/26/14 23:28	-97.26258	35.8863	4.99	3.6	MW	117	78	-22	72.8	24	165.7	6.4
6/27/14 7:10	-97.26083	35.88386	4.76	3.5	ML	108	78	-22	63.8	24	156.7	6.4
6/27/14 12:36	-97.31248	35.88562	5	3.3	ML	95	78	-12	51.3	16.9	321.2	0.2
6/27/14 15:09	-97.31031	35.88564	5	3.7	MW	101	78	-2	56.8	9.9	325.6	7.1
6/27/14 20:18	-97.8371	36.56491	5	3.1	ML	37	78	-170	260.7	15.5	351.2	1.5
6/27/14 22:35	-97.90328	36.71856	6.04	3.7	MW	86	57	-102	321.8	74.8	184.6	11.2
6/28/14 6:08	-98.26128	36.68325	5	3	ML	138	89	-22	91	16.1	185.3	14.6
6/29/14 16:29	-97.40409	35.59581	5.5	3	ML	100	71	-42	55.6	42.7	157.4	12.5
6/30/14 1:30	-97.85435	36.85315	4.48	3	ML	37	58	-162	252.7	34.1	350.2	10.9
6/30/14 11:03	-97.26579	35.88583	4.52	3.2	ML	16	78	138	72.4	18.4	327.5	37.6
7/1/14 7:42	-97.07488	35.82471	5.64	3	ML	52	78	-169	275.7	16.2	6	0.9
7/1/14 8:20	-97.95856	36.65069	5	3.2	ML	18	78	-162	241.9	21.1	150.4	3.8
7/1/14 14:22	-97.81879	36.58381	5	3.1	ML	208	62.1	156.8	77.3	4.9	170.7	35.2
7/3/14 14:43	-98.0476	36.7556	5	3.1	ML	220.7	67.1	-155.8	80.6	32.8	170.9	0.5
7/3/14 16:09	-96.93093	36.38421	5	3	ML	108	75	-42	61.2	39.8	164.9	15.9
7/3/14 20:14	-97.07477	35.93608	4.66	3.2	ML	63	90	-162	289.4	12.6	196.6	12.6
7/3/14 20:24	-98.05167	36.76016	3.98	3	ML	35	90	-166	260.9	9.8	169.1	9.8
7/4/14 4:55	-97.37064	36.89404	7.05	3.2	ML	205	75.9	-115.5	85.1	52.3	314.9	26.5
7/4/14 20:48	-97.92852	36.72326	5	3	ML	60	38	-142	249.4	55.6	5.6	16.8
7/6/14 1:44	-97.54166	36.21567	4.92	3.3	ML	118	58	-5	79.2	25.3	339.9	18.8
7/6/14 4:10	-97.74967	36.74968	4.82	3.3	ML	98	77	-42	50.1	38.3	154.5	17.6
7/6/14 15:22	-97.89295	36.72734	5	3.1	ML	107	71	-42	62.6	42.7	164.4	12.5
7/7/14 6:53	-98.04874	36.75745	6.03	3	ML	134	60	-2	93.7	22	355.5	19.4
7/7/14 7:44	-98.21083	36.67728	0.08	3.2	ML	110	68	-24	69.7	32.1	159.8	0.1
7/7/14 14:38	-97.48418	34.07052	7.44	3.2	ML	109	88.7	-14.9	63.2	11.4	155.2	9.6
7/11/14 12:17	-97.83673	36.55996	6.4	3.4	ML	151	73	-22	108.6	27.4	200	2.7
7/12/14 11:27	-97.31245	35.86275	5	3.2	ML	114	80	-42	64.5	36.1	170	20.1
7/12/14 17:11	-97.32444	35.86215	4.05	3.9	MW	28	90	-177	253	2.1	163	2.1
7/12/14 17:34	-97.32533	35.85804	5	3.1	ML	117	78	-22	72.8	24	165.7	6.4
7/13/14 14:51	-97.32368	35.85884	4.83	3	ML	119	78	-22	74.8	24	167.7	6.4
7/15/14 7:19	-97.15486	35.52362	5	3.8	MW	27	78	158	75.7	6.4	342.8	24
7/15/14 9:08	-97.15881	35.52429	6.65	3.9	MW	69	88	-149	297.9	22.9	199.1	19.8
