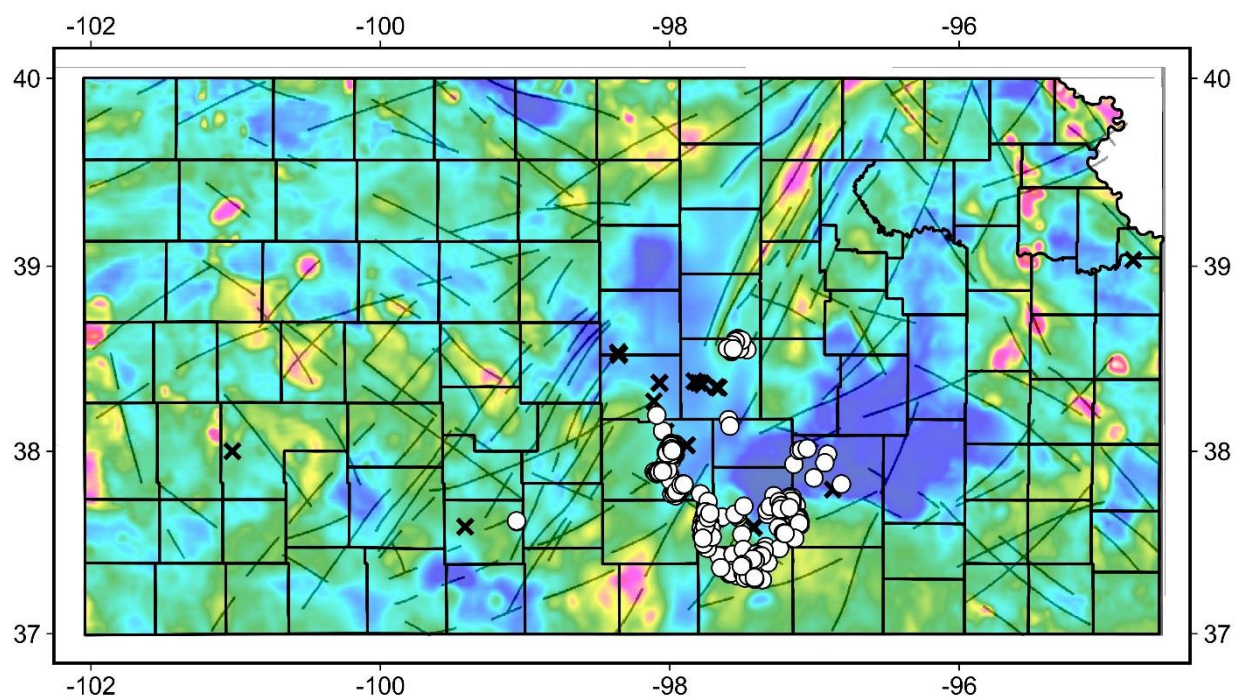


Consortium to Study Trends in Seismicity



July 1, 2017 – June 30, 2018

Annual Report by
Rex Buchanan, Shelby Peterie, Rick Miller

Kansas Geological Survey Open-file Report 2021-3



Cover Figure Caption: Earthquakes (white) located using CSTS stations that otherwise would have not been located by any other seismic network. Correlated with structural trends, the earthquakes provide insight into the stress conditions and relative stability of both unmapped faults and faults interpreted geologic and geophysical datasets.

Kansas Geological Survey
Consortium to Study Trends in Seismicity

2017-2018 Annual Report

NOTICE: This annual report was released in draft to Consortium members, as well as the Kansas Department of Health and Environment, at the Consortium's 2018 annual meeting held on July 18, 2018, and was subject to further review and comment by Consortium members until January 28, 2019. The KGS was then allowed an additional three months to revise the draft annual report and distribute the final annual report.

The Kansas Geological Survey makes no warranty or representation, either express or implied, with regard to the data, documentation, or interpretations or decisions based on the use of this data including the quality, performance, merchantability, or fitness for a particular purpose. Under no circumstances shall the Kansas Geological Survey be liable for damages of any kind, including direct, indirect, special, incidental, punitive, or consequential damages in connection with or arising out of the existence, furnishing, failure to furnish, or use of or inability to use any of the database or documentation whether as a result of contract, negligence, strict liability, or otherwise. This study was conducted in complete compliance with ASTM Guide D7128-05. All data, interpretations, and opinions expressed or implied in this report and associated study are reasonably accurate and in accordance with generally accepted scientific standards.

CONSORTIUM TO STUDY TRENDS IN SEISMICITY

ANNUAL MEETING

AGENDA

18 July 2018

Sedgwick County Extension Education Center
7001 W. 21st St. North — Wichita, Kansas

- 9:30 a.m. **Registration**, pick-up materials, coffee.
- 10:00 a.m. **Welcome, *Rolfe Mandel, Kansas Geological Survey (KGS)***.
Overview of KGS seismic activities.
- 10:10 a.m. **Update on National Induced Seismicity Issues, *Rex Buchanan, KGS***.
This will be a brief update on seismic activity, regulatory activity, and recent research publication on induced seismicity in the midcontinent.
- 10:25 a.m. **Kansas Seismic Monitoring Network/Consortium Monitoring Network Update, *Rick Miller, KGS***.
A report on station location and status of the KGS statewide monitoring network and the monitoring network funded by Consortium members. Focus on active earthquake clusters around the state and their relationship to injection practices and geology.
- 10:45 a.m. **Recent Seismic Activity in Kansas, *Shelby Peterie, KGS***.
Shelby will discuss recent seismic activity and earthquake trends, especially in relation to Consortium facilities.
- 11:15 a.m. **Arbuckle Issues, *K. David Newell, KGS***.
Fluid levels in the Arbuckle Formation have been a topic of concern, particularly in terms of their impact on future disposal. Dave will discuss what is known about Arbuckle fluid levels and recent attempts to collect additional data about the issue.
- 11:45 a.m. **Update on KCC Seismic Responses, *Ryan Hoffman, Kansas Corporation Commission (KCC)***.
Ryan will provide a brief update on regulatory activities of the KCC relative to Class 2 injection. Q&A about trends and plans for Class 2 UIC wells.
- Noon **Lunch**
- 1:00 p.m. **Discussion, Consortium Activities, and Direction**.
An opportunity for Consortium members to discuss monitoring issues, current Consortium activities, and make recommendations for future activities.
- 2:00 p.m. **Adjourn**

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CONSORTIUM TO STUDY TRENDS IN SEISMICITY
KANSAS GEOLOGICAL SURVEY
Fourth Quarter / Annual Report
July 1, 2017 – June 30, 2018

INTRODUCTION

The Kansas Geological Survey's Consortium to Study Trends in Seismicity (CSTS) is a public-private project aimed at studying trends in seismicity in Kansas. Seismicity has increased significantly in Kansas and the midcontinent since 2013, leading to a need to better define and understand seismicity, particularly as it relates to subsurface fluid disposal. The CSTS oversees the operation of a seismic network that records and allows accurate location and magnitude estimates of seismicity for both felt earthquakes and especially microseismic events that are hundreds of times smaller than can be routinely identified with previous regional seismic networks.

The CSTS is operated by the Kansas Geological Survey (KGS), a research and service division of the University of Kansas with a long history of studying the state's subsurface and seismic issues. Current members of the CSTS are from the state's Class 1 disposal well community—wells that are used for disposal of municipal and industrial waste and regulated by the Kansas Department of Health and Environment (KDHE). Membership in the CSTS is voluntary, with a common goal of understanding seismicity in proximity to member facilities. The CSTS works to establish the baseline or background seismicity near those facilities and provide a scientific basis for differentiating natural from induced seismicity.

The following report describes the first year of CSTS activities, including a discussion of membership status; network station installation and operation; earthquakes recorded and identified, and earthquake alerts provided to members; web page development; other activities, especially involving publications, presentations, and meeting attendance; and plans for the coming year. Three previous quarterly reports were provided to members after the Consortium's first meeting in July 2017. This current report includes summaries of seismicity and CSTS activities in both in the past quarter (April, May, and June of 2018) and the past year.

STATUS OF MEMBERS

The CSTS was established with a two-tier membership system. For Tier 1 members the CSTS provides equipment, installation, and monitoring of a seismograph station; maintains a catalog of seismic events, updated weekly, with a goal of providing e-mail alerts within 24 hours or less of any earthquakes greater than magnitude 2 within 30 miles of a facility; provides quarterly reports of monitoring findings; and hosts an annual meeting at which results are discussed and plans formulated for the coming year. Tier 2 members have access to information related to the general information about the seismicity being studied by the CSTS and can attend the annual meeting, but do not have the right to vote at that meeting.

The CSTS currently has eleven Tier 1 members and one Tier 2 member.

STATUS OF NETWORK

The CSTS seismic network currently consists of twelve stations in Kearny, Ellsworth, Rice, McPherson, Reno, Kiowa, Sedgwick, Butler, and Johnson counties, Kansas (Figure 1). Waveforms for these stations are available for Tier 1 members on the seismic network page of

the CSTS website (<http://www.kgs.ku.edu/Geophysics/CSTS/Group/index.html>). For each of those locations, ambient noise tests were completed. Those tests identified noise from nearby highways, trains, pump jacks, and other facilities that might interfere with earthquake analysis. In places where noise and vibrations interfered with stations, those stations were relocated. Many of the existing sites are in cemeteries, on government property, or in other locations where noise levels are likely to be low. In all cases, written agreements with landowners have been obtained.

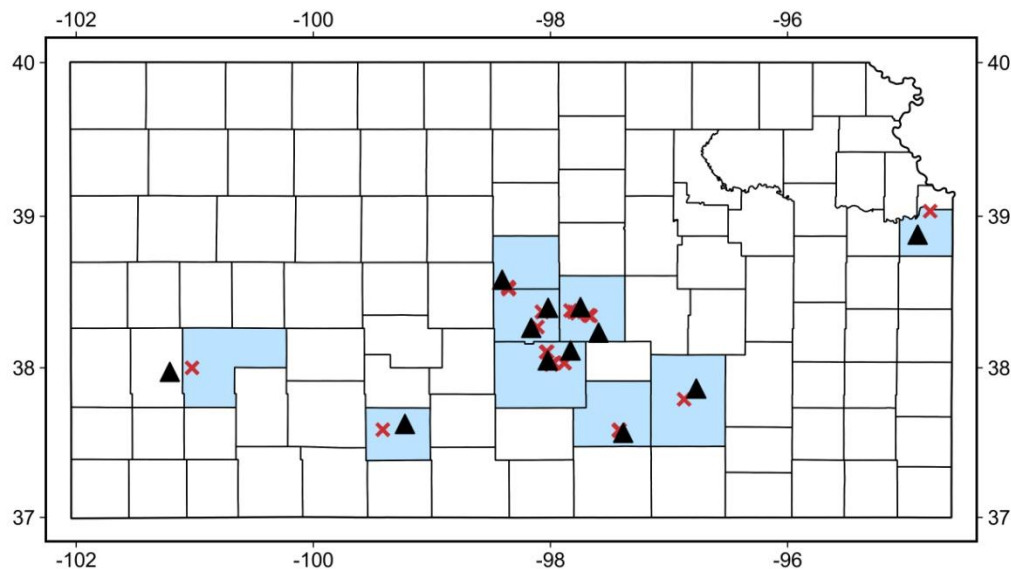


Figure 1. Earthquake stations (black triangles) with member facilities (red X) provide high sensitivity coverage with the potential to identify earthquakes with magnitudes below 0 within 20 miles of each facility.

Each station consists of a seismic sensor that includes a shallowly buried seismometer embedded in a concrete platform atop a gravel layer and a digitizer. Ground motion detected by the seismometer is transmitted back to KGS offices in Lawrence real-time via a cellular modem. That communication system is powered by a solar panel that charges two deep-cycle marine batteries. The footprint for each station is approximately 10 feet by 10 feet. The stations have operated with a better than 98% continuous data stream and within designated operational sensitivity and signal-to-noise ratio.

EARTHQUAKE ALERTS, EARTHQUAKE CATALOG

Earthquakes with magnitudes of 2 or larger are below felt levels but represent a threshold above which energy levels provide highly confident automatic analysis with a network as dense as the CSTS network in conjunction with the KGS regional and subregional networks. It is therefore reasonable to provide accurate epicenter locations using automated picking routines for each event, with results available within minutes of the fault rupture. KGS staff notify CSTS members of a M 2 or larger earthquake within 30 miles of Tier 1 member wells. In the first quarter of 2018, 20 earthquakes met these criteria, about the same as the previous quarter (Oct.-Dec. 2017). Both of those totals are down significantly from the third quarter of 2017 (July-October).

Table 1. M 2 or larger earthquakes recorded from July 1, 2017, to June 30, 2018, with epicenters located within 30 mi of member wells.

<u>Origin Time (UTC)</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Magnitude</u>	<u>County</u>
2017-07-06 07:02:43	37.9370	-96.9289	2.5	Butler
2017-07-27 18:54:46	37.1753	-97.5884	2.0	Sumner
2017-07-29 23:40:38	37.3239	-97.6341	2.3	Sumner
2017-07-30 00:13:46	38.0349	-97.9743	3.3	Reno
2017-07-30 00:16:16	38.0179	-97.9800	2.9	Reno
2017-08-03 15:18:10	37.1707	-97.5757	2.4	Sumner
2017-08-05 03:14:17	37.1758	-97.5915	3.4	Sumner
2017-08-05 05:15:53	37.4374	-97.4033	3.3	Sumner
2017-08-05 15:52:27	37.2837	-97.6174	2.7	Sumner
2017-08-05 20:13:07	37.2873	-97.6209	3.7	Sumner
2017-08-06 02:38:08	37.2809	-97.6137	3.3	Sumner
2017-08-09 07:37:47	38.6316	-97.4368	2.0	Saline
2017-08-12 22:46:35	37.4634	-97.4917	2.3	Sumner
2017-08-14 00:37:58	37.1759	-97.5501	2.0	Sumner
2017-08-15 12:27:21	37.3238	-97.7767	2.5	Sumner
2017-08-15 15:15:47	38.0422	-97.9916	2.6	Reno
2017-08-18 22:55:50	37.4240	-97.4077	2.0	Sumner
2017-08-19 05:46:47	37.4282	-97.3986	2.1	Sumner
2017-08-19 08:33:46	37.4362	-97.4079	2.2	Sumner
2017-08-20 23:07:30	37.2697	-97.6212	2.8	Sumner
2017-08-21 07:58:01	37.2649	-97.5804	2.5	Sumner
2017-08-21 11:55:22	37.2485	-97.5779	2.6	Sumner
2017-08-21 20:32:55	37.2513	-97.5792	3.2	Sumner
2017-08-22 07:16:17	37.2889	-97.4968	2.3	Sumner
2017-08-23 07:34:21	38.0095	-98.0030	2.3	Reno
2017-08-23 08:22:20	37.1766	-97.5868	2.2	Sumner
2017-08-26 05:45:44	37.1742	-97.5176	2.3	Sumner
2017-08-27 15:01:16	37.2451	-97.5808	3.2	Sumner
2017-08-29 05:27:14	37.6012	-97.7659	2.1	Sedgwick
2017-08-30 09:33:21	37.5919	-97.7725	2.0	Sedgwick
2017-08-30 11:30:50	37.6117	-97.7765	2.2	Sedgwick
2017-08-31 07:07:38	37.7003	-97.4881	2.0	Sedgwick
2017-08-31 07:21:17	37.5931	-97.7766	3.8	Sedgwick
2017-08-31 12:47:17	37.5902	-97.7607	2.1	Sedgwick
2017-09-01 12:14:59	37.5961	-97.7551	2.1	Sedgwick
2017-09-02 05:12:57	37.5817	-97.7704	2.5	Sedgwick
2017-09-02 06:58:01	37.5572	-97.7976	2.0	Sedgwick
2017-09-02 19:46:08	37.5669	-97.7882	2.4	Sedgwick
2017-09-03 15:42:35	37.6013	-97.7600	2.0	Sedgwick
2017-09-03 16:07:44	37.1861	-97.6211	2.6	Sumner
2017-09-03 19:18:00	37.5910	-97.7654	2.6	Sedgwick
2017-09-03 20:19:34	37.5803	-97.7680	2.0	Sedgwick
2017-09-03 20:51:06	37.5798	-97.7745	2.0	Sedgwick
2017-09-03 21:14:25	37.5919	-97.7669	2.3	Sedgwick
2017-09-03 23:16:25	37.5894	-97.7609	2.2	Sedgwick
2017-09-04 00:07:31	37.5917	-97.7699	2.1	Sedgwick
2017-09-04 06:10:13	37.5917	-97.7751	2.4	Sedgwick
2017-09-05 01:32:55	37.5835	-97.7812	2.8	Sedgwick
2017-09-08 09:59:44	37.3279	-97.7987	2.4	Sumner
2017-09-10 04:01:28	37.3345	-97.5723	2.0	Sumner
2017-09-10 15:19:19	37.3558	-97.8322	2.5	Harper
2017-09-12 03:49:52	37.2524	-97.5202	2.2	Sumner
2017-09-14 08:15:30	37.3439	-97.5569	2.1	Sumner
2017-09-15 01:13:09	37.2059	-97.6180	2.1	Sumner
2017-09-16 12:42:11	37.3395	-97.5831	2.6	Sumner
2017-09-20 15:27:34	37.3213	-97.8012	2.4	Sumner
2017-09-26 16:39:08	37.4807	-97.7384	2.2	Sedgwick
2017-09-27 07:45:44	37.3329	-97.7697	2.0	Sumner
2017-10-03 13:38:15	37.4300	-97.3997	2.7	Sumner

Table 1. Continued

2017-10-10 03:22:51	38.6795	-97.4964	2.2	Saline
2017-10-10 10:21:32	38.6687	-97.4717	2.1	Saline
2017-10-10 20:25:33	38.6737	-97.4970	2.9	Saline
2017-10-13 12:04:34	38.6550	-97.5027	2.6	Saline
2017-10-14 00:29:54	37.2360	-97.6574	2.5	Sumner
2017-10-17 19:01:55	38.6845	-97.4904	2.1	Saline
2017-10-19 09:19:58	37.4134	-97.4142	3.0	Sumner
2017-10-19 10:43:04	37.4075	-97.3995	2.1	Sumner
2017-10-26 05:35:56	37.3318	-97.7852	2.0	Sumner
2017-11-01 11:54:43	38.0133	-97.9593	2.0	Reno
2017-11-08 03:18:06	37.2715	-97.6222	2.8	Sumner
2017-11-13 15:52:14	38.6542	-97.5168	2.0	Saline
2017-11-24 17:47:01	37.6227	-97.1124	2.3	Butler
2017-11-28 02:11:22	37.7390	-97.1612	2.0	Sedgwick
2017-11-28 06:12:23	37.7482	-97.1692	2.3	Sedgwick
2017-11-28 11:40:15	37.3110	-97.4369	2.2	Sumner
2017-12-16 05:30:15	38.0134	-97.9645	2.0	Reno
2017-12-19 11:20:01	37.3619	-97.8018	2.1	Sumner
2017-12-19 20:44:00	37.7877	-97.9378	2.0	Reno
2017-12-25 13:33:18	37.7799	-97.9425	2.0	Reno
2017-12-25 23:05:14	37.7741	-97.9426	2.4	Reno
2017-12-30 10:25:45	37.7809	-97.9584	2.7	Reno
2017-12-30 14:34:18	37.7794	-97.9351	2.1	Reno
2017-12-31 05:36:55	37.7893	-97.9424	2.2	Reno
2017-12-31 11:46:35	37.7895	-97.9288	2.8	Reno
2018-01-01 01:08:33	37.2450	-97.5130	2.1	Sumner
2018-01-26 11:02:21	37.3280	-97.7680	2.1	Sumner
2018-02-05 09:18:39	38.0160	-97.9990	2.0	Reno
2018-02-07 06:02:57	38.0190	-97.9920	2.0	Reno
2018-02-07 06:18:25	38.0300	-97.9940	2.2	Reno
2018-02-08 05:08:38	37.3670	-97.7540	2.1	Sumner
2018-02-08 12:36:39	37.4890	-96.7630	2.1	Butler
2018-02-13 01:14:00	38.6890	-97.5510	2.0	Saline
2018-02-22 23:43:00	38.6520	-97.5350	2.1	Saline
2018-03-01 20:27:01	38.0196	-97.9801	3.0	Reno
2018-03-01 20:30:42	38.0210	-97.9870	2.3	Reno
2018-03-01 21:15:28	38.0188	-97.9952	2.3	Reno
2018-03-02 01:47:19	38.0130	-97.9800	2.0	Reno
2018-03-02 07:29:23	38.0130	-97.9870	2.5	Reno
2018-03-02 21:09:36	38.0180	-97.9710	2.0	Reno
2018-03-05 11:12:17	38.0150	-97.9760	2.2	Reno
2018-03-05 16:41:05	37.2740	-97.2820	2.3	Sumner
2018-03-08 10:48:21	38.0130	-97.9850	3.5	Reno
2018-03-13 02:43:47	37.6030	-99.0550	2.1	Kiowa
2018-03-18 02:17:16	38.0115	-98.0058	3.2	Reno
2018-03-21 00:43:41	38.0140	-97.9800	2.0	Reno
2018-04-03 19:26:19	38.0192	-97.9834	2.6	Reno
2018-04-03 21:56:10	38.0100	-98.0050	2.5	Reno
2018-04-08 23:34:26	38.0150	-97.9810	2.4	Reno
2018-04-10 10:56:18	37.5680	-97.8170	2.2	Kingman
2018-04-14 02:46:34	38.0180	-97.9810	3.3	Reno
2018-04-14 02:59:42	38.0260	-97.9900	2.3	Reno
2018-04-16 13:24:10	37.2970	-99.4420	2.2	Comanche
2018-04-17 23:05:47	38.0180	-97.9890	3.0	Reno
2018-04-18 00:40:27	38.0060	-97.9980	2.1	Reno
2018-04-18 02:43:36	38.0250	-97.9800	2.0	Reno
2018-04-18 09:14:08	38.0130	-97.9970	2.4	Reno
2018-04-20 02:54:47	38.0130	-97.9890	2.7	Reno
2018-04-20 05:42:36	38.0080	-97.9960	2.2	Reno
2018-04-24 12:14:40	37.3570	-97.6520	2.1	Sumner
2018-04-26 22:30:39	37.3570	-97.6650	3.0	Sumner

Table 1. Continued

2018-04-27 12:03:02	37.9910	-97.9980	2.1	Reno
2018-04-29 15:42:42	37.3570	-97.6610	2.8	Sumner
2018-05-23 17:05:23	38.6710	-97.6090	2.2	Saline
2018-05-24 06:50:20	38.6390	-97.5940	2.1	Saline
2018-05-26 10:39:14	38.0150	-97.9940	2.2	Reno
2018-06-01 15:37:36	37.3050	-97.4090	2.0	Sumner
2018-06-01 22:44:29	38.0140	-97.9960	2.1	Reno
2018-06-02 02:41:34	38.0110	-97.9990	2.0	Reno
2018-06-02 03:43:44	38.0130	-98.0010	2.7	Reno
2018-06-04 13:48:23	38.0140	-97.9780	2.8	Reno
2018-06-12 18:21:04	37.2240	-97.4830	2.0	Sumner
2018-06-20 21:45:29	37.2770	-97.6130	2.2	Sumner
2018-06-27 14:04:25	37.2920	-97.4270	3.5	Sumner

INTERESTING OBSERVATIONS AND SIGNIFICANT TRENDS

Network Observations

Regional Seismicity (M 2 or larger)

More than 500 earthquakes magnitude (M) 2 or larger were recorded in Kansas during the past year (Figure 2). The overall number of regional scale events (M 2 or larger) decreased by about 30% relative to the previous year (from July 2016 through June 2017). The vast majority of these events either occurred in parts of the state where historic earthquakes occurred along prominent uplift structures or where earthquakes were recorded in recent years. The notable exceptions are clusters of earthquakes in southern Comanche County adjacent to the Oklahoma border and near the southwest corner of Republic County in the north-central part of the state.

South-Central Kansas

About half of the earthquakes recorded by the KGS network during the past year were located in south-central Kansas, primarily in Harper and Sumner counties (Figure 3). The earthquake rate in these counties has dropped dramatically since the KGS network was installed in 2015. About 220 earthquakes were recorded during the past year, down more than 80% relative to 2015. Earthquake clusters generally occurred in areas where earthquakes were observed in previous years. One notable exception was a M 3.5 earthquake on June 27, 2018, that occurred about 3 mi northwest of Wellington in an area with only occasional, sparse seismic activity the past few years.

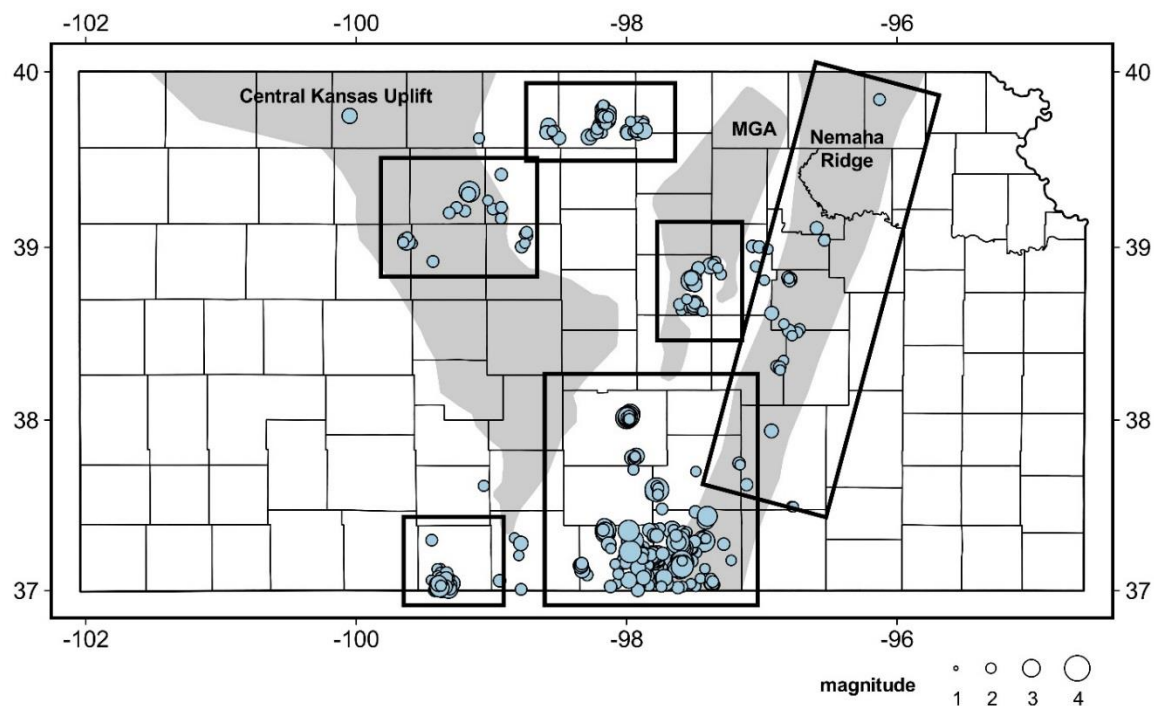


Figure 2. M 2 or larger earthquakes recorded in Kansas by the KGS seismic network from July 2017 through June 2018 superimposed on the prominent basement structures (gray). Black boxes indicate areas discussed in the text.

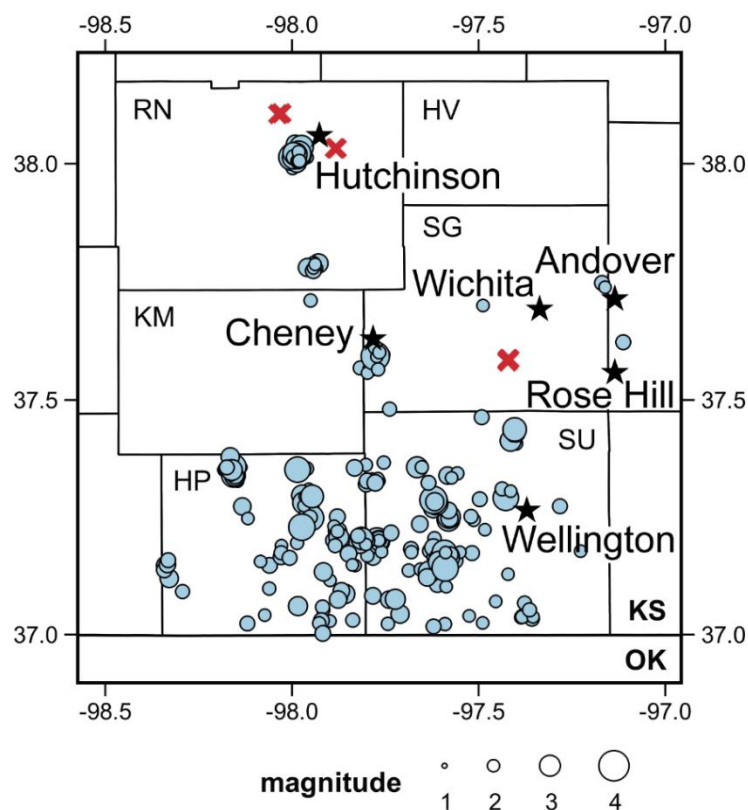


Figure 3. M 2 or larger earthquakes recorded in south-central Kansas from July 2017 through June 2018.

From 2015 to 2017, earthquakes migrated from the high seismicity zones in Harper and Sumner counties progressively farther along structural trends into surrounding counties, including Sedgwick, western Butler, Kingman, and Reno counties. Earthquakes along these trends are most likely induced, triggered as a result of elevated fluid pressure reducing frictional resistance of critically stressed basement faults. Seismicity has continued in western Sedgwick County near Cheney, with a cluster of 20 M 2 or larger earthquakes. East of Wichita at the Sedgwick–Butler county line, relatively low-rate seismicity has continued with two M 2 or larger earthquakes near Andover and one M 2.3 near Rose Hill during the past year. The Rose Hill event is near where a cluster of earthquakes began in mid-2016. The Andover events occurred a little to the northeast along structural and earthquake trends recorded in 2016.

One M 2 earthquake was recorded on August 31, 2017, in central Sedgwick County west of Wichita. Although this event may have been influenced by elevated pore pressures attributed to high-volume saltwater disposal near the Kansas–Oklahoma border, it is isolated from any other recorded earthquake and did not occur along the same or extensions of trends in seismicity and structure as other likely induced events. This earthquake is located on the western limb of the Valley Center anticline within 10 mi of felt reports of historic earthquakes near Wichita, and may represent natural movement along a stressed fault associated with this structure.

To the north, seismicity in Kingman County has largely subsided, with only one M 2.2 near the Cheney cluster and one M 2.1 near the Kingman–Reno county line. In Reno County, more than 50 M 2 or larger earthquakes were recorded in distinct clusters during the reporting period. These events are discussed in detail in the section on local seismicity near Reno County member wells.

Comanche County

Although some earthquakes occurred in southern Comanche County in previous years, seismicity was sparse and at a low rate, with only about a dozen earthquakes M 2 or larger. A series of earthquakes including more than 60 M 2 or larger, began in July 2017 near the southern Comanche County border, the largest of which were two M 3.2 earthquakes that occurred on July 21 and July 29 (Figure 4). The USGS also reported more than a dozen earthquakes (M 2.5 to M 3.1) in adjacent Woods County in Oklahoma during this time. These events occurred along the hinge of a synclinal feature. While there are no high-rate (10,000 bbl/day or more) disposal wells in this area, interpolated bottomhole pressures recorded in wells that terminate in the Arbuckle Group suggest that high-volume saltwater disposal near the south-central Kansas border caused a pore pressure increase in Comanche County large enough to trigger earthquakes on hydraulically connected, critically stressed basement faults. Despite the lack of high-volume injection in the vicinity of this active earthquake cluster, these events are mostly likely induced.

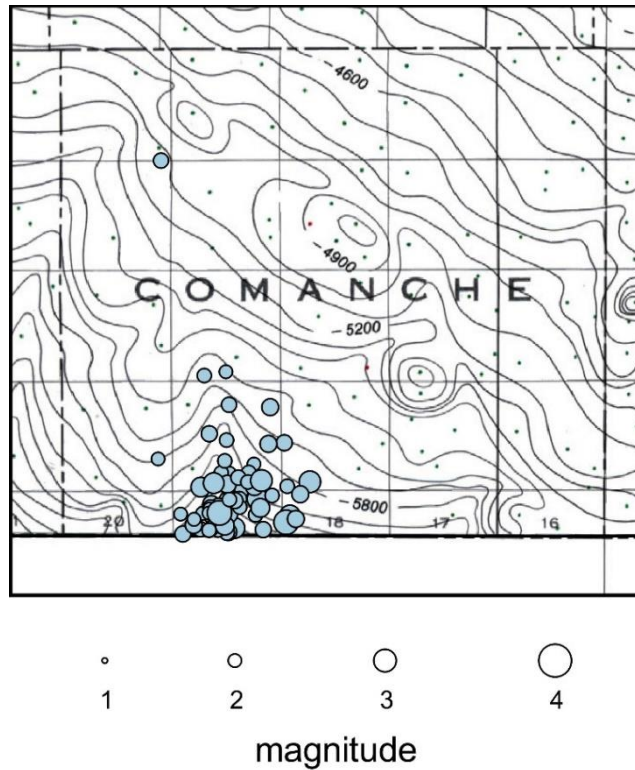


Figure 4. M 2 or larger earthquakes recorded in Comanche County from July 2017 through June 2018 superimposed on Precambrian structural contours (from Cole, 1976).

Central Kansas Uplift

Nearly two dozen earthquakes were recorded in areas affected by the Central Kansas Uplift (Figure 5). Although few of these events occur on mapped faults, basement rocks contain a large number of unmapped faults as evidenced by sparse sampling of basement rocks during exploration drilling. Most of the seismicity associated with the Central Kansas Uplift was recorded along the eastern margin in Rooks, Osborne, and Russell counties in areas that have historically experienced seismicity (Armbruster et al., 1989). An unusually active cluster began in mid-2016 in northeast Trego County near the northern extension of the Rush Rib, along the crest of which Arbuckle Group rocks are locally absent and truncate against Precambrian basement rock. Although nearly 100 M 2 or larger earthquakes have been recorded since mid-2016, activity tapered down significantly in 2017 with only a few events recorded here during the past year. Considering the history of seismicity in this general area, the unprecedented number of events in this county could represent natural release of energy along a critically stressed fault. However, given the proximity (10 miles) of this cluster to a spatially dense area of deep injection wells into formations that are likely hydraulically connected to basement faults, these events may be induced.

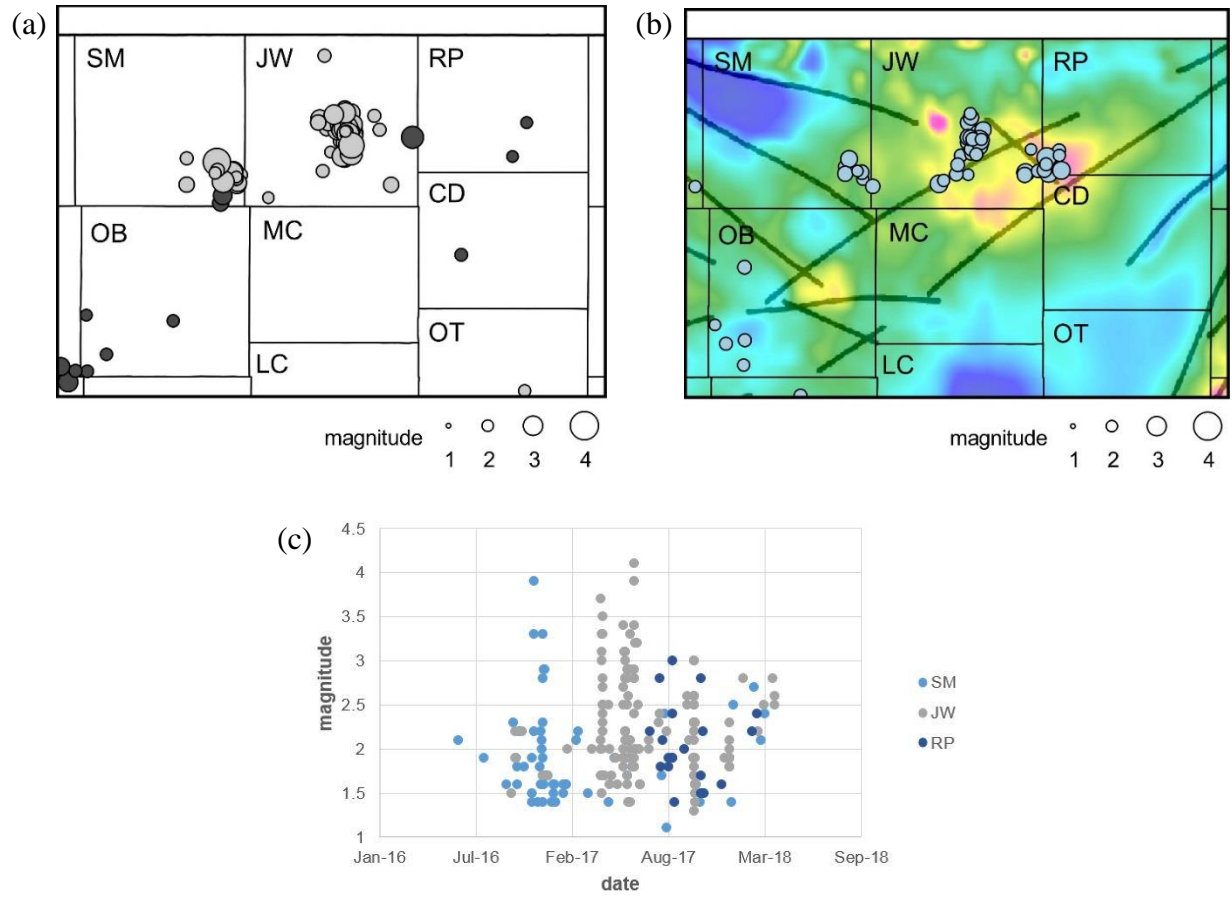


Figure 6. M 2 or larger earthquakes recorded in the Salina Basin (a) prior to July 2017 (gray indicates earthquakes recorded by the KGS network after 2015, black indicates earthquakes recorded by other regional networks prior to 2015), and (b) from July 2017 through June 2018, superimposed on the aeromagnetic map of Kansas and mapped magnetic lineaments (from Yarger, 1983). (c) Histogram illustrating the magnitude and timing of earthquakes recorded in Smith (light blue), Jewell (gray), and Republic (navy) counties.

These events occur within the Salina Basin where there is very little oil and gas production. With the nearest disposal well located more than 20 miles from any of these north-central Kansas earthquakes, it is likely these events are natural. Although there are no prominent uplift structures in this area, historic seismicity (albeit sparse) indicates the presence of stressed basement faults. Mapped magnetic lineaments that trend northwest and northeast in these counties likely correspond to basement faults associated with Central Kansas Uplift and Midcontinent Rift System, respectively. The temporal progression of these sequences is notable, trending from approximately west to east along interpreted basement lineaments (Figure 6c). This progression may indicate that the Smith County earthquakes resulted in a redistribution of stress, subsequently reactivating adjacent faults that were near failure. Alternately and unlikely, the mapped lineament could represent a more permeable pathway providing a preferential transport corridor increasing pore pressure along the any interconnected fault surfaces.

Midcontinent Geophysical Anomaly

The Midcontinent Geophysical Anomaly (MGA, the largest positive gravity anomaly in North America) is caused by a thick sequence of mafic igneous rocks that formed during major late Precambrian rifting as part of the Midcontinent Rift System. Two ongoing clusters of earthquakes have been recorded along the southeastern margin of the MGA since the KGS network was installed in 2015. Almost 20 M 2 or larger earthquakes were recorded in distinct clusters in eastern Saline County (Figure 7). These clusters are discussed in greater detail in the section on local seismicity near McPherson County member wells.

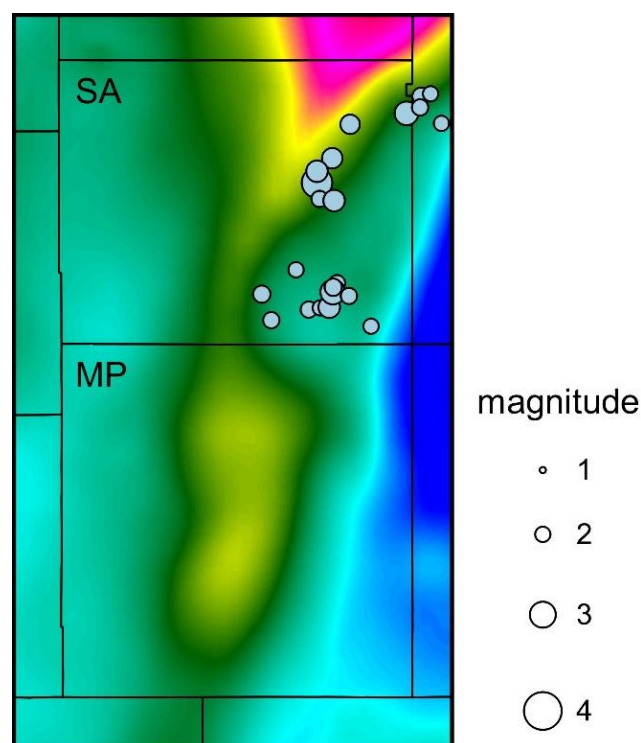


Figure 7. M 2 or larger earthquakes recorded near the Midcontinent Geophysical Anomaly from July 2017 through June 2018 superimposed on the gravity anomaly map of Kansas.

Nemaha Ridge

The Nemaha Ridge is one of the most prominent crustal features in Kansas, extending across the state with a northeast-southwest orientation. The Nemaha Ridge formed during post-Mississippian uplift of Precambrian age granite. A system of normal and reverse faults on the eastern margin of the Nemaha Ridge forms the Humboldt Fault Zone. Transform faults with a northwest-southeast trend intersecting the Nemaha Ridge represent a pre-Phanerozoic crustal extension associated with the Midcontinent Rift System. Dozens of historic earthquakes have been felt or recorded along the Nemaha Ridge, including an estimated M 5.2 near Wamego in 1867.

More than two dozen M 2 or larger earthquakes were recorded during the reporting period along the Nemaha Ridge ranging from Nemaha County to Butler County (Figure 8). Earthquakes in northern and southern Butler County occurred on the crest of and eastern margin of the Nemaha Ridge, respectively. These do not occur along the trends of induced earthquakes to the southwest, and likely represent natural movement on faults associated with the Nemaha Ridge.

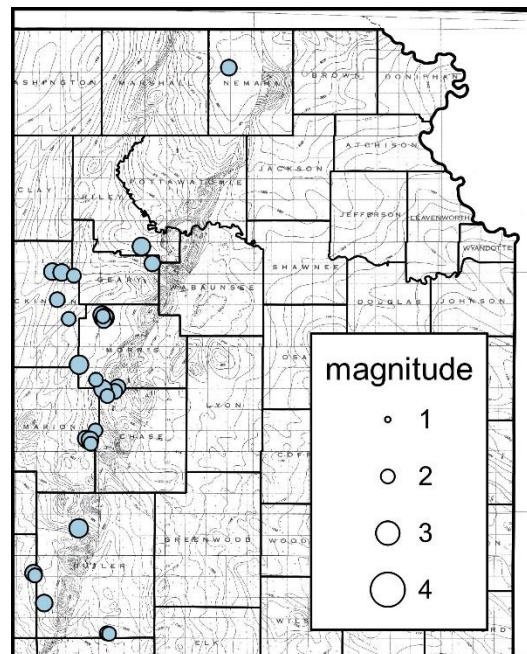


Figure 8. M 2 or larger earthquakes recorded along the Nemaha Ridge from July 2017 through June 2018 superimposed on Precambrian structural contours (from Cole, 1976).