7/23/14 2:02	-97.30932	35.87792	5.26	3.3	MW	205.4	63.7	-164.4	64.3	28.9	158.9	8.2
7/25/14 4:56	-98.27989	36.66222	0.71	3.4	MW	226.2	75.8	-173.7	89.7	14.4	181.1	5.6
7/29/14 2:46	-98.04534	36.75605	5.29	4.1	MW	219.7	76.2	-166.5	83	19.2	173.1	0.5
7/30/14 16:21	-97.42738	35.71943	5.28	3.3	MW	236.2	70.5	-171.2	98.3	19.8	191	7.7
7/30/14 16:46	-97.42681	35.71772	5	3.3	ML	236.3	70.4	-171	98.3	20	191.1	7.6
7/30/14 23:48	-97.43198	35.71854	5	3.2	ML	133	78	-22	88.8	24	181.7	6.4

origintime	longitude	latitude	depth	magnitude	type	strike	dip	rake	P-trend	P-plunge	T-trend	T-plunge
7/31/14 6:00	-96.94683	35.61913	5	2.9	ML	17	68	-175	238.9	18.8	333.1	12
7/31/14 6:09	-97.54301	36.30069	5	3.2	ML	101	84	-42	49.8	33	156.1	23.4
7/31/14 23:28	-97.6107	36.58234	5.29	3.2	ML	-20	90	2	115	1.4	205	1.4
8/1/14 14:19	-98.04485	36.7498	4.6	3.1	MW	38	58	-171	255.8	27.9	354.7	16.3
8/1/14 14:44	-98.04385	36.76217	11.68	3.2	MW	28	58	-166	244.6	31.3	342.8	13.3
8/2/14 1:44	-98.06934	36.77306	5.78	3.1	ML	108	17	-24	114	49.5	324.7	36.3
8/3/14 4:57	-97.47987	35.77153	6.66	3.2	ML	21	88	-179	246	2.1	336	0.7
8/3/14 12:21	-97.42246	35.81849	3.77	3	ML	99	48	-22	71	42.1	326	16
8/3/14 17:11	-96.94083	35.61411	5.59	3.1	ML	16.7	68.9	163.7	243.8	4	335.8	26.1
8/4/14 15:30	-97.41959	35.81474	5	3.3	MW	22	64	-174	242.6	22.1	338.5	14.1
8/4/14 18:23	-97.40663	35.5977	6.39	3.2	MW	14	68	-180	236.8	15.4	331.2	15.4
8/5/14 17:09	-97.98949	36.81878	4.17	3.3	ML	225.3	83.5	-171.3	89.9	10.7	359.7	1.5
8/6/14 16:06	-97.60595	36.58066	5	3	ML	-22	90	-34	287.7	23.3	28.3	23.3
8/7/14 16:03	-97.27699	35.57761	5.31	3	ML	9	78	-170	232.7	15.5	323.2	1.5
8/7/14 16:39	-97.99593	36.81748	5.39	3.2	ML	108	44	-28	86	47.7	337.5	16.1
8/8/14 18:07	-97.42928	35.82002	5	3.3	ML	42	42	-162	246.8	42.2	358.6	22.3
8/8/14 20:21	-97.42007	35.81576	4.04	3.3	MW	105	75	-22	61.9	26	153.9	4.2
8/8/14 20:45	-97.41731	35.81416	4.16	3	ML	101	48	-24	73.7	43.4	329	15
8/8/14 20:58	-97.42209	35.8156	3.81	3	ML	98	48	-26	71.4	44.7	327.1	14.1
8/10/14 14:54	-97.86306	36.85865	5	3.3	ML	194.2	73	-180	57.9	11.9	150.5	11.9
8/10/14 22:29	-97.12238	36.28851	5	3.3	ML	31	90	-170	256.4	7.1	165.6	7.1
8/12/14 12:34	-97.51378	36.04441	5	3	ML	65	88	-180	290	1.4	20	1.4
8/13/14 15:44	-97.68499	36.62676	5.64	3.3	ML	224.5	56.1	-179.7	84.1	23.4	184.7	23
8/14/14 14:15	-97.32269	35.86131	5.12	3.2	ML	103	48	-29	77.4	46.7	333.7	12.6