Local Seismicity within 20 mi of Member Wells

During the past year, more than 1,600 earthquakes with M less than 2 were recorded by the KGS seismic network (with enhanced sensitivity and improved location accuracy with the addition of CSTS stations) (Figure 9). Similar to regional scale earthquakes, the overall number of microearthquakes is down slightly (about 25%) relative to the previous year. Analysis of events well below M 2 greatly improves our ability to interpret earthquakes relative to structures and evaluate possible causal factors.

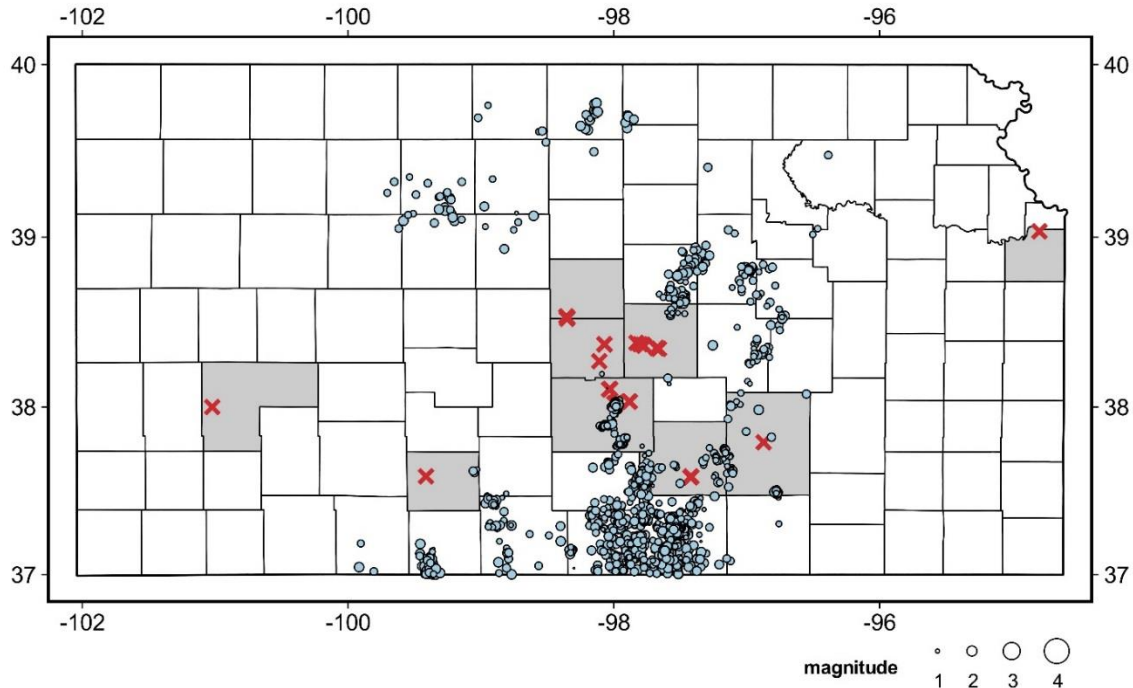


Figure 9. Microearthquakes (M less than 2) recorded in Kansas by the KGS seismic network from July 2017 through June 2018. Gray shading indicates counties with CSTS member wells (red Xs).

Finney County

No earthquakes were located within 20 mi of member wells in Finney County.

Kiowa County

A cluster of four earthquakes was recorded about 20 mi east of the member well in Kiowa County. These earthquakes are located northwest of the Sun City earthquake swarm along structural trend consistent with the southwest margin of the Central Kansas Uplift and Pratt Anticline (Figure 10). Although there are some subnetwork events within 20 miles (discussed in the next section), these events are currently low magnitude and low recursion rate. Rising bottomhole fluid pressure measured in Kiowa County suggests fluid migration and pressure diffusion northwest, probably along the Pratt Anticline.

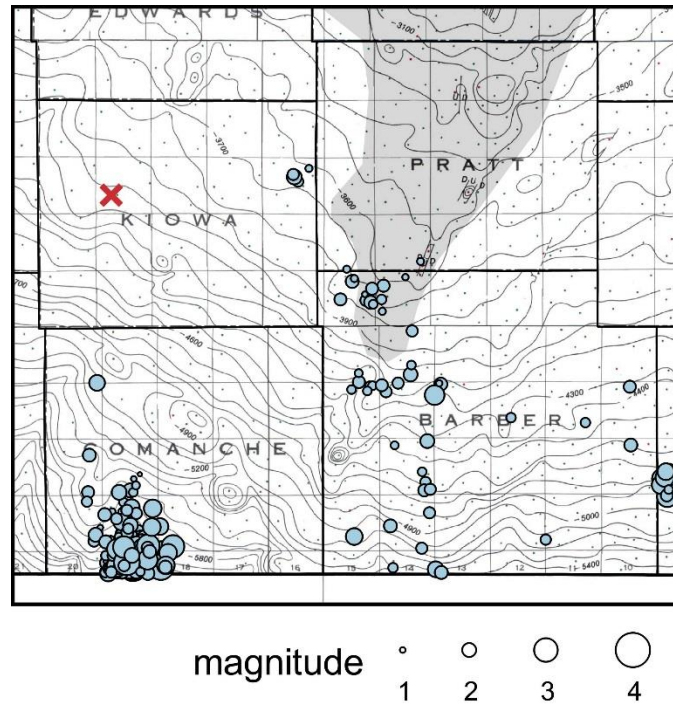


Figure 10. Earthquakes recorded in Kiowa County from July 2017 through June 2018 superimposed on Precambrian structural contours (from Cole, 1976) and inferred Pratt Anticline at the southern end of the Central Kansas Uplift (gray). CSTS member well(s) are indicated by a red X.

Reno County

Four distinct clusters of earthquakes were recorded in Reno County (Figure 11). Two clusters of earthquakes were recorded in December 2017 and February 2018 in the southern part of the county within about 3 miles of Cheney Reservoir. The largest event was a M 2.8 on December 31, 2018. A small cluster of microearthquakes was recorded about 5 mi east of Arlington that occurred sporadically throughout the reporting period. The largest event in the Arlington cluster was a M 1.9 on March 26, 2018. The Arlington cluster has a west-east trending linearity, less than 2 mi long, and is roughly parallel to the structural grain, as evidenced by the Precambrian structural contour map. The alignment of microearthquakes may indicate low energy slip along a relatively stable, although active, basement fault or fault zone.

The most notable cluster of earthquakes was recorded about 2 mi west of South Hutchinson. More than 200 earthquakes were recorded in the Hutchinson cluster during the last year, the largest of which was a M 3.6 on March 8, 2018. Microseismic activity occurred regularly, with the exception of a nearly two month period from December 2017 to February 2018 (Figure 12). Although this period coincides with the dates of the earthquake clusters near Cheney Reservoir, it is unlikely that these events are related to seismicity near Hutchinson. The Hutchinson cluster is a dense, circular swarm about 2 mi in diameter. The maximum size of an earthquake is related to the length of the fault that ruptures. Based on the fault expanse delineated by the Hutchinson earthquakes, it is unlikely that an earthquake with the potential to cause major damage is possible from within this cluster.

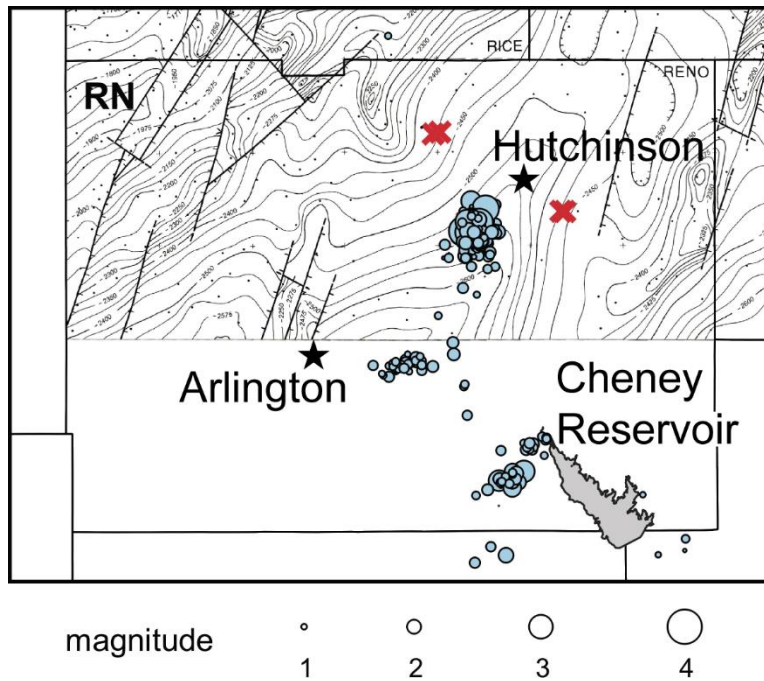


Figure 11. Earthquakes recorded in Reno County from July 2017 through June 2018 superimposed on Arbuckle Group structural contours (from Berendsen and Blair, 1986). CSTS member well(s) are indicated by a red X.

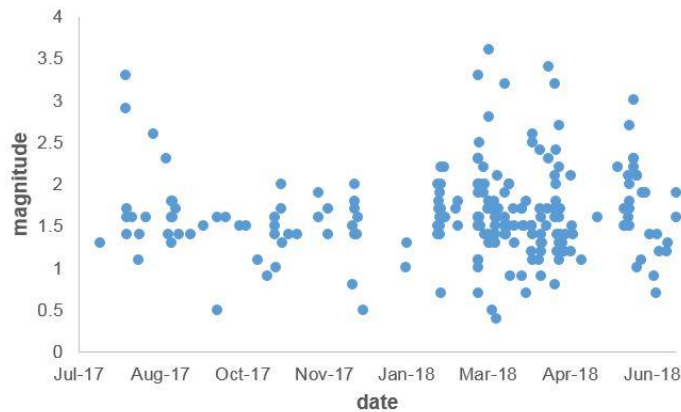


Figure 12. Histogram illustrating the magnitude and timing of earthquakes recorded near Hutchinson.

The four earthquake clusters in Reno County all occur within a structural low, bounded by the Central Kansas Uplift to the west and the Voshell Anticline to the east (Figure 11). In late 2016 and 2017, earthquakes progressed from the south along this structural low toward the axis of the Conway Syncline, a south-plunging synclinal fold at the northern margin of the Sedgwick Basin that extends northeast into McPherson County. The northward progression of earthquakes is likely the result of elevated fluid pressure from high-volume saltwater disposal near the Kansas–Oklahoma border.

One microearthquake (M 0.3) occurred on September 7, 2017, in northern Reno County about 6 mi north-northwest of the Hutchinson cluster. The northern migration of earthquakes is consistent with the spatial trend of the Arbuckle pressure surge identified in bottomhole pressure measurements. In southern Kansas, fluid migrated along permeable faults parallel to the dominant structural trends, inducing earthquakes along the structural grain. Although this northern Reno County event could represent northern migration of seismicity, it is isolated and with no ties to any established trend that are typical of induced earthquakes. In addition, it occurred north-northwest of the induced earthquake trend, which is not consistent with the northeast structural grain in Precambrian and Arbuckle Group rocks. Therefore, the solitary event in northern Reno County may represent natural movement on a stressed, unmapped basement fault.

Rice County

Only one microearthquake was recorded in southern Rice County, a M 1.1 event on February 1, 2018. The epicenter occurred near the north end of a mapped fault in the Peace Creek Tectonic Zone (Figure 13). Similar to the single northern Reno County earthquake, this event is isolated, and against the structural grain relative to induced earthquake clusters to the south and, therefore, may represent natural movement on a stressed basement fault. However, the influence of elevated pressure from the south or from local injection operations has not been definitively ruled out.

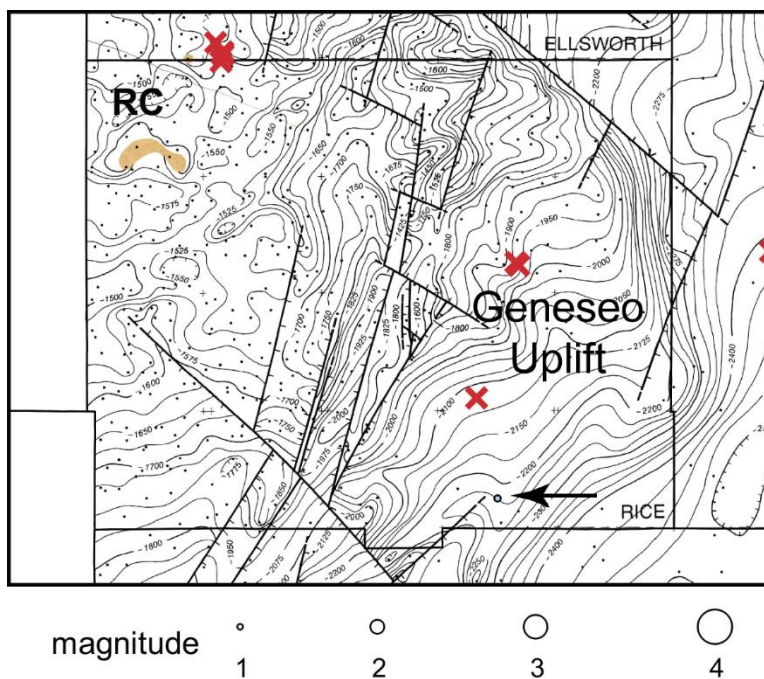


Figure 13. Earthquake (indicated by black arrow) recorded in Rice County from July 2017 through June 2018 superimposed on Arbuckle Group structural contours (from Berendsen and Blair, 1986). CSTS member well(s) are indicated by a red X.

Ellsworth County

No earthquakes were located within 20 mi of member wells near the Ellsworth–Rice county line.

McPherson County

Although no earthquakes were recorded in proximity to member wells in McPherson County, earthquakes were near both the northern and southern county lines (Figure 14). Two microearthquakes were recorded 12 to 20 mi away in northern Harvey County between the Voshell Anticline to the west and Halstead Fault to the east. A cluster of about 60 earthquakes occurred near the McPherson–Saline county line 14 mi or more from member wells. These events occur near the eastern margin of the Midcontinent Geophysical Anomaly along and east of the Salina Fault in Saline County. Seismicity in this area has been ongoing—since installation of the KGS seismic network in 2015, more than 50 M 2 or larger earthquakes have been recorded in this cluster and to the north along the same general structure. Historically, seismicity in this area is extremely sparse, with only one M 1.7 earthquake on February 9, 1983, about 10 mi to the west. Therefore, persistent seismicity in this area is somewhat unexpected.

Clustering of earthquakes and persistent seismicity can be an indicator that elevated pore pressures may be influencing seismicity. Nearly 50 Class II saltwater disposal wells operate in the immediate vicinity of the McPherson–Saline earthquakes, more than a dozen of which terminate in the Arbuckle Group. However, these wells are relatively low-rate, with the highest rate

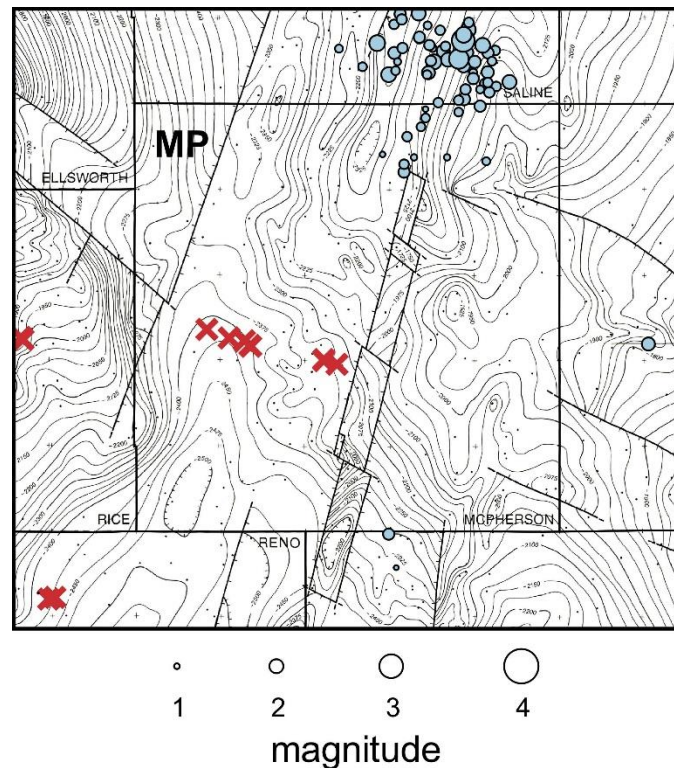


Figure 14. Earthquakes recorded in McPherson County from July 2017 through June 2018 superimposed on Arbuckle Group structural contours (from Berendsen and Blair, 1986). CSTS member well(s) are indicated by a red X.

well injecting less than 3,000 bbl/day. Therefore, it is unclear what role nearby disposal may play in the elevated seismic activity.

Sedgwick County

Seismic activity in and around Sedgwick County is largely induced as a result of elevated pore pressures from high-volume saltwater disposal near the Kansas–Oklahoma border. Earthquakes occurred primarily in three areas within 20 mi of member wells in Sedgwick County (Figure 15). The most active cluster is at the Sedgwick–Kingman county line where seismic activity began in early 2015 near Cheney. About 150 earthquakes were recorded here during the reporting period, the largest of which was a M 3.8 on August 31, 2017. The Cheney events occur along a synclinal feature evident in structural contours of Precambrian rocks.

A cluster of earthquakes began in northern Sumner County in mid-2016 about 10 mi south of the Sedgwick County member wells. More than 30 earthquakes were recorded in this cluster during the past year, the largest of which was a M 3.3 on August 5, 2017. This cluster occurred northeast of the majority of the Sumner County seismicity along a gravity anomaly trend parallel to the Midcontinent Rift System and Nemaha Ridge. Further to the northeast along this same gravitational trend, several sparse earthquakes and two distinct clusters were recorded near the Sedgwick–Butler county line at the western margin of the Nemaha Ridge. The cluster in southwest Butler County north of Rose Hill had several distinct periods of activity since it began in mid-2016, but only one during the reporting period. A sequence of 12 earthquakes occurred in late 2017, culminating in a M 2.3 main shock on November 24, 2017. At about the same time, a sequence of 11 earthquakes occurred in eastern Sedgwick County northwest of

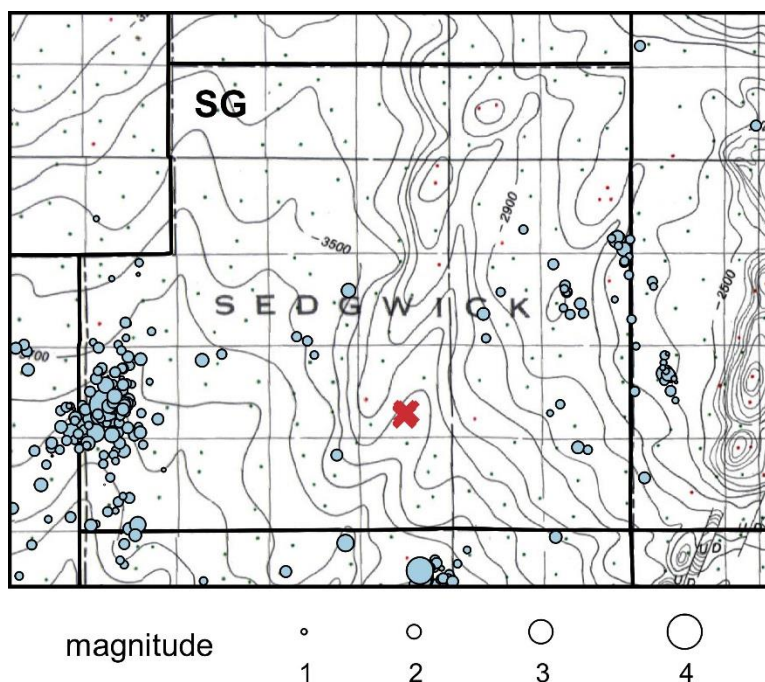


Figure 15. Earthquakes recorded in Sedgwick County from July 2017 through June 2018 superimposed on Precambrian structural contours (from Cole, 1976). CSTS member well(s) are indicated by a red X.

Andover, which culminated in a M 2.3 main shock on November 28, 2017. This cluster occurred at about the same place as (within the location accuracy of) a historic M 2.2 earthquake on February 24, 1982.

Migration of fluid and pressure diffusion away from high-volume saltwater disposal wells near the Kansas–Oklahoma border triggered earthquakes progressively farther from the injection points. Earthquakes typically occurred along linear trends consistent with the structural grain of Precambrian rocks, primarily to the northeast. The events in the Sedgwick County area discussed in this section occur along identified trends in seismicity and structure and are likely induced as a result of elevated fluid pressure associated with high-volume saltwater disposal.