8/16/14 10:54	-97.87144	36.86111	6.1	3.4	ML	28	49	-162	238.1	39	342.8	17.4
8/17/14 6:18	-97.87301	36.8605	5.01	3.6	MW	28	49	-162	238.1	39	342.8	17.4
8/17/14 6:31	-97.86901	36.85582	5	3.2	MW	106	78	1	61.5	7.8	330.3	9.2
8/17/14 15:59	-97.87143	36.85838	5	3.1	MW	28	58	-162	243.7	34.1	341.2	10.9
8/17/14 16:35	-97.87001	36.85585	5	3.1	ML	28	58	-162	243.7	34.1	341.2	10.9
8/18/14 1:25	-98.25406	36.83951	5	3.7	MW	47	58	174	269.3	18.2	8.4	25.9
8/18/14 2:50	-96.487	35.372	1.58	3.5	MW	42	68	-158	262.3	30.7	353	1.1
8/19/14 12:41	-97.46767	35.77268	4.92	4.1	MW	-66	90	22	66.8	15.4	161.2	15.4
8/20/14 11:01	-97.2625	35.88324	4.46	3.1	ML	213.4	67.6	-151.8	73.6	35.3	342	2.3
8/20/14 11:31	-97.26337	35.88604	4.89	3.3	ML	106.5	58	-10.2	69	28.7	330.2	15.6
8/31/14 7:20	-97.99849	36.6189	5.22	3.4	MW	23.3	75	143.8	77.5	12.7	338.1	35.9
9/8/14 16:21	-97.72166	36.82121	5	3.9	MW	216.7	42.2	-97.5	11	84.1	132	3
9/12/14 14:41	-97.27048	36.18392	5	3.7	MW	120	85	-13	74.9	12.7	166.2	5.6
9/15/14 20:08	-97.42748	35.81407	4.43	3.7	MW	30.3	71.7	-171	252.7	19.1	345	6.7
9/18/14 7:12	-97.26929	36.18127	5.21	3.8	MW	117	85	3	71.9	1.4	341.8	5.7
9/19/14 1:31	-97.61298	36.60293	4.56	3.9	MW	225.7	53.1	-178.4	83.8	26.1	186.5	24.1

origintime	longitude	latitude	depth	magnitude	type	strike	dip	rake	P-trend	P-plunge	T-trend	T-plunge
9/19/14 17:23	-97.41996	35.81848	4.14	3.7	MW	41	65	-162	260.2	29.8	353.5	5.8
9/23/14 13:37	-97.56409	34.61046	5	2.9	ML	99	63	-17	60.6	30.3	326	7.9
9/24/14 5:49	-96.7616	36.40354	5	3.5	MW	81	90	-2	36	1.4	126	1.4
9/30/14 3:01	-97.55351	36.22347	2.2	3.7	MW	112	88	-22	65.2	16.8	159.5	13.9
10/7/14 16:51	-96.76562	35.94777	5.28	3.8	MW	9	90	-178	234	1.4	144	1.4
10/10/14 13:51	-96.75941	35.94664	5	3.9	MW	186.7	80.2	-170.5	50.8	13.6	140.9	0.3
10/14/14 4:55	-98.47285	36.51886	3.5	3.3	ML	18	58	-167	234.8	30.6	333.2	13.9
10/14/14 6:26	-97.90327	36.65799	2.34	3.3	ML	89	38	-62	98.7	70.3	339.3	10
10/20/14 16:41	-96.78189	35.94675	4.91	2.8	ML	25	68	-176	247.1	18.1	341.3	12.7
10/21/14 0:46	-97.88368	36.7435	2.41	3.3	ML	28	68	-144	249.2	40.6	153.2	6.9
10/21/14 8:55	-97.7036	36.63604	3.98	3	ML	117	78	-42	68.5	37.6	173.4	18.4
10/23/14 7:06	-97.7149	36.67972	3.9	3.1	ML	51	58	178	271.9	20.7	11.3	23.3
10/25/14 12:36	-97.30438	35.85957	5	3.1	ML	24	58	-173	242.3	26.6	341.4	17.6
10/29/14 16:53	-97.52679	35.73383	6.12	3.2	ML	158	87	-22	111.4	17.5	205.7	13.2
10/30/14 18:57	-97.25767	36.04504	1.94	3.4	ML	54	88	-180	279	1.4	9	1.4
11/9/14 0:35	-97.52656	36.32981	8.2	3.7	ML	62	87	-160	288.2	16.2	194.8	11.8
11/9/14 20:10	-97.09753	36.02438	4.36	3.8	MW	48	87	-162	273.9	14.8	181.1	10.4
11/10/14 2:30	-97.56463	36.75553	4.11	3.5	ML	27	88	-169	252.3	9.2	161.3	6.3
11/13/14 1:28	-96.53889	35.35038	3.08	3.6	MW	121	89	-22	74	16.1	168.3	14.6
11/14/14 11:58	-98.00011	36.62578	3.52	3.6	ML	295.2	58.5	21.6	246.9	8.5	150.6	36.3
11/15/14 13:39	-97.70985	36.61691	6.2	3.4	ML	160	84	-2	115.2	5.7	25	2.8
11/16/14 7:26	-97.32405	36.06491	4.74	3.4	ML	127	65	-42	87	46.7	185	7.5
11/22/14 2:39	-97.43542	36.11818	5.78	3.1	ML	152	71	-45	106.7	44.7	211	14
11/22/14 9:39	-97.57832	36.75617	5.11	3.7	ML	28.1	80.3	-171.6	252.3	12.8	342.5	1
11/24/14 6:36	-97.53135	36.32766	5	3.8	MW	62	90	-165	288	10.5	196	10.5
11/24/14 19:05	-98.33431	36.86814	5.33	3.9	MW	126	58	-42	92.4	50.9	184.3	1.5
11/25/14 1:43	-97.84594	36.85458	3.9	2.7	MW	14	46	-164	222.8	39.2	330.5	20.5
11/25/14 14:43	-97.71915	36.82012	4.13	3.8	MW	31	68	-162	251.5	27.9	343.4	3.6
11/30/14 6:59	-96.77094	35.53828	6.89	3.6	MW	223.9	89	167.8	269.7	7.9	178.4	9.3
11/30/14 10:24	-97.60654	36.60262	5.68	3.9	MW	237.5	82.8	175	102.7	1.6	192.9	8.6
11/30/14 12:18	-97.37882	35.67269	6.26	3.3	MW	117	73	-22	74.6	27.4	166	2.7
12/1/14 17:57	-99.08341	36.49548	7.42	3.7	MW	60	50	-127	262.8	62.5	355.2	1.3
12/2/14 12:04	-97.3788	35.67096	7.1	3.5	MW	203.3	89.8	172.6	248.6	5.1	158.1	5.4
12/3/14 13:33	-99.02788	36.50212	6.66	3.5	MW	48	30	-162	241.7	46.2	9.1	30.2
12/5/14 3:54	-97.09463	36.02299	4.01	3.7	MW	43.9	71.3	-162.2	265.6	25.6	356.2	1.3
12/7/14 22:13	-97.43935	35.81967	5.15	3.9	ML	57	89	-175	282.1	4.2	191.9	2.8
12/8/14 14:05	-97.58632	35.73784	6.98	3.2	ML	271	61	-33.8	234.9	43.4	325	0.1
12/11/14 7:53	-98.05231	36.76191	3.66	4	ML	214.3	66.8	-167.2	74.8	25	168.4	7.7
12/14/14 9:14	-98.12724	36.87056	5.41	4.2	ML	156	82	-15	111.3	16.2	202.7	4.8
12/14/14 21:18	-96.7557	36.31673	4.68	3.9	MW	90	66	-120	318.3	57.9	201.6	15.8

origintime	longitude	latitude	depth	magnitude	type	strike	dip	rake	P-trend	P-plunge	T-trend	T-plunge
12/22/14 3:40	-98.19328	36.80236	5	3.7	MW	19	90	-173	244.2	4.9	153.8	4.9
12/25/14 20:32	-97.41666	35.81239	6.95	3.9	ML	50	79	-162	274.1	20.5	182.4	4.6
12/25/14 23:11	-97.06841	36.36799	1.98	3.9	ML	114	78	-2	69.8	9.9	338.6	7.1
12/30/14 15:11	-98.32513	36.57086	5	3.1	ML	37	74	-166	259.7	21.1	350.3	1.7