Butler County

In addition to the earthquakes near the Sedgwick–Butler county line discussed in the previous section, there were several earthquakes in Butler County with no clear trend (Figure 16). A cluster of microearthquakes occurred in late 2017 about 7 mi northwest of Potwin. This cluster is located on the steeply dipping western flank of the Nemaha Ridge. These earthquakes do not follow the northeasterly trend of induced earthquakes that have migrated progressively farther from the high-volume saltwater disposal near the southern Kansas border. Although it is possible for pore pressures to be elevated in Butler County, the earthquakes in northern Butler County do not follow a clear temporal or spatial trend that would suggest these events were induced. To the south, a cluster of more than 20 earthquakes occurred in late 2017 and early 2018 near the Cowley County line. These events are east of the Nemaha Ridge. It is unclear whether

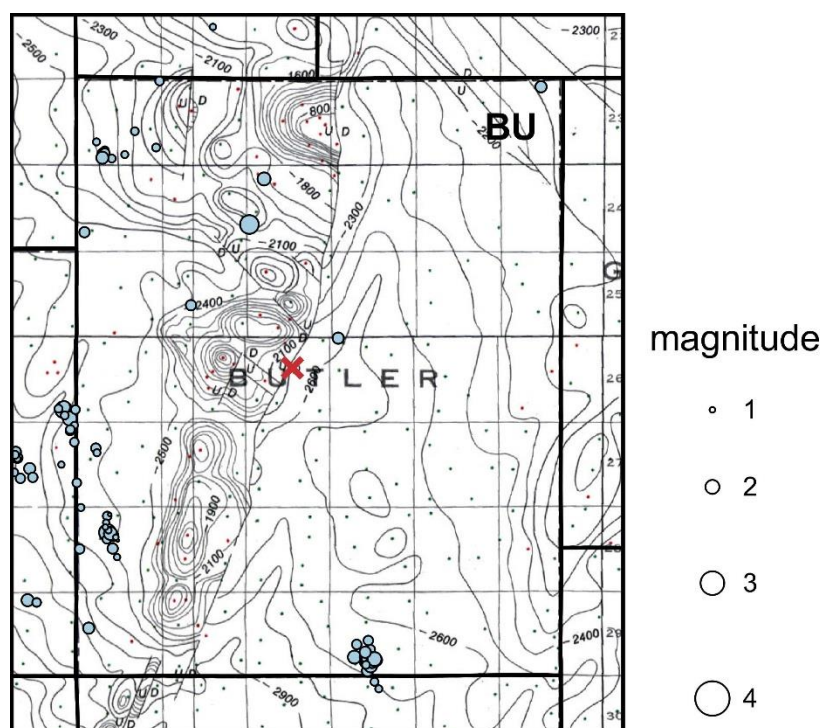


Figure 16. Earthquakes recorded in Butler County from July 2017 through June 2018 superimposed on Precambrian structural contours (from Cole, 1976). CSTS member well(s) are indicated by a red X.

the Nemaha Ridge and Humboldt Fault Zone on the eastern flank would be an impermeable barrier for fluid flow. While this cluster of events likely represents natural movement of a critically stressed fault, the influence of elevated pore pressures has not been ruled out.

Johnson County

No earthquakes were located within 20 mi of member wells in Johnson County.

Subnetwork Seismic Events

Locating the epicenter of an earthquake requires detecting P- or S-waves at three or more stations. Subnetwork events are only recorded on a single or at most two station (s) and therefore, the epicenter location cannot be determined uniquely. Rather, the epicenter exists somewhere on a circle centered on the seismic station with radius equal to the calculated distance to the earthquake epicenter (Figure 6). The magnitude of a subnetwork event is estimated from the coda, or duration—the time from the P-wave arrival until the energy is approximately equal to or drops below the noise floor at that time and station (background noise). More than 1,000 subnetwork events were recorded at CSTS stations during this reporting period. Some events may have an anthropogenic origin (for example, underground blasting). However, the majority of these subnetwork events are low-energy microearthquakes that provide insight into the relative stability and stress conditions of faults in close proximity to the station (within about 12 mi).

KE01—Four subnetwork seismic events were detected near station KE01 ranging from M 0.0 to 0.4 (Figure 17a). Three events occurred shortly after 7:50 (UTC) about 2 mi away from the station. The coincidental timing and distance is not expected for a natural earthquake, suggesting these events are likely some type of seismic noise associated with anthropogenic activity possibly at nearby Lakin, Lake McKinney, or US Highway 50. The fourth event occurred approximately 10 mi from KE01, which is the same distance as a M 3 earthquake on October 20, 1986 (Figure 17b). It is possible this subnetwork event was a microearthquake associated with the same fault as the historic M 3 earthquake. Given that only one low-magnitude event associated with this structure was recorded in the past year, a regional scale earthquake (M 2 or larger) is not anticipated in the near term.

KW01—Eight subnetwork seismic events were detected near station KW01 ranging from M -0.6 to 0.8 (Figure 18a). These events occurred at various times of day at distances ranging from 1 to 10 mi. The two most distant events (about 8 mi and 11 mi away) overlay nearby clusters of earthquakes that occurred in late 2015 and early 2018, respectively (Figure 18b). Therefore, these events are likely real earthquakes and may correspond to faults associated with the southwest margin of the Central Kansas Uplift that are critically stressed. The closest events to the station (ranging from 1 to 4 mi) all have characteristics expected for microearthquakes. These events occurred within the span of a month in late 2017 and may represent low energy movement of nearby unmapped faults, clearly worth an elevated awareness.

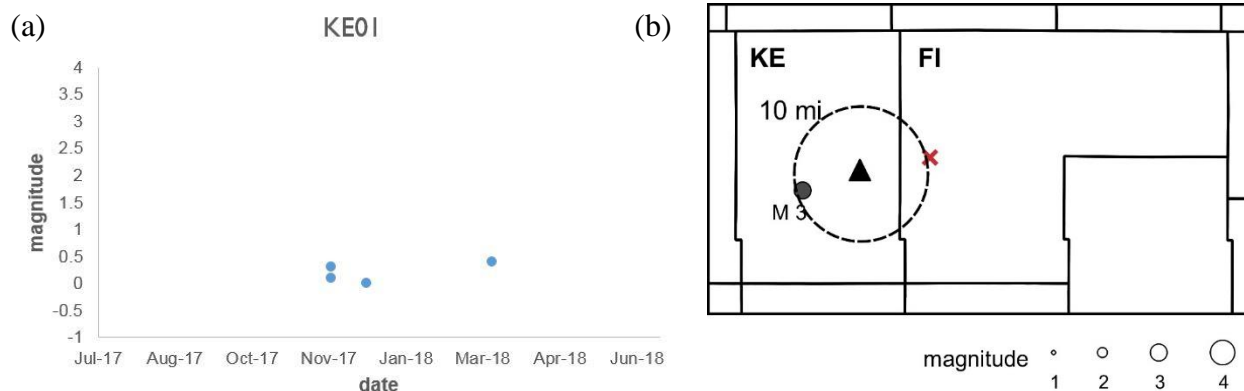


Figure 17. (a) Histogram of subnetwork events recorded at station KE01. (b) Map of historic seismicity in Kearney County and epicentral distance of subnetwork events recorded at KE01. CSTS member well(s) are indicated by a red X.

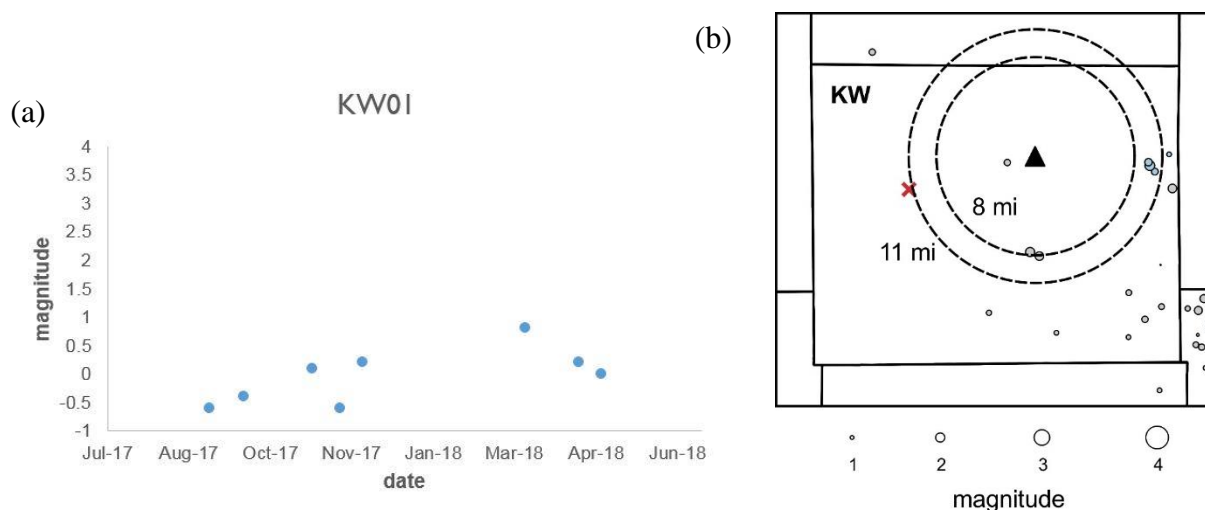


Figure 18. (a) Histogram of subnetwork events recorded at station KW01. (b) Map of earthquakes recorded in Kiowa County by the KGS network and epicentral distances of subnetwork events recorded at KW01. CSTS member well(s) are indicated by a red X.

EW01—Eleven subnetwork seismic events were detected near station EW01 ranging from M -0.9 to 0.7 (Figure 19a). These events occurred at various times of day at an average distance of 4.5 mi. This epicentral distance corresponds to the location of a M 2 earthquake recorded on September 7, 1983, near the Ellsworth–Barton county line as well as a mapped fault to the east (Figure 19b). This suggests these microearthquakes represent continued natural movement along a previously active, critically stressed fault. With activity of this type and consistency with historical earthquakes, a recursion estimate (b-factor) could possibly be made with a year or more continued recording at this station.

RC02—Station RC02 is located in eastern Rice County near the center of the Geneseo Uplift, an eastern lobe of the Central Kansas Uplift that is bounded by faults mapped on the top of the

Arbuckle Group to the north, west, and east (Berendsen and Blair, 1986). More than 30 subnetwork events ranging from M -0.9 to 0.7 have been recorded near station RC02 (Figure 20a), the majority of which occurred around 5 mi away. This epicentral distance corresponds to all three fault zones bounding the Geneseo Uplift, and these events could have originated from any of them. However, this distance also roughly corresponds to the location of a M 2.7 earthquake that occurred on August 1, 1981, near a mapped fault at the Rice–McPherson county line (Figure 20b). Although these events could occur anywhere along a 5 mi radius circle centered at RC02, these events likely correspond to this fault zone known to have been previously produced an earthquake.

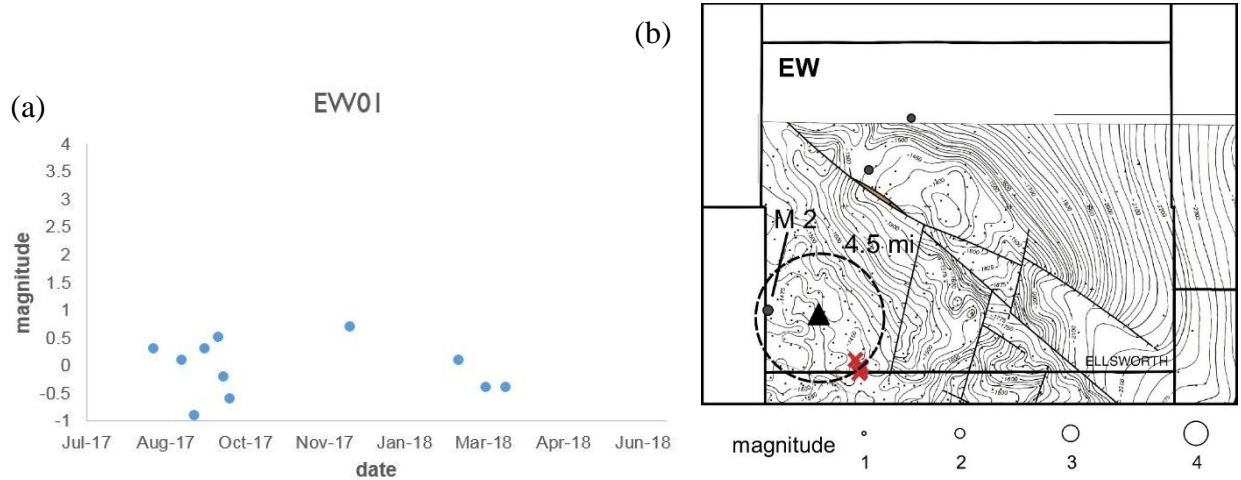


Figure 19. (a) Histogram of subnetwork events recorded at station EW01. (b) Map of historic seismicity in Ellsworth County and epicentral distance of subnetwork events recorded at EW01 superimposed on Arbuckle Group structural contours (from Berendsen and Blair, 1986). CSTS member well(s) are indicated by a red X.

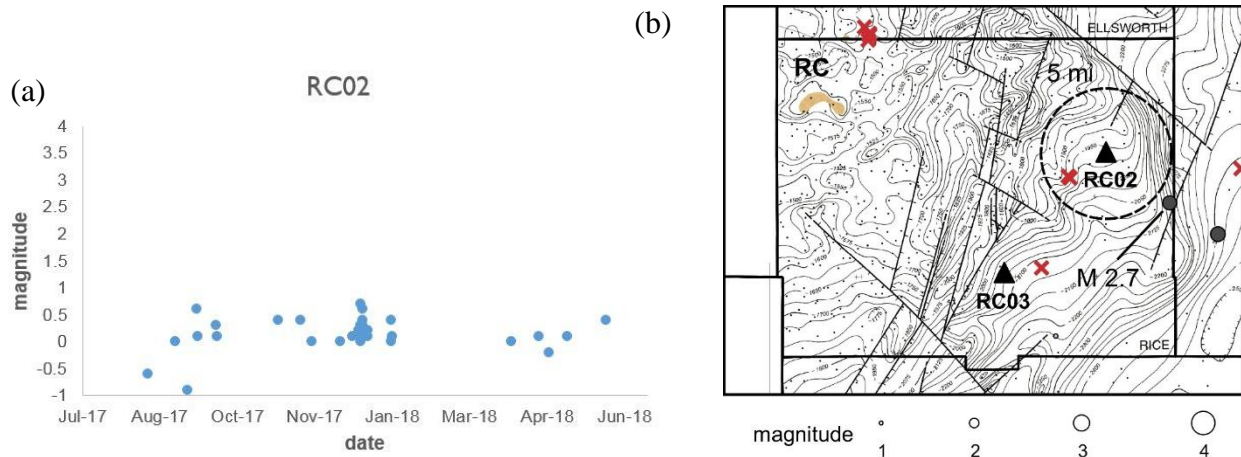


Figure 20. (a) Histogram of subnetwork events recorded at station RC02. (b) Map of historic seismicity in Rice County and epicentral distance of subnetwork events recorded at RC02 superimposed on Arbuckle Group structural contours (from Berendsen and Blair, 1986). CSTS member well(s) are indicated by a red X.

RC03—Station RC03 is located in south-central Rice County near the Peace Creek Fault Zone located on the western margin of the Geneseo Uplift. More than 300 subnetwork seismic events were recorded at RC03 with magnitudes ranging from -0.6 to 1.2. The vast majority of these events occur at regular times of day, corresponding to 5AM, 1PM, and 9 PM local time (Figure 21a). This regular timing and clustering at a distance of about 8 mi (Figure 21b) strongly suggest these events have an anthropogenic origin. The amplitude spectrum of small, close-by micro-earthquakes is typically dominated by higher frequencies. The majority of seismic events near RC03 have relatively large amplitudes toward the low frequency end of the amplitude spectrum.

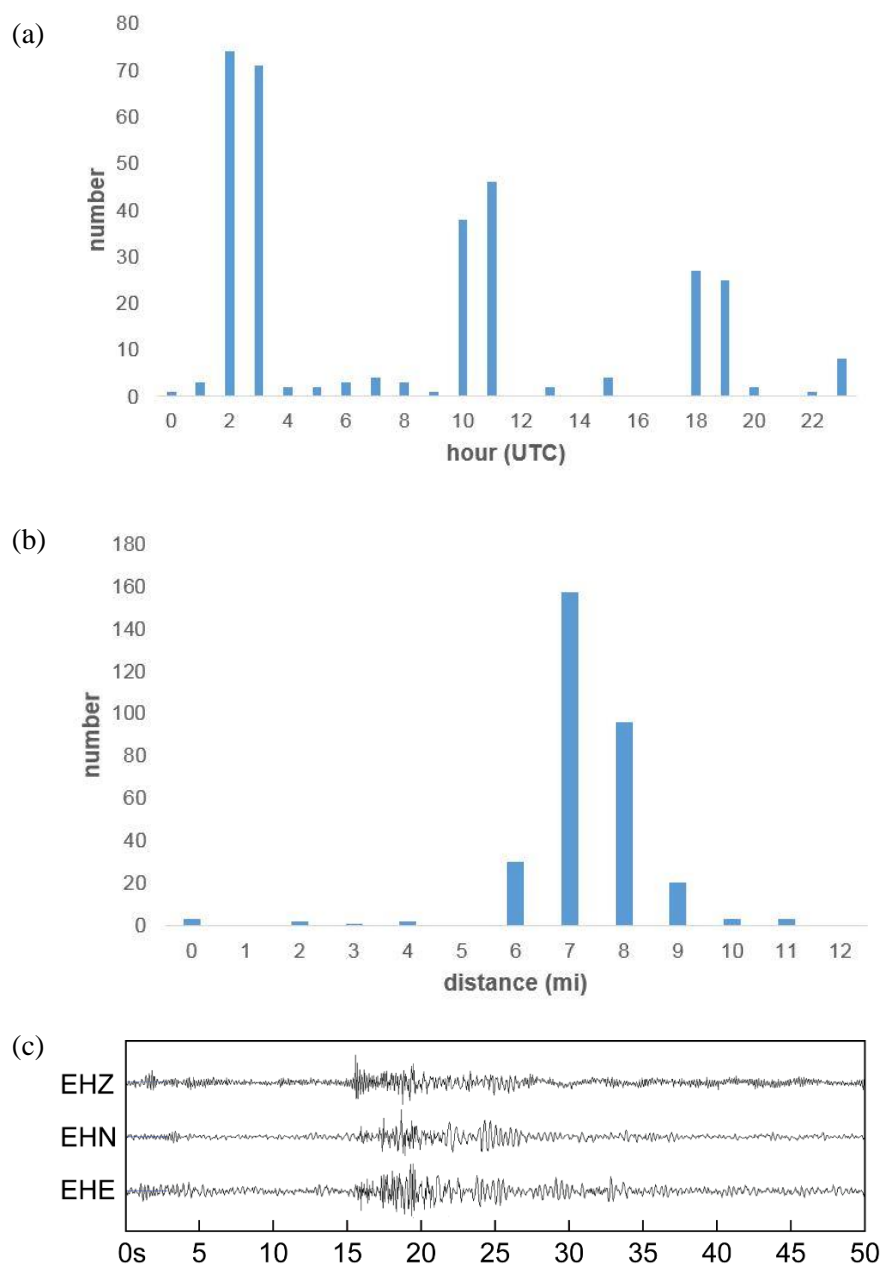


Figure 21. Histogram indicating the (a) time of day (UTC) and (b) epicentral distance of subnetwork events recorded at station RC03. (c) A representative waveform of a subnetwork event recorded at RC03.

Although local geology may influence the amplitude spectrum (i.e., a highly attenuative shallow subsurface may reduce the amplitude of high frequency signal), the time series of these events is characteristic of an explosion (Figure 21c). The city of Lyons is located about 6 mi from RC03, where the Lyons Salt Company operates an underground salt mine. Based on the distance, timing, and frequency characteristics, the majority of seismic events recorded at RC03 are likely mining blasts.

RN01—Station RN01 is located 2-3 mi northwest of the dense cluster of earthquakes near Hutchinson. Nearly 600 subnetwork events were recorded at RN01 with magnitudes ranging from -0.9 to 1.3 (Figure 22a). These events occur at all times of day and the estimated epicentral distances of nearly all these events is about 4.5 mi (Figure 22b). Although this is slightly larger than the 2.8 mi to the center of the Hutchinson earthquake swarm, these microearthquakes almost certainly originate from the same fault(s). The epicentral distance was calculated assuming a fixed earthquake depth of 3 mi, which is a common assumption used to locate earthquakes in the midcontinental U.S. Earthquakes are likely occurring on faults within the shallow Precambrian basement, which is at a depth of about 1 mi in this part of Reno County. Recalculating the epicentral distance using a depth of 1 mi results in an average distance of 2.6 mi, which is consistent with the location of the swarm of earthquakes located by the KGS regional seismic network. These events are not only consistent with the accepted recursion relationship, but they have provided confidence in suggestions that the focus of the Hutchinson Swarm earthquakes is around 1 mile deep.

The occurrence pattern of subnetwork microearthquakes recorded at RN01 is similar to the overall pattern of earthquakes located by the KGS seismic network (Figure 22a). For example, between mid-December 2017 and February 2018, only two earthquakes were located by the KGS network. Similarly, there was a notable decrease in subnetwork events, with only about 10 recorded during this time. An uptick in both located and subnetwork earthquakes occurred in February followed by another lull until earthquakes picked up again in March, after which seismicity continued at varying rates. This observation (that the occurrence pattern of subnetwork events is representative of the overall pattern of larger, located earthquakes) supports the study of subnetwork events for insight into patterns of seismicity in areas where earthquakes

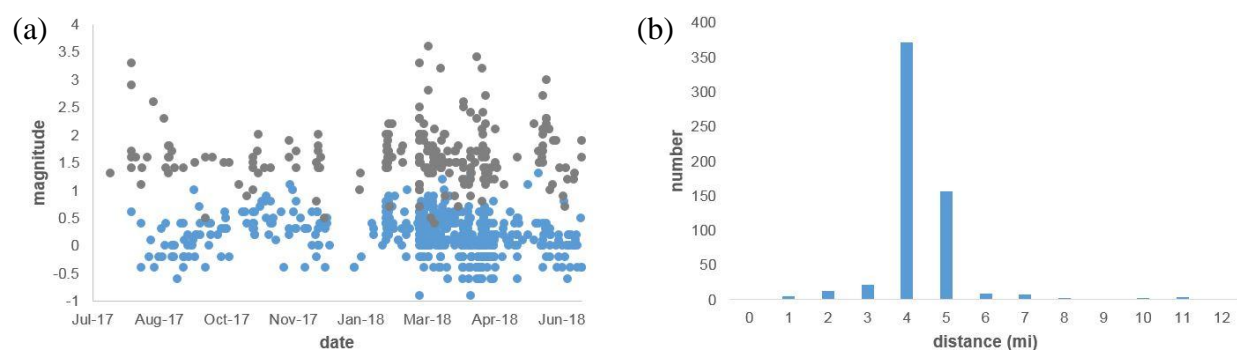


Figure 22. (a) Histogram indicating the time of day (UTC) of earthquakes in the Hutchinson cluster (blue) and subnetwork events recorded at station RN01 (gray). (b) Histogram of the epicentral distance of subnetwork events recorded at RN01.

are occurring but at magnitudes below the detection/location threshold of regional networks. This implies that earthquakes and recursion relationships can potentially be identified prior to a regional scale or felt earthquake.

RN02—More than 100 subnetwork events were recorded at station RN02 with magnitudes ranging from -0.9 to 1.3. These events largely occur around midnight local time (Figure 23a) at an epicentral distance of about 8.5 mi (Figure 23b), on average. Similar to RC03, the regular timing and clustering at a particular distance strongly suggest these events have an anthropogenic origin. The amplitude spectra for most of these events are characteristic of underground explosions. Based on the distance, timing, and frequency characteristics, the majority of seismic events recorded at RN02 are likely mining blasts. However, about a dozen events recorded at RN02 occur outside the time and distance windows characteristic of mining blasts, and have frequency characteristics expected for microearthquakes. Many of these events occur at distances ranging from 1 to 4 mi. The Hutchinson Fault, mapped from structural configuration of Arbuckle Group rocks, is oriented northeast about a mile east of RN02 (Figure 23c). Although this fault is mapped in the Arbuckle Group, it is expressed in underlying basement rocks and associated structures. The subnetwork events at RN02 that are not blasts may represent movement of this nearby basement fault. No historic earthquakes (within the detection threshold of regional networks, $\sim M 3$) were recorded along this fault. However, microearthquakes may indicate that elevated pore pressure (associated with deep saltwater disposal near the KS–OK border) has reactivated this and other basement faults near RN02 that have not experienced enough displacement to produce an earthquake measurable by the regional or subregional networks.

MP01—Station MP01 is bounded to the west and east by northeast trending faults mapped in Precambrian and/or Arbuckle Group rocks associated with the Midcontinent Rift System. More than a dozen subnetwork events were recorded at MP01 with magnitudes ranging from -0.6 to 1.2 (Figure 24a). These events occurred at various times of day at an average distance of about 4.5 mi. This distance corresponds to the location of a M 2.6 earthquake that occurred on November 3, 2014 (Figure 24c). Therefore, these microearthquakes likely represent continued movement on a critically stressed fault that slipped on November 3, 2014, to produce that M2.6. Although regular low-energy activity was recorded during the second half of 2017, few events were recorded during the first half of 2018, indicating relative stability and potentially a return to a lower stress environment consistent with observations from the regional and subregional networks. Given the sparse and measured characteristics of this activity, these events are likely natural.

MP02—More than two dozen subnetwork events were recorded at station MP02 with magnitudes ranging from -0.9 to 1.0 (Figure 24b). These events occurred at epicentral distances ranging from 1 to 10 mi, the majority of which occurred 1–2 mi from the station. MP02 is bounded to the west by a system of faults associated with the Voshell Anticline, to the southeast by the Halstead Fault, and is surrounded by a number of anticlinal and synclinal structures. A few microearthquakes ranging from M 0.9 to M 1.7 have been recorded by the KGS seismic network in northwest Harvey County about 5 mi or more south of MP02 (Figure 24c). Although some subnetwork events may have occurred on the same structure as the located earthquakes, the majority probably occurred on a closer structure such as the Voshell Anticline, which is less than

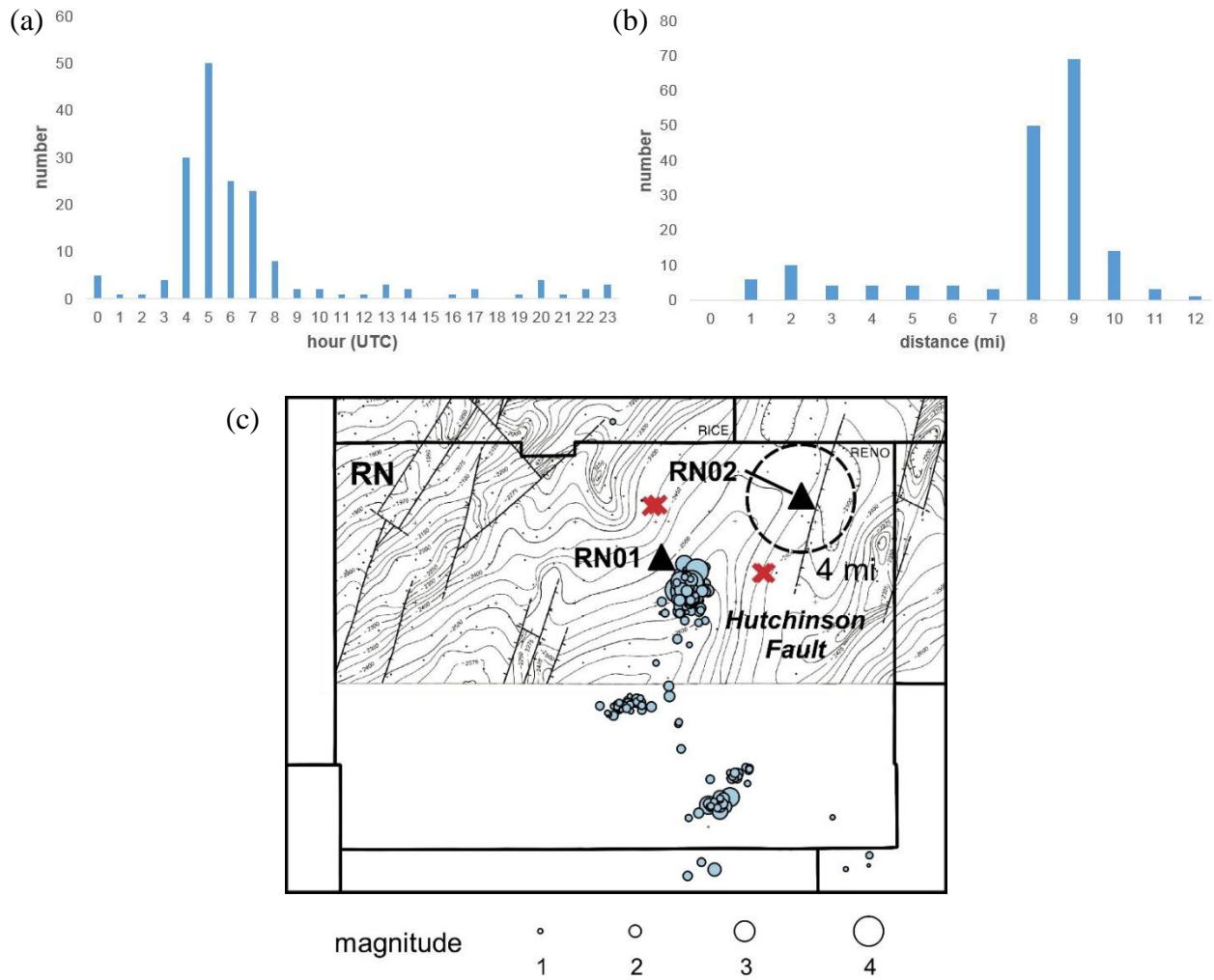


Figure 23. Histogram indicating the (a) time of day (UTC) and (b) epicentral distance of subnetwork events recorded at station RN02. (c) Map indicating epicentral distance of possible subnetwork earthquakes recorded at RN02 superimposed on Arbuckle Group structural contours (from Berendsen and Blair, 1986). CSTS member well(s) are indicated by a red X.

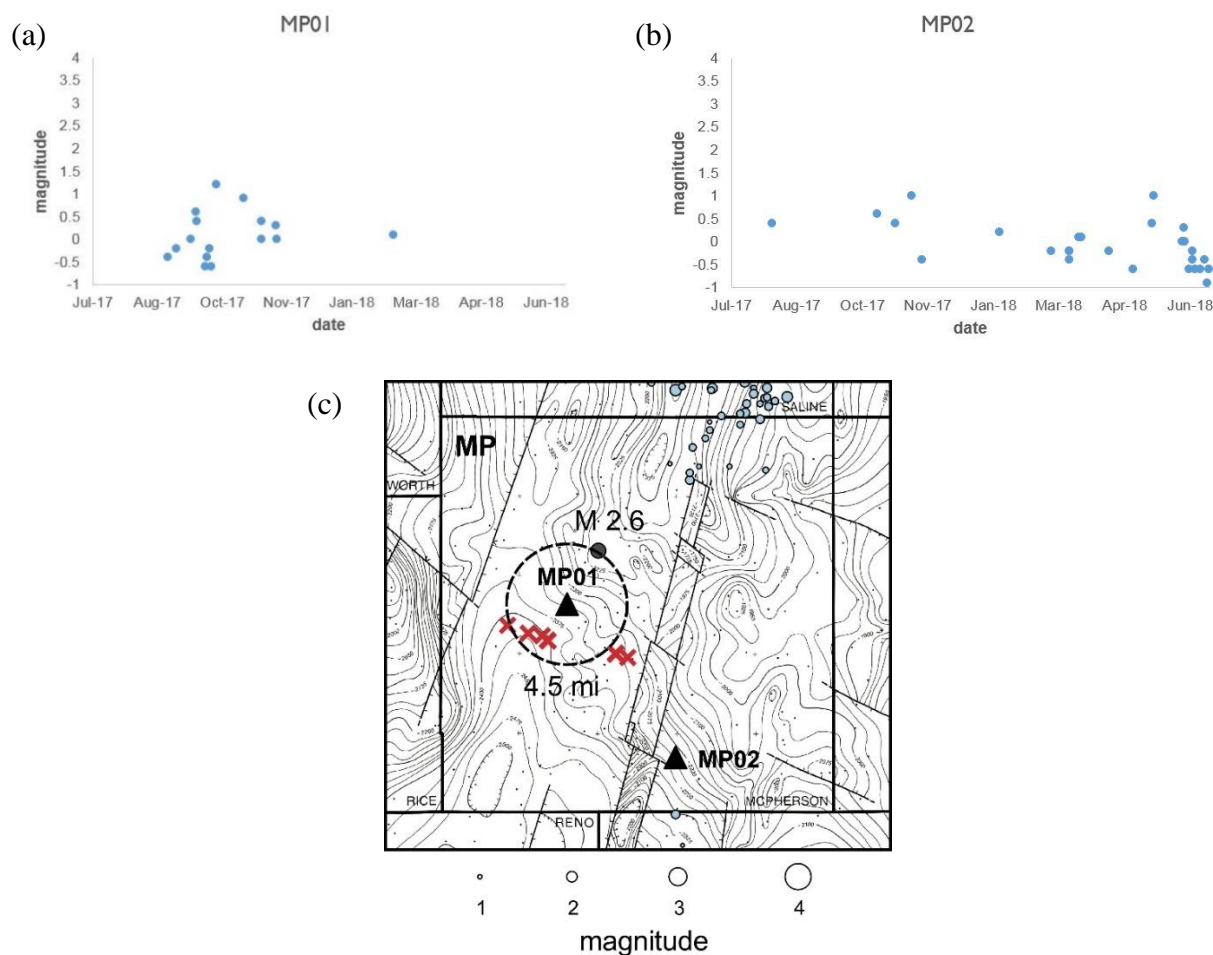


Figure 24. (a) Histogram of subnetwork events recorded at station MP01. (b) Histogram of subnetwork events recorded at station MP02. (c) Map of historic seismicity in McPherson County and epicentral distance of subnetwork events recorded at MP01 and MP02 superimposed on Arbuckle Group structural contours (from Berendsen and Blair, 1986). CSTS member well(s) are indicated by a red X.

a mile from the station. Given the sparse and measured characteristics of this activity, these events are likely natural. However, events that can be correlated to a mapped structure that has not produced an earthquake that can be located on the regional network suggests this area needs to be monitored with added attention to potential increases in the magnitude of microearthquakes.

SG02—Twenty subnetwork events were recorded at station SG02 with magnitudes ranging from -0.9 to 1.0 (Figure 25a). These events occurred at epicentral distances ranging from less than a mile to about 11 mi. The more distant subnetwork events likely originate from the cluster of earthquakes about 10 mi south of SG02 in northern Sumner County that has been active since 2016 (Figure 25b). A sequence of subnetwork events occurred in early January at an epicentral distance of about a mile. These events were low energy and isolated, but may indicate that increased pore pressure migrating from south central Kansas and Oklahoma (as evidenced by elevated Arbuckle Group fluid pressure measured in Sedgwick County) may have affected nearby, hydraulically connected basement faults resulting in this elevated level of activity.

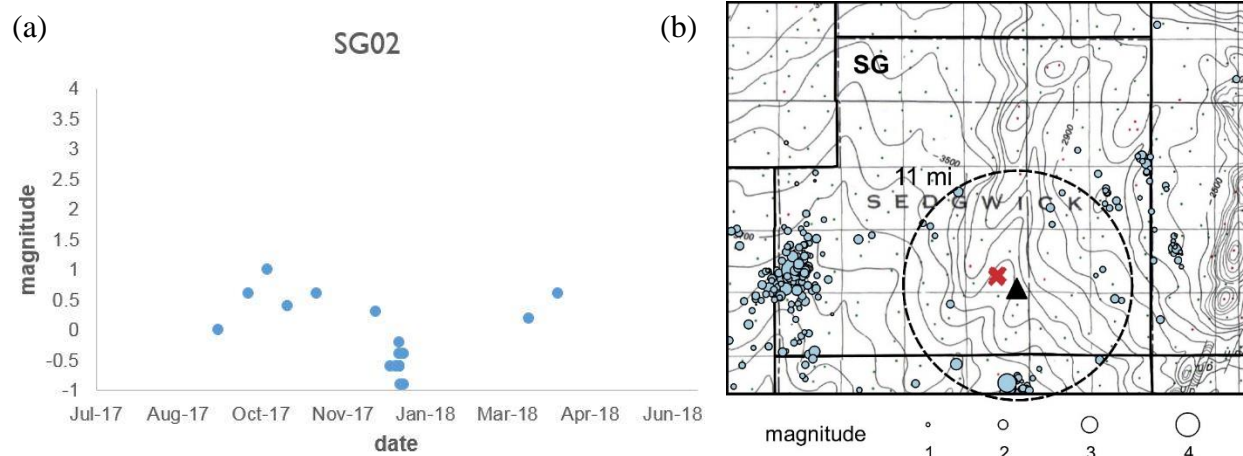


Figure 25. (a) Histogram of subnetwork events recorded at station SG02. (b) Map of earthquakes recorded in Sedgwick County by the KGS network and epicentral distance of subnetwork events recorded at SG02 superimposed on Precambrian structural contours (from Cole, 1976). CSTS member well(s) are indicated by a red X.

BU02—More than a dozen subnetwork events were recorded at station BU02 with magnitudes ranging -0.9 to 1.6 (Figure 26a). These events primarily occurred in two spatial groupings at about 3 mi and 11 mi. A small clustering of earthquakes was recorded by the KGS regional seismic network in 2016 and 2017 at about the same location as the M 2.5 earthquake on July 6, 2017, about 11 mi northwest of BU02 along the Nemaha Ridge (Figure 26b). This coincident

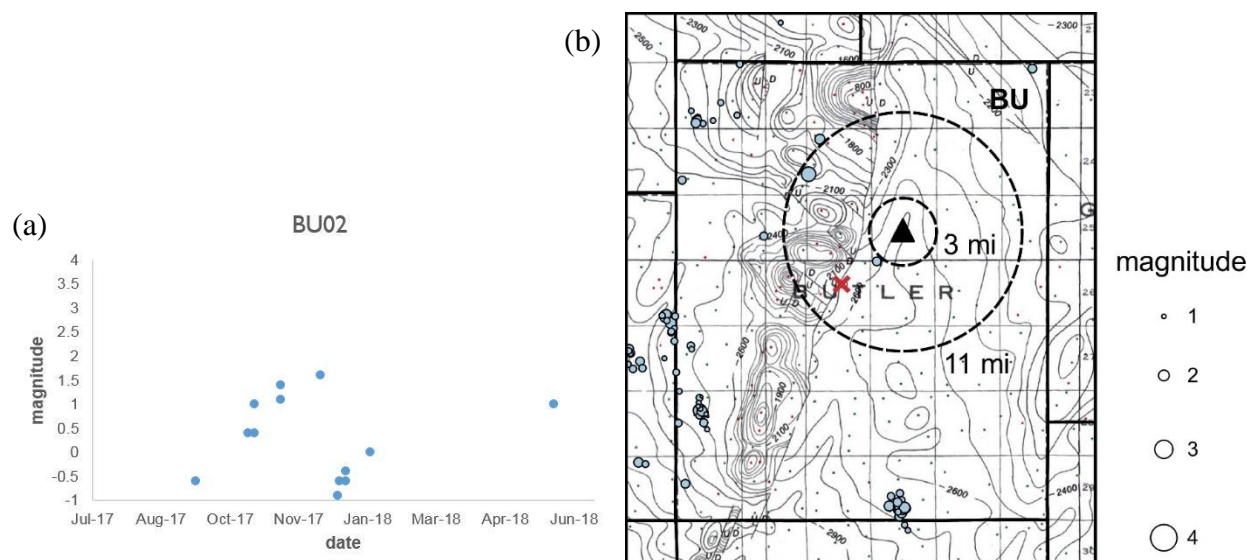


Figure 26. (a) Histogram of subnetwork events recorded at station BU02. (b) Map of earthquakes recorded in Butler County by the KGS network and epicentral distances of subnetwork events recorded at BU02 superimposed on Precambrian structural contours (from Cole, 1976). CSTS member well(s) are indicated by a red X.

location of these larger earthquakes strongly suggests the grouping of subnetwork events at 11 mi likely represent low-energy movement along the same fault, which is no doubt associated with the Nemaha Ridge. Likewise, the grouping of events with an epicentral distance of 3 mi corresponds with a M 1.7 microearthquake on August 25, 2017, suggesting low-energy movement along a fault on the eastern margin of the Nemaha Ridge.

JO01—Only one subnetwork event was recorded at station JO01, a M 0.7 event that occurred at an epicentral distance of about 5 mi (Figure 27). Although there are no mapped basement faults in Johnson County, very few wells have been drilled to the Precambrian basement that would have allowed for the mapping of structural trends. The structural grain of Precambrian rocks runs parallel to northwest trending basement faults mapped in Linn and Bourbon counties to the south. Sparse historic earthquake activity in neighboring Wyandotte, Douglas, and Miami counties suggests that natural, generally low energy slip on unmapped faults is possible (though, infrequent) in this area. In addition to the one subnetwork event, a large number of surface blasts were also recorded at this station. Surface blasts have unique spectral characteristics with a very high amplitude surface wave that make these events easily distinguishable from microearthquakes. Therefore, nearby surface blasts were not cataloged.

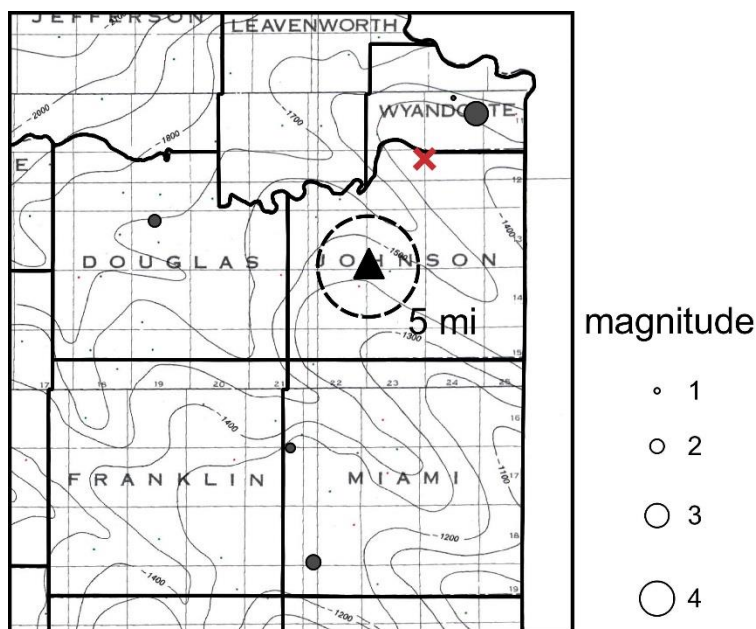


Figure 27. Map of historic seismicity (black) in northeast Kansas and epicentral distance of subnetwork events recorded at station JO01 superimposed on Precambrian structural contours (from Cole, 1976). CSTS member well(s) are indicated by a red X.

Summary

Changes in pore pressure within fault zones and along fault planes are generally accepted as responsible for the dramatic increases in felt earthquakes in southern Kansas observed since 2011. Migration of waste fluid from the Arbuckle formation into critically stressed basement faults is a function of the local geology and pore pressure in proximity to the injection well. Increasing the pore pressure along critically stressed fault planes has been determined to be the catalyst for inducing earthquakes in a wide range of settings. Considering the thousands of disposal wells injecting into the Arbuckle Formation in Kansas and the extremely variable sensitivity of basement faults to changes in pore pressure, it is critical to identify seismic from aseismic areas and match that against historical versus recent injection practices. The need to understand historical versus current seismicity on smaller than township scales is necessary to allow well-specific injection practices and regulations to be based on local seismicity rather than regional seismicity and to insure adverse influences of waste water disposal can be properly associated with well-specific operations.

Several areas in Kansas have been identified by regional earthquake recording to have experienced elevated seismicity over the last decade consistent with increased Arbuckle Formation fluid pressures. Some of these areas have seen unprecedented volumes of waste fluids injected into the Arbuckle and other areas with elevated seismicity have either static or even declining volumes of waste fluids injected into the Arbuckle. Monitoring earthquake activity for extended periods of time provides insights into the influence of elevated fluid pressures and areas with heightened seismic sensitivity to changes in fluid pressure. Earthquake monitoring over the last year as part of the CSTS program has provided valuable data points for identifying and classifying faults that are producing earthquakes at various magnitudes and faults that are unaffected by regional changes in formation fluid pressures.

Using the KGS regional network to identify all earthquakes above the network's magnitude of completeness (M 1.8) provided information significantly more sensitive than possible with USGS earthquake catalogs for Kansas and helped to focus facility specific observations and correlations. Several areas important to CSTS members could be identified with extremely low levels of seismicity using subnetwork identification techniques. Some of the earthquakes at magnitude of 0 or below could be correlated with historical events that occurred prior to elevated injection practices and therefore natural and some events at these extremely low magnitudes were associated with never before identified trends and therefore critically stressed faults. In nearly every case, earthquakes were preliminarily classified as natural based on historical events that could have occurred at or near the same location and with locations, timing, and waveform character that precluded anthropogenic or induced. Events that were potentially induced were noted with their approximate location relative to particular facilities identified to allow continued focus on those areas and attention to event characteristics for these areas.

Based on these data, there were no earthquakes or fault zones that could be definitively correlated to injection practices logged at local wells. Some earthquakes were suspiciously consistent with earthquake trends characterized as induced in areas where significant increases in injection volumes over the last decade were reported and areas with seismicity trends mimicking pressure trends. With continued recording with the existing CSTS network in collaboration with the regional and subregional KGS networks more earthquakes will be recorded and characteristics identified so confidence can be gained in distinguishing induced from natural. As well, with the improved understanding of where M less than 1 earthquakes are, temporary stations can

be deployed to triangulate the locations and dramatically improve characterizations of local earthquakes.

WEB PAGE CONTENT

The CSTS web page (<http://www.kgs.ku.edu/Geophysics/CSTS/index.html>) is operated by the KGS. It includes links to information about meetings, publications, network updates, and seismic updates (for Tier 1 members), and information about the seismic network for Tier 2 members. It includes semi-annual newsletters about earthquake activity, along with access to a comprehensive catalog of events, including time, location, magnitude, and the Seismic Action Score (based on evaluation criteria developed by the State's Induced Seismicity Task Force) for each event. The website also includes a series of pictures and accounts of the installation process and gives a feel for the environment and footprint of each consortium station. Currently at least one station has been installed within 20 miles of every Tier 1 member's well (Figure 2). A short discussion and set of pictures are posted on the website documenting the installation process.

OTHER ACTIVITIES

In the second quarter of 2018, Shelby Peterie was the lead author of a feature article in *Eos*, a publication of the American Geophysical Union. Entitled "Fluid Injection Wells Can Have a Wide Seismic Reach," its co-authors were Rick Miller and Rex Buchanan of the KGS and Brandy DeArmond of KDHE. The on-line version of the article (at <https://eos.org/features/fluid-injection-wells-can-have-a-wide-seismic-reach>) was published on April 17, 2018; the hard copy version appeared in the July 2018 issue of *Eos*.

The KGS participated in a public meeting in Hutchinson concerning recent seismicity in Reno County in May. That meeting, held at the request of local legislators, included representatives of the Kansas Corporation Commission (KCC) and KDHE. Approximately 75-100 members of the public were present; there were several questions about Class 1 disposal and seismicity.

Other activities from the past year that were discussed in previous quarterly reports include the following:

- Shelby Peterie was the lead author of the article "Earthquakes in Kansas Induced by Extremely Far-Field Pressure Diffusion" in the refereed journal *Geophysical Research Letters*, published by the AGU. That article is available on-line (at <http://onlinelibrary.wiley.com/doi/10.1002/2017GL076334/full>).
- Consortium staff attended and made a presentation at the annual meeting of the American Geophysical Union (AGU) in December 2017. That meeting included presentations and posters on the topic of induced seismicity in the midcontinent.
- Consortium staff members attended an Oklahoma Seismicity Workshop in Norman, Oklahoma, in February 2018. About 200 attendees discussed the latest information on induced seismicity in the Midcontinent. Rex Buchanan gave a brief talk on the Kansas Consortium. Rick Miller gave a presentation for Shelby Peterie entitled "The Role of Far-Field Pressure Diffusion in Triggering Earthquakes in Kansas." Co-authors of that presentation were Shelby Peterie, Rick Miller, John Intfen, Julio Gonzales, Rex Buchanan (all of the KGS), and Brandy DeArmond and Mike Cochran of KDHE.

- Rex Buchanan and Rick Miller met with the state of Oklahoma's seismicity task force in Oklahoma City, also in February. That meeting included an update on Oklahoma seismicity, latest enforcement activities by the Oklahoma Corporation Commission (OCC), and a presentation on Arbuckle fluid levels by Kyle Murray of the Oklahoma Geological Survey. There was also discussion of scheduling a joint meeting of Kansas and Oklahoma regulatory agencies and geological surveys in the coming two or three months.
- The KGS joined a federally funded research consortium on induced seismicity. The current members are the state geological surveys of Kansas, Oklahoma, Texas, and New Mexico. This group should provide another way to help keep Consortium members current with induced seismicity activities (regulator as well as trends) in surrounding states.
- Throughout the past year, Consortium staff members have been engaged with a joint task force created by the KGS, KDHE, and KCC, studying issues related to fluid disposal in the Arbuckle Formation. That task force was expanded to include representatives of industries that use both Class 1 and Class 2 wells. The full task force met in May in Wichita, with plans to continue meeting quarterly. As part of that process, the KGS is acquiring additional data on fluid levels in wells that dispose of fluids in the Arbuckle.

PLANS

Continued monitoring and extracting earthquake characteristics that can lend to a better understanding of the catalyst (induced vs natural) and sensitivities will be a primary goal going forward. A few things that will be a focus:

- Review areas with subnetwork earthquakes and determine if sufficient interest exists to deploy temporary stations to isolate the fault responsible for these very small earthquakes. This effort would be specifically for identifying seismically sensitive zones to avoid or better characterize.
- Begin developing recursion relationships on a fault by fault basis.
- Use the subnetwork events to help delineate depth to the focus and fault trends.
- Evaluate the statistical relationship between subnetwork events and earthquakes detected with the regional network—depth, location, etc.
- Develop and release a version of the on-line earthquake mapper for consortium members.
- Complete fully automated alerts for earthquakes M2.0 or larger and within 30 miles of member facilities.
- Increase communication on web associated with seismicity—presentations, articles, meetings, opinion pieces published by various groups (KIOGA, etc).

CONCLUSION

The CSTS had a successful first year. Agreements for the twelve Tier 1 members and the one Tier 2 member have remained in place. The installed stations have operated successfully, and alerts have been, for the most part, delivered to members as prescribed in the agreement. Quarterly reports were provided to CSTS members. Staff members have published several significant scientific papers that focused on the affect of distant pressure changes on seismicity, improving the understanding of earthquakes in south-central Kansas. CSTS staff also gave presentations at scientific and public meetings, explaining Kansas seismicity and, when appro-

priate, the role of the Consortium. CSTS staff have worked to develop techniques for accurately locating and characterizing extremely low-energy earthquake epicenters. Improved information on low-level seismicity is central to identifying areas where additional, larger activity could occur. CSTS staff have worked with the regulatory community and industry to better understand the issue, and the impact, of rising fluid levels in the Arbuckle. Additional activities in the coming year will be based on continuing efforts from the past year, and on direction and conversation during the July 2018 annual meeting.

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- Berendsen, P., and K.P. Blair, 1986, Subsurface structural maps over the central North American rift system (CNARS), central Kansas, with discussion: Kansas Geological Survey, Subsurface Geology Series 8, 16 p.
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- Yarger, H.L., 1983, Regional interpretation of Kansas aeromagnetic data: Kansas Geological Survey Geophysics Series 1, 35 p.

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Appendix A: CSTS Station Locations, Pictures, and Descriptions

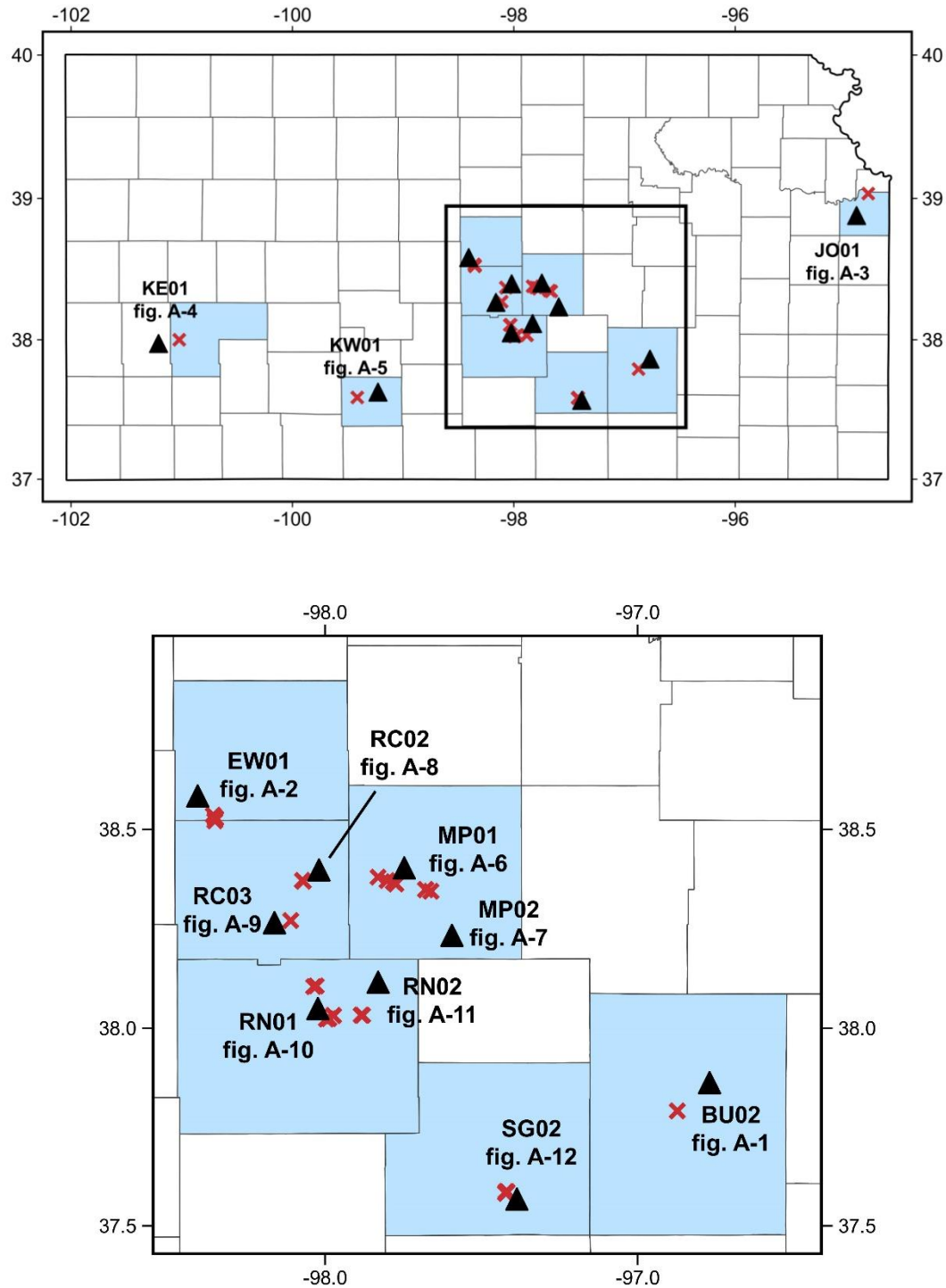


Figure A-0. Base map for pictures of equipment configuration at each station included in this appendix. Top figure is State of Kansas with the bottom figure enlargement of black box in upper figure. Black triangles are earthquake stations and red Xs are each member's injection facility location(s).



Figure A-1. BU02 is located in the El Dorado State Park in northern Butler County. This station is in a pasture near the El Dorado Lake about 4 mi from Interstate 35.



Figure A-2. EW01 is located in southwestern Ellsworth County near the city of Holyrood. The station is in a cemetery about 1 mi from highway Kansas Highway 156.

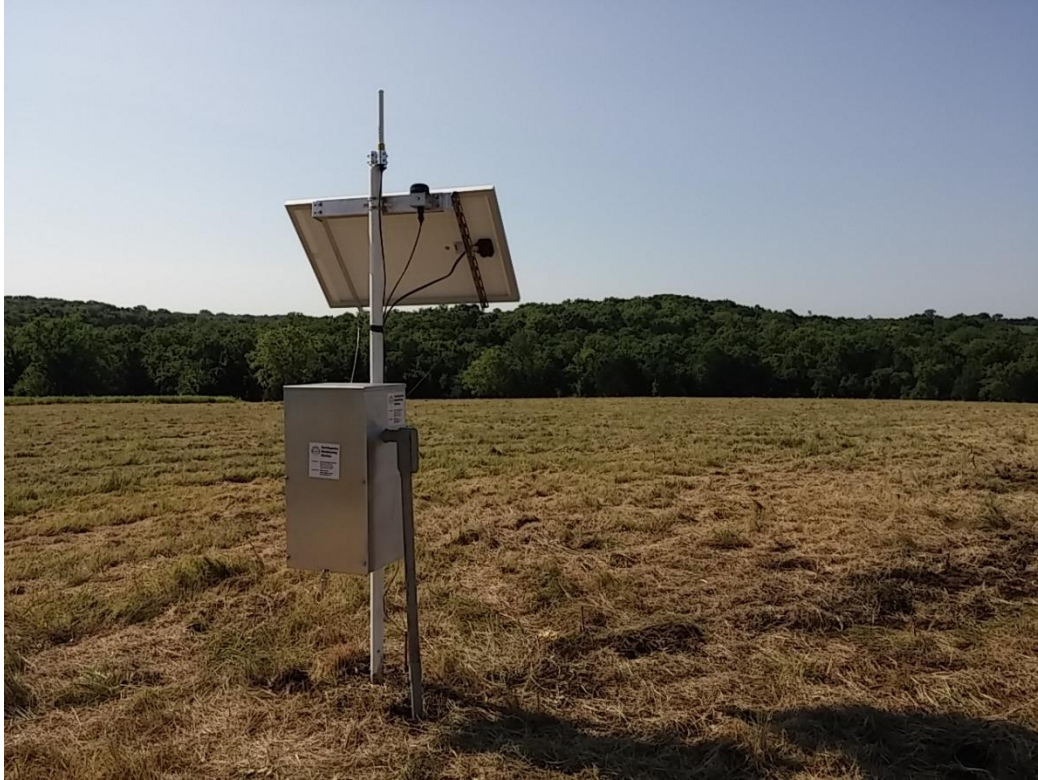


Figure A-3. JO01 is located on the grounds of the Olathe Prairie Center in Johnson County about 4 mi west of Kansas Highway 10. There is light traffic around the station and two rock quarries within about 5 mi.



Figure A-4. KE01 is located in eastern Kearny County between Lakin and Deerfield. The station is near the dam of Lake McKinney about a mile from US Highway 50.



Figure A-5. KW01 is located in northern Kiowa County near Greensburg. This station is within 1 mi a set of railroad tracks, US Highway 54, and an active construction site for a future airport. Due to unacceptable noise conditions and flooding, this station will be decommissioned and is scheduled to be moved to a pasture located between Mullinville and Greensburg more than 1 mi from the railroad and highway.



Figure A-6. MP01 is located in the McPherson Valley Wetlands Wildlife Area in McPherson County. The station is northwest of Conway about 2 mi from US Highway 56.



Figure A-7. MP02 is located in south-central McPherson County southeast of the McPherson. The station is in a pasture on the grounds of a local church about 3 mi from Interstate 135.



Figure A-8. RC02 is located in eastern Rice County near the city of Little River. This station is installed in a pasture more than 1 mi from US Highway 56 and Kansas Highway 46.



Figure A-9. RC03 is located in Rice County between Lyons and Sterling. This station is installed in a pasture about 2 mi from highway Kansas Highway 96 and is near a small landing strip.



Figure A-10. RN01 is located in Reno County west of Hutchinson. This station is installed in a cemetery about 2 mi from Kansas Highway 14.



Figure A-11. RN02 is located in Reno County northeast of Hutchinson in Sand Hills State Park. It is installed in a 2.5 mi from Kansas Highway 61.



Figure A-12. SG02 is located in Sedgwick County south of Wichita. This station is on the grounds of a local church about 3 mi from Interstate 35 and US Highway 81 and 2 mi from two sets of railroad tracks to the west and east.

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Appendix B: CSTS Earthquake Catalog 7/1/2017 – 6/30/2018

This catalog includes all earthquakes that were uniquely located and within 20 miles of a consortium member facility. Yellow highlights are events that could only be located using CSTS stations.

Origin Time (UTC)	Latitude	Longitude	Magnitude	Origin Time (UTC)	Latitude	Longitude	Magnitude
2017-07-06 07:02:43	37.9370	-96.9289	2.5	2017-08-27 03:38:09	37.3196	-97.5338	1.4
2017-07-14 02:09:19	38.0192	-98.0115	1.3	2017-08-27 07:09:47	38.0026	-97.9715	1.6
2017-07-16 05:05:55	37.3186	-97.4581	1.1	2017-08-27 08:02:44	37.4300	-97.3793	1.2
2017-07-16 05:11:08	37.3075	-97.4813	0.8	2017-08-27 20:49:58	37.4293	-97.3698	1.6
2017-07-24 01:28:13	37.4272	-97.3646	1.7	2017-08-27 21:38:08	37.4258	-97.3746	1.4
2017-07-24 02:28:03	37.4301	-97.3758	1.6	2017-08-28 03:00:09	37.3305	-97.5841	1.4
2017-07-24 04:16:30	37.8876	-98.0369	1.7	2017-08-28 04:30:53	37.3332	-97.5669	1.0
2017-07-24 07:33:45	37.8925	-98.0512	1.6	2017-08-28 04:49:40	37.5805	-97.7827	1.4
2017-07-28 03:07:40	37.8902	-98.0569	1.2	2017-08-29 05:14:05	37.5931	-97.7541	1.7
2017-07-30 00:13:46	38.0349	-97.9743	3.3	2017-08-29 05:27:14	37.6012	-97.7659	2.1
2017-07-30 00:16:16	38.0179	-97.9800	2.9	2017-08-29 08:47:59	38.0126	-97.9979	1.7
2017-07-30 02:36:42	38.0091	-97.9747	1.4	2017-08-30 07:28:44	37.5953	-97.7675	1.7
2017-07-30 09:10:20	37.9904	-97.9710	1.6	2017-08-30 07:30:29	37.6559	-97.7523	1.2
2017-07-30 10:37:53	37.9944	-97.9690	1.7	2017-08-30 07:42:19	37.6066	-97.7561	1.5
2017-07-31 15:29:07	37.9610	-98.0011	1.6	2017-08-30 08:08:16	37.5953	-97.7544	1.7
2017-08-01 05:24:48	38.1368	-97.5842	0.9	2017-08-30 09:22:39	37.5787	-97.7596	0.4
2017-08-02 07:09:51	37.5247	-97.1367	1.7	2017-08-30 09:33:21	37.5919	-97.7725	2.0
2017-08-02 11:17:00	38.0050	-97.9902	1.6	2017-08-30 09:59:24	37.6006	-97.7672	0.3
2017-08-05 05:15:53	37.4374	-97.4033	3.3	2017-08-30 10:32:27	37.5844	-97.7594	1.5
2017-08-05 05:30:43	37.4569	-97.3473	1.2	2017-08-30 11:30:50	37.6117	-97.7765	2.2
2017-08-05 06:22:31	37.4400	-97.3925	1.7	2017-08-30 12:00:02	37.5967	-97.7621	1.9
2017-08-05 07:20:30	37.4439	-97.3587	1.3	2017-08-30 12:05:15	37.5951	-97.7646	0.5
2017-08-05 07:23:24	37.4445	-97.3836	1.6	2017-08-30 12:05:42	37.5572	-97.7599	1.7
2017-08-05 08:25:16	37.9834	-96.9099	1.9	2017-08-30 12:26:53	37.5459	-97.7787	1.4
2017-08-05 14:36:37	37.6703	-97.7530	1.6	2017-08-31 02:39:21	37.5890	-97.7678	1.5
2017-08-06 13:22:08	38.0337	-97.9909	1.1	2017-08-31 03:01:47	37.6129	-97.7677	1.3
2017-08-07 08:01:45	38.0144	-97.9808	1.4	2017-08-31 03:02:08	37.6442	-97.7579	1.4
2017-08-07 13:25:59	37.5854	-97.7610	1.3	2017-08-31 05:17:55	37.9809	-97.9629	1.4
2017-08-10 17:49:00	37.3348	-97.4943	1.5	2017-08-31 05:53:22	37.5764	-97.7605	1.5
2017-08-11 06:32:39	38.0175	-97.9710	1.6	2017-08-31 06:59:17	37.5951	-97.7511	1.7
2017-08-12 22:46:35	37.4634	-97.4917	2.3	2017-08-31 07:00:39	37.6054	-97.7560	1.4
2017-08-14 00:21:16	37.2982	-97.3606	1.5	2017-08-31 07:01:12	37.3482	-97.5658	1.4
2017-08-15 06:18:54	37.8922	-98.0593	1.6	2017-08-31 07:02:24	37.6132	-97.7512	1.4
2017-08-15 15:15:47	38.0422	-97.9916	2.6	2017-08-31 07:03:15	37.5945	-97.7609	1.7
2017-08-18 10:28:53	37.4396	-97.3775	0.9	2017-08-31 07:07:38	37.7003	-97.4881	2.0
2017-08-18 10:29:23	37.4286	-97.3803	1.1	2017-08-31 07:14:21	37.5798	-97.7145	1.7
2017-08-18 22:55:50	37.4240	-97.4077	2.0	2017-08-31 07:19:01	37.6179	-97.7574	0.9
2017-08-19 05:46:47	37.4282	-97.3986	2.1	2017-08-31 07:19:38	37.4937	-97.7648	1.1
2017-08-19 08:33:46	37.4362	-97.4079	2.2	2017-08-31 07:21:17	37.5931	-97.7766	3.8
2017-08-19 09:22:41	37.4420	-97.3908	1.7	2017-08-31 07:25:27	37.5717	-97.7503	1.7
2017-08-19 19:19:30	37.4475	-97.3855	1.5	2017-08-31 07:30:21	37.5632	-97.7722	1.1
2017-08-20 09:11:55	37.4325	-97.3957	1.2	2017-08-31 07:36:59	37.7264	-97.7368	1.3
2017-08-21 17:29:54	37.4377	-97.3946	1.8	2017-08-31 07:39:53	37.6012	-97.7600	1.5
2017-08-23 05:22:39	37.5322	-97.7076	0.8	2017-08-31 07:42:00	37.6123	-97.7453	1.2
2017-08-23 07:34:21	38.0095	-98.0030	2.3	2017-08-31 07:43:54	37.5947	-97.7454	1.2
2017-08-24 03:30:34	38.0154	-97.0495	1.3	2017-08-31 07:54:23	37.5074	-97.7560	1.2
2017-08-24 22:10:13	37.9787	-97.9719	1.4	2017-08-31 07:55:47	37.6051	-97.7551	1.2
2017-08-25 13:14:22	37.8211	-96.8139	1.7	2017-08-31 07:56:19	37.5860	-97.7639	1.8
2017-08-26 21:01:44	38.0312	-97.9858	1.8	2017-08-31 08:25:33	37.6002	-97.7661	1.4
2017-08-26 21:10:09	38.0121	-97.9976	1.3	2017-08-31 08:25:56	37.5760	-97.7752	1.3
2017-08-24 22:10:13	37.9787	-97.9719	1.4	2017-08-31 08:26:45	37.5993	-97.7604	1.5
2017-08-25 13:14:22	37.8211	-96.8139	1.7	2017-08-31 08:28:30	37.6497	-97.7617	1.3
2017-08-26 21:01:44	38.0312	-97.9858	1.8	2017-08-31 08:45:33	37.5838	-97.7588	1.2
2017-08-26 21:10:09	38.0121	-97.9976	1.3	2017-08-31 09:17:19	37.6009	-97.7671	1.4
2017-08-26 23:24:04	38.0177	-97.9959	1.6	2017-08-31 10:10:49	37.5796	-97.7761	1.7
2017-08-27 01:17:52	37.3352	-97.5741	1.7	2017-08-31 10:22:36	37.3448	-97.5566	1.4
2017-08-27 02:33:37	37.9939	-97.9803	1.8	2017-08-31 10:41:42	37.5942	-97.7697	1.7

Appendix B. Continued

Origin Time (UTC)	Latitude	Longitude	Magnitude
2017-08-31 10:55:16	37.6149	-97.7244	1.1
2017-08-31 12:46:51	37.5862	-97.7657	1.7
2017-08-31 12:47:17	37.5902	-97.7607	2.1
2017-08-31 12:50:49	37.5759	-97.7611	1.4
2017-08-31 12:51:34	37.5906	-97.7551	1.7
2017-08-31 12:53:33	37.6238	-97.7652	1.6
2017-08-31 13:04:51	37.6002	-97.7652	1.5
2017-08-31 14:51:24	37.5979	-97.7494	1.8
2017-08-31 23:27:39	37.5703	-97.7522	1.2
2017-09-01 00:47:21	37.3275	-97.4492	1.9
2017-09-01 12:14:59	37.5961	-97.7551	2.1
2017-09-01 13:43:22	37.5853	-97.7342	1.4
2017-09-01 19:52:49	37.6011	-97.7642	1.6
2017-09-02 05:12:57	37.5817	-97.7704	2.5
2017-09-02 20:04:15	37.5948	-97.7586	1.8
2017-09-02 21:07:21	37.5859	-97.7636	1.2
2017-09-02 21:29:01	37.5769	-97.7783	1.6
2017-09-03 07:19:31	37.7155	-97.7378	0.7
2017-09-03 12:50:44	37.5863	-97.7534	1.5
2017-09-03 13:04:37	37.5672	-97.7354	1.8
2017-09-03 14:41:39	37.5557	-97.7321	1.4
2017-09-03 15:27:35	37.5728	-97.7374	1.3
2017-09-03 15:42:35	37.6013	-97.7600	2.0
2017-09-03 15:48:18	37.6119	-97.7611	0.1
2017-09-03 18:46:45	37.4708	-97.7413	1.8
2017-09-03 19:18:00	37.5910	-97.7654	2.6
2017-09-03 19:31:26	37.6000	-97.7544	1.8
2017-09-03 20:19:34	37.5803	-97.7680	2.0
2017-09-03 20:32:35	37.5877	-97.7536	1.6
2017-09-03 20:38:41	37.5857	-97.7677	1.7
2017-09-03 20:40:29	37.5910	-97.7635	1.6
2017-09-03 20:45:43	37.7883	-97.9422	1.3
2017-09-03 20:51:06	37.5798	-97.7745	2.0
2017-09-03 21:14:25	37.5919	-97.7669	2.3
2017-09-03 21:50:31	37.6274	-97.7571	1.5
2017-09-03 22:06:51	37.5673	-97.7617	1.6
2017-09-03 22:48:02	37.6274	-97.7560	1.6
2017-09-03 23:16:25	37.5894	-97.7609	2.2
2017-09-03 23:49:24	37.5838	-97.7651	1.6
2017-09-04 00:07:31	37.5917	-97.7699	2.1
2017-09-04 00:30:18	37.5404	-97.7647	1.2
2017-09-04 01:59:15	37.5378	-97.7793	1.4
2017-09-04 04:48:14	37.5957	-97.7658	1.5
2017-09-04 04:50:29	37.5904	-97.7638	1.9
2017-09-04 06:10:13	37.5917	-97.7751	2.4
2017-09-04 07:23:34	37.5964	-97.7649	1.4
2017-09-04 10:08:22	37.5917	-97.7500	1.4
2017-09-04 10:47:18	37.5927	-97.7611	1.3
2017-09-04 12:00:45	37.5936	-97.7626	1.4
2017-09-04 12:52:51	37.5464	-97.7670	1.4
2017-09-05 01:32:55	37.5835	-97.7812	2.8
2017-09-05 05:39:00	37.6694	-97.7500	1.1
2017-09-05 16:23:50	37.4341	-97.3686	1.4
2017-09-05 16:25:49	37.4314	-97.3670	1.4
2017-09-05 23:39:22	37.5506	-97.7644	1.3
2017-09-06 03:06:49	37.5948	-97.7679	1.7
2017-09-06 15:06:23	37.7279	-97.1605	1.4
2017-09-07 01:36:18	38.1108	-98.0501	0.3
2017-09-07 01:41:35	38.0140	-97.9840	1.4
2017-09-07 12:26:23	38.0082	-97.0900	1.2

Origin Time (UTC)	Latitude	Longitude	Magnitude
2017-09-10 04:01:28	37.3345	-97.5723	2.0
2017-09-11 10:21:33	37.3313	-97.5651	1.5
2017-09-13 00:06:04	37.3369	-97.5529	1.5
2017-09-13 11:19:08	37.4453	-97.3893	1.0
2017-09-14 08:15:30	37.3439	-97.5569	2.1
2017-09-14 08:54:08	37.3422	-97.5830	1.1
2017-09-14 17:04:08	37.3489	-97.5664	1.5
2017-09-14 20:13:05	37.4366	-97.5626	1.7
2017-09-15 02:12:59	37.3908	-97.3213	1.0
2017-09-15 05:37:22	38.0138	-97.9723	1.5
2017-09-16 12:42:11	37.3395	-97.5831	2.6
2017-09-16 17:33:23	37.3473	-97.5580	1.9
2017-09-16 20:16:42	37.3481	-97.5892	1.7
2017-09-17 03:08:04	37.3473	-97.5788	1.3
2017-09-17 07:53:27	37.3610	-97.4231	1.2
2017-09-17 20:07:34	37.3313	-97.5059	1.2
2017-09-18 08:37:29	37.6571	-97.5497	1.5
2017-09-21 02:53:10	37.6098	-97.7549	1.4
2017-09-21 07:14:54	37.4277	-97.6603	1.3
2017-09-23 02:56:41	37.5021	-97.7615	1.5
2017-09-23 12:16:38	37.9945	-97.9867	0.5
2017-09-23 12:40:25	38.0129	-97.9760	1.6
2017-09-24 03:29:26	37.3457	-97.5526	1.7
2017-09-24 07:02:18	37.3437	-97.5646	0.9
2017-09-24 09:09:30	37.3512	-97.5315	1.5
2017-09-24 16:31:22	37.3445	-97.5589	1.8
2017-09-25 06:46:36	37.3375	-97.5354	1.5
2017-09-26 04:31:43	37.9547	-97.9847	1.1
2017-09-26 16:39:08	37.4807	-97.7384	2.2
2017-09-26 16:44:06	37.5057	-97.7484	1.6
2017-09-26 18:35:06	37.4768	-97.7485	1.8
2017-09-27 06:51:08	37.6062	-97.1056	1.6
2017-09-28 17:47:46	38.0013	-98.0226	1.6
2017-09-29 04:46:22	38.0042	-97.1068	1.3
2017-09-29 05:52:23	37.6407	-97.6386	1.5
2017-09-29 08:44:13	37.5533	-97.2157	1.8
2017-09-29 14:37:15	37.5500	-97.7551	1.9
2017-09-29 14:43:52	37.5647	-97.7424	1.7
2017-10-01 16:05:15	37.4691	-97.2421	1.8
2017-10-03 13:38:15	37.4300	-97.3997	2.7
2017-10-03 16:25:45	37.4265	-97.3974	1.4
2017-10-03 17:19:22	37.4406	-97.3864	1.5
2017-10-06 09:34:35	37.6230	-97.7666	1.3
2017-10-07 11:18:17	37.9972	-97.9958	1.5
2017-10-07 20:41:27	37.4060	-97.3850	1.9
2017-10-07 20:47:49	37.4180	-97.3897	1.7
2017-10-07 21:12:07	37.4181	-97.3905	1.3
2017-10-09 05:04:20	37.5854	-97.2488	1.1
2017-10-09 12:06:36	38.6106	-97.5295	1.5
2017-10-11 08:03:24	38.0163	-97.9741	1.5
2017-10-13 05:32:43	37.6531	-97.5369	1.5
2017-10-13 20:05:04	37.5945	-97.7728	1.6
2017-10-15 17:43:38	37.7677	-97.7875	1.0
2017-10-16 12:20:16	37.6989	-97.3074	1.4
2017-10-18 04:08:31	38.0317	-97.9960	1.1
2017-10-19 09:19:58	37.4134	-97.4142	3.0
2017-10-19 09:30:59	37.4155	-97.3809	1.2
2017-10-19 10:43:04	37.4075	-97.3995	2.1
2017-10-19 13:24:18	37.6382	-97.7499	1.7
2017-10-19 16:07:08	37.4796	-97.3371	0.1

Appendix B. Continued

Origin Time (UTC)	Latitude	Longitude	Magnitude	Origin Time (UTC)	Latitude	Longitude	Magnitude
2017-10-21 17:08:43	37.7800	-97.9441	0.6	2017-11-28 13:20:09	37.8868	-98.0791	1.7
2017-10-24 00:13:03	37.9895	-97.9944	0.9	2017-11-28 23:27:54	37.7867	-97.9420	1.2
2017-10-25 06:19:01	37.8874	-98.0844	1.2	2017-11-30 04:50:44	38.0111	-97.9961	1.4
2017-10-25 07:46:17	37.9351	-98.0305	1.2	2017-11-30 07:07:48	38.0185	-97.9793	1.7
2017-10-28 03:16:27	37.6019	-97.7589	1.4	2017-12-03 09:54:30	37.8840	-98.0813	1.3
2017-10-28 18:32:07	38.0387	-97.9625	1.6	2017-12-06 04:48:30	37.3831	-97.4410	1.4
2017-10-28 21:24:47	38.0234	-97.9693	1.4	2017-12-06 04:51:32	37.3781	-97.4275	1.1
2017-10-28 21:36:13	38.0097	-97.9726	1.5	2017-12-07 06:54:26	37.5925	-97.7683	1.6
2017-10-29 02:16:55	38.0375	-97.9918	1.0	2017-12-07 15:52:42	37.8901	-98.0839	1.4
2017-10-30 07:37:45	37.7150	-97.1553	1.4	2017-12-10 06:20:02	37.6785	-97.3281	1.8
2017-10-30 08:11:39	37.7264	-97.1609	1.4	2017-12-13 16:41:39	37.8548	-97.0044	1.6
2017-10-30 08:53:17	37.7575	-97.2805	1.4	2017-12-14 07:43:37	37.9292	-97.1421	1.6
2017-10-31 08:00:27	37.7423	-97.1677	1.3	2017-12-15 02:15:19	38.0205	-97.9847	1.5
2017-11-01 10:01:02	38.0153	-97.9644	1.7	2017-12-15 04:59:23	38.0048	-97.9895	0.8
2017-11-01 10:41:52	37.6399	-97.5288	1.3	2017-12-15 20:52:47	37.3097	-97.4521	1.5
2017-11-01 11:54:43	38.0133	-97.9593	2.0	2017-12-16 05:04:24	38.0136	-97.9788	1.8
2017-11-01 13:06:15	37.7790	-97.9564	1.4	2017-12-16 05:05:33	38.0135	-97.9944	1.4
2017-11-02 03:08:56	38.0187	-97.9890	1.3	2017-12-16 05:30:15	38.0134	-97.9645	2.0
2017-11-06 10:19:22	38.0183	-97.9850	1.4	2017-12-16 05:48:38	38.0147	-97.9762	1.7
2017-11-08 05:34:46	37.5929	-97.7580	1.5	2017-12-16 06:19:13	37.3104	-97.4727	1.3
2017-11-09 11:49:50	37.8901	-98.0651	1.4	2017-12-17 12:30:17	38.0181	-97.9896	1.4
2017-11-09 11:58:05	37.8992	-98.0668	1.0	2017-12-17 13:33:07	37.7824	-97.9387	1.7
2017-11-11 03:25:45	38.0215	-97.9824	1.4	2017-12-18 04:37:32	37.6556	-97.3249	1.4
2017-11-12 06:39:51	37.4251	-97.3852	1.4	2017-12-18 06:47:10	38.0104	-97.9945	1.6
2017-11-12 07:15:55	37.4379	-97.3918	1.0	2017-12-19 05:05:25	37.7846	-97.9506	1.3
2017-11-12 09:26:51	37.6281	-97.1151	1.0	2017-12-19 15:04:34	37.7824	-97.9578	1.8
2017-11-12 10:03:47	37.3945	-97.4257	1.4	2017-12-19 15:11:51	37.7723	-97.9718	1.7
2017-11-13 07:39:53	37.6178	-97.1016	1.0	2017-12-19 20:44:00	37.7877	-97.9378	2.0
2017-11-15 07:51:13	37.8844	-98.0781	1.0	2017-12-20 01:02:47	37.8809	-98.0973	1.1
2017-11-15 16:05:53	37.6482	-97.1467	1.2	2017-12-20 01:55:53	37.8896	-98.0738	1.2
2017-11-17 06:58:17	37.6327	-97.1142	1.1	2017-12-20 01:57:18	37.8793	-98.0956	1.1
2017-11-17 10:05:58	37.3087	-97.4401	1.6	2017-12-21 09:56:43	38.0133	-97.9940	0.5
2017-11-17 23:12:41	37.3233	-97.4310	1.5	2017-12-22 00:40:56	37.3680	-97.3990	1.5
2017-11-19 19:39:12	37.5937	-97.2368	1.4	2017-12-22 06:58:01	37.7777	-97.9514	0.3
2017-11-22 10:59:38	37.6248	-97.1112	1.1	2017-12-22 06:58:42	37.7825	-97.9489	0.4
2017-11-23 10:20:45	37.6145	-97.0992	0.6	2017-12-22 13:13:33	37.6734	-97.1520	1.4
2017-11-23 10:23:12	37.3502	-97.5212	1.8	2017-12-23 12:23:29	37.8920	-98.0690	1.5
2017-11-23 10:52:32	37.3580	-97.5512	1.3	2017-12-25 13:33:18	37.7799	-97.9425	2.0
2017-11-24 09:28:28	37.6197	-97.7739	0.4	2017-12-25 13:35:22	37.7835	-97.9451	0.9
2017-11-24 13:33:07	37.6217	-97.1086	1.9	2017-12-25 22:10:12	37.7794	-97.9453	1.6
2017-11-24 13:41:23	37.6058	-97.1484	1.5	2017-12-25 23:05:14	37.7741	-97.9426	2.4
2017-11-24 13:42:29	37.6157	-97.1132	1.4	2017-12-25 23:09:12	37.7756	-97.9561	0.7
2017-11-24 15:06:35	38.0135	-97.9652	1.6	2017-12-26 03:11:16	37.8882	-98.0889	1.2
2017-11-24 15:10:17	38.0188	-97.9841	1.9	2017-12-26 04:22:07	37.7574	-97.9586	0.2
2017-11-24 17:22:09	37.6198	-97.1064	1.8	2017-12-26 19:29:12	37.7799	-97.9475	0.6
2017-11-24 17:24:16	37.6410	-97.1095	0.7	2017-12-27 08:55:49	37.7670	-97.9856	1.3
2017-11-24 17:29:46	37.5974	-97.0999	1.1	2017-12-28 01:20:56	37.8044	-97.9046	1.2
2017-11-24 17:47:01	37.6227	-97.1124	2.3	2017-12-30 02:58:29	37.3243	-97.4195	1.2
2017-11-24 18:01:19	37.6395	-97.1128	1.4	2017-12-30 10:25:45	37.7809	-97.9584	2.7
2017-11-25 22:07:53	37.6299	-97.7476	1.4	2017-12-30 14:34:18	37.7794	-97.9351	2.1
2017-11-26 05:42:27	37.7321	-97.1551	1.2	2017-12-31 05:36:55	37.7893	-97.9424	2.2
2017-11-26 23:27:40	37.5722	-97.7616	1.5	2017-12-31 11:46:35	37.7895	-97.9288	2.8
2017-11-27 02:14:28	37.7482	-97.1538	1.4	2017-12-31 15:27:08	37.3310	-97.5907	1.4
2017-11-27 07:51:37	37.7492	-97.1757	1.3	2017-12-31 16:23:01	37.3182	-97.4773	1.7
2017-11-27 10:55:16	37.7041	-97.1260	1.2	2018-01-04 04:33:37	37.7800	-97.9490	1.8
2017-11-28 02:11:22	37.7390	-97.1612	2.0	2018-01-04 04:58:48	37.7780	-97.9460	1.4
2017-11-28 05:41:41	37.7507	-97.1686	1.8	2018-01-04 05:58:04	37.7830	-97.9330	1.9
2017-11-28 05:46:46	37.7088	-97.1274	1.5	2018-01-04 06:09:06	37.7800	-97.9400	1.8
2017-11-28 06:12:23	37.7482	-97.1692	2.3	2018-01-04 09:26:02	37.7790	-97.9500	1.5
2017-11-28 11:40:15	37.3110	-97.4369	2.2	2018-01-05 07:29:04	37.7820	-97.9480	1.9

Appendix B. Continued

Origin Time (UTC)	Latitude	Longitude	Magnitude	Origin Time (UTC)	Latitude	Longitude	Magnitude
2018-01-07 23:32:15	37.8690	-98.0000	1.3	2018-03-01 23:17:24	38.0180	-97.9810	1.6
2018-01-09 07:16:49	37.8710	-97.9990	1.3	2018-03-02 01:47:19	38.0130	-97.9800	2.0
2018-01-11 01:04:36	37.4050	-97.4100	1.8	2018-03-02 02:13:58	38.0130	-98.0020	1.6
2018-01-15 17:43:30	37.4040	-97.4100	1.7	2018-03-02 02:58:54	38.0050	-97.9790	1.5
2018-01-16 09:59:25	37.4120	-97.4260	1.7	2018-03-02 03:16:54	38.0060	-97.9920	1.0
2018-01-16 11:17:25	37.4080	-97.4120	1.9	2018-03-02 07:29:23	38.0130	-97.9870	2.5
2018-01-16 11:20:26	37.4060	-97.4170	1.9	2018-03-02 07:51:15	38.0130	-97.9890	1.6
2018-01-16 13:03:54	38.0000	-97.9940	1.0	2018-03-02 21:09:36	38.0180	-97.9710	2.0
2018-01-17 08:58:04	38.0090	-97.9770	1.3	2018-03-02 23:54:21	38.0080	-97.9840	2.0
2018-01-21 13:31:52	37.8840	-98.0500	1.5	2018-03-03 01:12:53	38.0030	-97.9970	1.5
2018-01-22 01:12:15	37.8830	-98.0650	1.1	2018-03-05 08:42:57	38.0134	-97.9630	1.9
2018-01-24 10:05:00	37.3810	-97.4970	1.4	2018-03-05 11:12:17	38.0150	-97.9760	2.2
2018-01-25 02:58:41	37.9100	-98.0130	1.7	2018-03-05 16:46:26	38.0160	-97.9760	2.0
2018-01-29 02:23:16	37.3720	-97.5050	1.5	2018-03-06 03:11:38	38.0090	-97.9860	1.4
2018-01-29 06:22:42	37.5460	-97.5020	1.7	2018-03-08 02:09:39	38.0020	-97.9820	1.7
2018-02-01 19:52:40	38.1960	-98.0900	1.1	2018-03-08 03:16:58	38.0190	-97.9740	1.4
2018-02-02 10:50:54	37.5830	-97.7590	1.4	2018-03-08 10:48:23	38.0140	-98.0000	3.6
2018-02-02 16:55:59	37.6120	-97.7560	1.7	2018-03-08 10:49:28	38.0020	-97.9870	2.8
2018-02-05 04:59:31	38.0160	-97.9730	1.5	2018-03-08 11:00:39	38.0130	-97.9810	1.8
2018-02-05 07:31:05	38.0140	-97.9800	1.4	2018-03-08 11:35:03	38.0030	-97.9820	1.3
2018-02-05 09:18:39	38.0160	-97.9990	2.0	2018-03-08 11:44:47	38.0140	-97.9730	1.8
2018-02-05 17:05:08	38.0150	-97.9680	1.8	2018-03-08 11:45:41	38.0160	-97.9860	1.7
2018-02-05 17:35:43	38.0050	-97.9730	1.7	2018-03-08 13:17:00	38.0090	-97.9800	1.7
2018-02-06 05:45:43	38.0120	-97.9610	1.5	2018-03-08 13:30:28	38.0150	-97.9840	1.7
2018-02-06 15:01:58	38.0070	-97.9870	1.6	2018-03-08 17:22:22	37.8886	-98.1078	1.5
2018-02-06 15:23:08	38.0190	-97.9900	1.9	2018-03-09 03:56:22	38.0080	-97.9830	1.3
2018-02-06 17:02:58	37.9920	-97.9690	1.4	2018-03-10 01:27:44	38.0190	-97.9740	1.7
2018-02-07 05:23:30	38.0220	-97.9900	1.7	2018-03-10 16:18:40	37.9970	-97.9890	0.5
2018-02-07 06:02:57	38.0190	-97.9920	2.0	2018-03-12 00:11:20	38.0170	-97.9730	1.8
2018-02-07 06:18:25	38.0300	-97.9940	2.2	2018-03-12 05:25:30	38.0190	-97.9830	1.3
2018-02-07 10:25:08	38.0070	-97.9870	0.7	2018-03-12 10:06:16	38.0290	-97.9830	1.5
2018-02-08 07:10:33	38.0210	-97.9620	1.6	2018-03-12 11:26:36	38.0150	-98.0010	1.6
2018-02-08 09:15:05	37.8900	-98.0660	1.4	2018-03-12 12:03:06	38.0200	-97.9950	1.4
2018-02-08 10:04:15	37.8780	-98.0890	1.6	2018-03-13 01:42:57	38.5550	-97.5180	1.1
2018-02-09 09:32:10	38.0190	-97.9840	2.2	2018-03-13 02:43:50	37.6160	-99.0570	2.1
2018-02-09 13:33:08	38.0230	-97.9800	1.6	2018-03-13 05:59:22	38.0090	-97.9980	0.4
2018-02-12 04:37:04	37.8160	-97.9290	1.2	2018-03-13 06:09:21	38.6040	-97.5460	1.0
2018-02-12 05:05:19	37.8140	-97.9210	1.2	2018-03-13 09:53:27	38.0100	-97.9860	2.1
2018-02-12 05:43:32	37.8100	-97.9260	1.7	2018-03-13 18:29:51	38.0040	-97.9770	1.6
2018-02-12 08:03:46	37.8120	-97.9170	1.3	2018-03-13 21:39:19	38.0140	-97.9820	1.7
2018-02-12 08:37:18	37.8100	-97.9220	1.3	2018-03-13 23:34:19	37.6200	-99.0590	1.7
2018-02-12 09:28:58	37.8090	-97.9560	1.5	2018-03-14 12:35:12	38.0140	-97.9860	1.7
2018-02-12 09:35:45	37.8100	-97.9190	1.6	2018-03-17 17:18:19	37.8960	-98.0570	1.7
2018-02-12 09:46:56	37.5510	-97.2040	1.4	2018-03-18 02:17:14	38.0130	-97.9950	3.2
2018-02-12 14:48:37	37.8120	-97.9250	1.4	2018-03-18 02:22:07	38.0170	-97.9820	1.4
2018-02-16 14:13:56	38.0070	-97.9890	1.7	2018-03-18 02:26:07	38.0245	-98.0010	1.5
2018-02-17 13:09:37	38.0210	-97.9790	1.5	2018-03-18 02:34:12	38.0150	-97.9830	1.5
2018-02-17 16:44:59	38.0174	-97.9747	1.8	2018-03-18 03:50:05	38.0030	-97.9910	1.5
2018-02-17 17:12:14	37.6350	-97.6620	1.9	2018-03-18 06:03:28	38.0040	-97.9930	1.6
2018-02-21 14:37:04	37.8420	-97.9960	1.5	2018-03-18 06:36:45	38.0040	-98.0010	1.9
2018-02-22 19:32:00	38.5510	-97.4670	1.3	2018-03-18 17:15:26	38.0020	-97.9870	1.4
2018-03-01 20:27:01	38.0180	-97.9800	3.3	2018-03-19 09:16:01	37.5650	-97.7690	2.1
2018-03-01 20:30:42	38.0210	-97.9870	2.3	2018-03-20 17:07:05	38.0190	-97.9840	2.0
2018-03-01 20:32:02	38.0240	-97.9820	2.0	2018-03-21 00:43:41	38.0140	-97.9800	2.0
2018-03-01 20:37:28	38.0100	-97.9870	1.1	2018-03-21 02:16:16	37.9910	-97.9820	1.5
2018-03-01 20:53:53	38.0020	-97.9790	1.5	2018-03-21 03:25:44	37.9900	-97.9880	0.9
2018-03-01 20:55:00	38.0030	-97.9870	1.1	2018-03-22 15:59:51	37.8990	-98.0120	1.8
2018-03-01 21:04:50	38.0370	-97.9910	0.7	2018-03-23 04:17:17	38.0180	-97.9770	1.7
2018-03-01 21:15:06	38.0070	-97.9800	1.9	2018-03-24 03:34:26	38.0080	-97.9770	1.3
2018-03-01 21:15:28	38.0188	-97.9952	2.3	2018-03-24 04:15:33	38.0120	-97.9780	1.5

Appendix B. Continued

Origin Time (UTC)	Latitude	Longitude	Magnitude
2018-03-24 21:57:22	37.7250	-97.2450	1.6
2018-03-24 23:56:25	37.6790	-97.2090	1.5
2018-03-25 10:44:38	37.6980	-97.2290	1.1
2018-03-25 13:26:01	37.6880	-97.2130	1.7
2018-03-25 17:18:30	37.6990	-97.2290	1.6
2018-03-26 11:47:51	37.6780	-97.2250	1.5
2018-03-26 17:06:05	37.7050	-97.2310	1.6
2018-03-26 20:07:14	37.8930	-98.0680	1.9
2018-03-26 22:51:28	37.8920	-98.0810	1.3
2018-03-27 01:14:39	37.7020	-97.2320	1.3
2018-03-28 11:30:30	38.0210	-97.9740	1.7
2018-03-28 11:46:40	38.0020	-97.9950	0.9
2018-03-28 19:28:38	38.0010	-97.9860	1.7
2018-03-29 03:53:18	38.6010	-97.5030	1.4
2018-03-29 07:15:18	38.0230	-97.9740	1.5
2018-03-29 11:29:48	37.5890	-97.7560	1.8
2018-03-29 19:21:28	38.0070	-97.9800	1.5
2018-03-30 05:06:07	37.6840	-97.2330	1.3
2018-03-30 22:05:32	37.9890	-98.0240	0.7
2018-03-31 02:11:51	38.0180	-97.9760	1.8
2018-03-31 03:10:32	37.6360	-97.7350	1.8
2018-04-01 21:05:31	37.8930	-98.0570	1.4
2018-04-03 03:50:28	38.0110	-97.9820	1.5
2018-04-03 09:21:01	37.9960	-98.0000	1.5
2018-04-03 09:34:54	38.0330	-98.0010	1.2
2018-04-03 10:30:59	38.0140	-97.9790	1.5
2018-04-03 19:26:19	38.0160	-97.9880	2.6
2018-04-03 21:56:10	38.0100	-98.0050	2.5
2018-04-04 00:43:24	38.0310	-97.9930	1.4
2018-04-04 07:41:40	38.0320	-97.9870	1.1
2018-04-07 12:52:58	37.7800	-97.9550	1.3
2018-04-08 03:24:18	38.0240	-97.9880	1.1
2018-04-08 23:10:41	38.0100	-97.9990	1.7
2018-04-08 23:34:26	38.0150	-97.9810	2.4
2018-04-09 01:30:55	38.0240	-97.9790	1.4
2018-04-09 07:39:12	38.0050	-97.9830	0.9
2018-04-09 07:40:17	38.0100	-97.9850	1.2
2018-04-09 08:59:00	38.0220	-97.9850	1.6
2018-04-09 09:09:19	38.0140	-97.9860	1.3
2018-04-09 22:00:33	38.0200	-97.9820	1.3
2018-04-12 08:46:00	37.9890	-97.9980	1.5
2018-04-13 13:05:21	38.0170	-97.9930	1.7
2018-04-14 02:46:36	38.0220	-97.9820	3.4
2018-04-14 02:59:42	38.0260	-97.9900	2.3
2018-04-17 23:05:48	38.0200	-97.9900	3.2
2018-04-17 23:49:47	38.0190	-97.9920	0.8
2018-04-18 00:00:47	38.0160	-97.9810	1.7
2018-04-18 00:40:29	38.0130	-97.9890	2.1
2018-04-18 00:41:29	38.0040	-97.9840	1.6
2018-04-18 01:35:53	38.0290	-97.9940	1.7
2018-04-18 02:43:36	38.0250	-97.9800	2.0
2018-04-18 09:14:08	38.0130	-97.9970	2.4
2018-04-18 13:13:19	38.0120	-97.9960	1.8
2018-04-19 03:44:56	37.9980	-97.9840	1.4
2018-04-19 04:14:49	38.0200	-97.9800	1.2
2018-04-20 02:54:47	38.0130	-97.9890	2.7
2018-04-20 03:48:16	38.0160	-97.9920	1.2
2018-04-20 04:14:23	38.0210	-97.9870	1.2
2018-04-20 04:22:08	38.0170	-97.9810	1.3
2018-04-20 05:41:43	38.0120	-97.9950	1.6

Origin Time (UTC)	Latitude	Longitude	Magnitude
2018-04-20 05:42:36	38.0080	-97.9960	2.2
2018-04-20 09:05:29	38.0210	-97.9830	1.2
2018-04-20 10:04:37	38.0140	-97.9860	1.1
2018-04-20 22:36:33	38.0220	-97.9980	1.7
2018-04-21 07:10:09	38.0160	-97.9800	1.4
2018-04-22 03:56:48	38.0150	-97.9810	1.3
2018-04-22 06:51:51	38.0040	-97.9900	1.2
2018-04-23 15:29:18	38.0110	-97.9800	1.2
2018-04-24 10:58:19	38.0160	-97.9790	1.4
2018-04-27 06:35:03	37.9990	-97.9820	1.2
2018-04-27 12:03:02	37.9910	-97.9980	2.1
2018-04-27 21:28:12	37.9810	-97.9910	1.5
2018-04-28 22:26:24	38.0030	-97.9900	1.4
2018-05-04 03:27:36	37.8970	-98.0520	1.2
2018-05-04 03:43:19	38.0100	-97.9950	1.1
2018-05-06 10:41:45	37.3630	-97.6480	1.6
2018-05-13 19:25:13	38.0290	-97.9920	1.6
2018-05-16 12:45:40	37.5250	-97.7710	1.4
2018-05-19 14:04:41	37.6920	-97.1720	1.1
2018-05-20 20:49:33	37.8190	-97.9030	1.5
2018-05-21 07:14:48	37.8220	-97.9070	1.4
2018-05-21 08:12:07	37.8210	-97.9020	1.4
2018-05-21 08:33:18	37.8150	-97.9180	1.8
2018-05-21 08:52:37	37.8160	-97.9220	1.6
2018-05-21 12:27:19	37.8200	-97.9020	1.3
2018-05-26 10:39:14	38.0150	-97.9940	2.2
2018-05-30 02:37:27	38.0120	-97.9880	1.7
2018-05-30 05:46:25	38.0220	-97.9910	1.5
2018-05-30 10:41:28	38.0250	-97.9830	1.5
2018-05-30 17:25:09	38.1710	-97.5940	1.7
2018-06-01 14:00:01	38.0140	-97.9770	1.6
2018-06-01 15:37:42	37.3060	-97.4140	2.0
2018-06-01 22:44:29	38.0140	-97.9960	2.1
2018-06-01 23:34:22	38.0220	-97.9870	1.8
2018-06-02 02:41:34	38.0110	-97.9990	2.0
2018-06-02 03:43:44	38.0130	-98.0010	2.7
2018-06-02 03:46:52	38.0180	-97.9880	1.7
2018-06-02 04:24:52	38.0070	-97.9890	1.5
2018-06-03 22:34:27	37.3010	-97.4130	1.8
2018-06-04 13:48:25	38.0230	-97.9960	3.0
2018-06-04 13:49:40	38.0140	-97.9950	2.3
2018-06-04 14:12:08	38.0050	-97.9830	2.3
2018-06-04 15:36:26	38.0050	-97.9800	2.2
2018-06-06 16:57:30	38.0250	-97.9820	2.1
2018-06-06 18:54:54	38.0060	-97.9800	2.1
2018-06-07 03:07:10	38.0310	-97.9910	1.0
2018-06-08 15:47:32	37.3090	-97.4150	1.7
2018-06-09 07:24:47	37.8860	-98.0710	1.5
2018-06-09 08:06:42	37.8890	-98.0500	1.4
2018-06-09 09:32:51	38.0160	-97.9820	1.1
2018-06-09 22:14:23	38.0030	-97.9980	1.9
2018-06-10 17:53:01	38.5860	-97.5520	1.4
2018-06-12 04:11:22	38.0130	-97.9670	1.9
2018-06-12 20:54:15	38.5400	-97.5740	1.7
2018-06-12 21:09:15	38.5480	-97.5740	1.5
2018-06-13 02:43:35	38.5950	-97.5460	1.4
2018-06-13 03:00:21	38.5760	-97.5700	1.5
2018-06-13 05:19:48	38.5580	-97.6020	1.0
2018-06-13 09:59:24	38.5550	-97.5610	1.1
2018-06-14 17:19:28	38.0220	-98.0020	1.4

Appendix B. Continued

Origin Time (UTC)	Latitude	Longitude	Magnitude
2018-06-17 09:36:06	38.0310	-97.9860	0.9
2018-06-18 18:11:05	38.0000	-97.9830	0.7
2018-06-19 10:35:57	37.9890	-98.0180	1.4
2018-06-20 09:17:40	37.6620	-97.7220	1.3
2018-06-20 09:22:33	38.0080	-97.9760	1.2
2018-06-25 00:48:43	38.0260	-97.9830	1.2
2018-06-25 11:18:34	38.0280	-97.9910	1.3
2018-06-30 20:37:35	38.0130	-97.9880	1.9
2018-06-30 21:35:16	38.0030	-97.9830	1.6

Appendix C: Subnetwork Events Catalog

Subnetwork events recorded from July 1, 2017, to June 30, 2018, with epicentral distance within 12 miles of member wells. Epicentral distance is the estimated distance from the earthquake epicenter to the seismic station where it was recorded.

Origin Time (UTC)	Station	Distance	Magnitude	Origin Time (UTC)	Station	Distance	Magnitude
2017-09-14 01:32:52	BU02	2.4	-0.6	2017-11-03 10:05:43	MP02	9.1	0.4
2017-10-21 23:46:35	BU02	3.5	0.4	2017-11-15 10:39:50	MP02	2.5	1.0
2017-10-27 02:27:10	BU02	10.9	1.0	2017-11-23 05:05:06	MP02	2.4	-0.4
2017-10-27 02:27:53	BU02	10.6	0.4	2018-01-21 08:08:14	MP02	7.9	0.2
2017-11-15 01:18:19	BU02	11.8	1.4	2018-03-02 05:16:58	MP02	4.1	-0.2
2017-11-15 04:08:06	BU02	11.7	1.1	2018-03-15 14:04:23	MP02	2.2	-0.2
2017-12-13 16:41:39	BU02	11.7	1.6	2018-03-15 15:49:14	MP02	3.3	-0.2
2017-12-26 10:56:32	BU02	0.9	-0.9	2018-03-16 00:43:34	MP02	2.3	-0.4
2017-12-27 10:49:15	BU02	2.0	-0.6	2018-03-23 08:49:21	MP02	5.4	0.1
2018-01-01 03:24:35	BU02	1.2	-0.6	2018-03-25 01:56:49	MP02	3.5	0.1
2018-01-01 03:47:26	BU02	2.9	-0.4	2018-04-15 07:17:23	MP02	3.2	-0.2
2018-01-18 15:58:22	BU02	2.7	0.0	2018-05-03 16:15:17	MP02	2.0	-0.6
2018-06-01 02:26:31	BU02	11.9	1.0	2018-05-18 03:51:37	MP02	3.9	0.4
2017-08-12 08:04:09	EW01	4.9	0.3	2018-05-19 03:45:01	MP02	3.5	1.0
2017-08-30 00:17:22	EW01	2.4	0.1	2018-06-10 04:13:51	MP02	2.8	0.0
2017-09-06 16:36:53	EW01	2.5	-0.9	2018-06-11 00:24:22	MP02	2.4	0.3
2017-09-13 08:39:03	EW01	8.5	0.3	2018-06-11 17:56:55	MP02	1.6	0.0
2017-09-22 08:09:46	EW01	8.5	0.5	2018-06-15 07:51:54	MP02	1.4	-0.6
2017-09-25 12:04:34	EW01	6.3	-0.2	2018-06-17 15:11:55	MP02	1.5	-0.4
2017-09-28 23:08:01	EW01	2.6	-0.6	2018-06-18 02:12:59	MP02	1.7	-0.2
2017-12-13 16:58:03	EW01	6.8	0.7	2018-06-19 14:55:01	MP02	1.7	-0.6
2018-02-20 03:16:01	EW01	6.4	0.1	2018-06-23 23:15:25	MP02	2.6	-0.6
2018-03-09 10:54:02	EW01	2.1	-0.4	2018-06-27 04:15:35	MP02	1.6	-0.4
2018-03-21 18:45:09	EW01	2.7	-0.4	2018-06-29 06:06:24	MP02	1.4	-0.9
2017-10-17 15:24:31	JO01	5.1	0.7	2018-06-30 07:40:55	MP02	1.4	-0.6
2017-11-29 07:50:09	KE01	2.3	0.3	2017-08-12 02:30:08	RC02	5.1	-0.6
2017-11-29 07:52:27	KE01	3.1	0.1	2017-08-30 06:46:24	RC02	6.9	0.0
2017-12-22 07:53:59	KE01	1.3	0.0	2017-09-07 02:43:09	RC02	1.9	-0.9
2018-03-14 05:23:02	KE01	10.2	0.4	2017-09-12 14:24:13	RC02	12.0	0.6
2017-09-01 19:14:37	KW01	3.1	-0.6	2017-09-13 09:00:01	RC02	7.6	0.1
2017-09-22 23:37:10	KW01	7.6	-0.4	2017-09-25 13:30:50	RC02	8.8	0.3
2017-11-04 00:05:59	KW01	4.1	0.1	2017-09-25 20:16:53	RC02	3.9	0.1
2017-11-20 16:09:44	KW01	1.0	-0.6	2017-11-04 06:05:01	RC02	5.4	0.4
2017-12-04 15:02:06	KW01	2.7	0.2	2017-11-19 00:42:35	RC02	8.6	0.4
2018-03-14 15:14:07	KW01	10.6	0.8	2017-11-25 21:34:02	RC02	0.7	0.0
2018-04-16 04:21:30	KW01	7.4	0.2	2017-12-14 09:17:37	RC02	2.4	0.0
2018-04-30 10:18:53	KW01	2.0	0.0	2017-12-22 07:28:07	RC02	2.0	0.1
2017-08-28 00:17:37	MP01	8.6	-0.4	2017-12-26 11:44:11	RC02	4.0	0.2
2017-09-03 08:41:51	MP01	4.3	-0.2	2017-12-27 10:20:03	RC02	3.3	0.7
2017-09-15 03:29:17	MP01	5.0	0.0	2017-12-27 12:39:04	RC02	4.5	0.2
2017-09-18 12:33:07	MP01	2.5	0.6	2017-12-27 12:51:52	RC02	4.2	0.3
2017-09-19 02:53:22	MP01	10.3	0.4	2017-12-27 13:16:15	RC02	4.9	0.1
2017-09-25 17:48:54	MP01	4.6	-0.6	2017-12-27 14:40:05	RC02	4.7	0.0
2017-09-27 09:44:28	MP01	2.7	-0.4	2017-12-27 23:14:51	RC02	7.7	0.1
2017-09-29 12:40:41	MP01	4.9	-0.2	2017-12-29 00:49:24	RC02	5.2	0.4
2017-09-30 06:41:04	MP01	2.3	-0.6	2017-12-29 01:38:47	RC02	4.7	0.3
2017-10-04 12:10:56	MP01	5.4	1.2	2017-12-29 01:51:38	RC02	4.4	0.1
2017-10-25 09:59:14	MP01	7.8	0.9	2017-12-29 03:41:31	RC02	8.6	0.6
2017-11-08 09:26:07	MP01	5.1	0.4	2017-12-29 06:42:28	RC02	5.4	0.1
2017-11-08 09:27:02	MP01	5.9	0.0	2017-12-29 07:37:35	RC02	5.3	0.1
2017-11-19 11:16:01	MP01	6.0	0.3	2018-01-01 04:34:04	RC02	5.3	0.1
2017-11-20 05:45:37	MP01	2.2	0.0	2018-01-01 05:34:25	RC02	4.7	0.2
2018-02-18 10:00:14	MP01	3.4	0.1	2018-01-16 10:43:19	RC02	5.5	0.4
2017-08-01 05:24:48	MP02	8.8	0.4	2018-01-16 12:17:32	RC02	4.0	0.0
2017-10-20 04:36:49	MP02	7.4	0.6	2018-01-17 09:09:41	RC02	4.6	0.1

Appendix C. Continued

Origin Time (UTC)	Station	Distance	Magnitude	Origin Time (UTC)	Station	Distance	Magnitude
2018-04-04 02:21:19	RC02	1.9	0.0	2017-11-16 03:13:11	RC03	8.1	0.0
2018-04-21 13:14:48	RC02	2.8	0.1	2017-11-16 03:13:52	RC03	7.4	0.5
2018-04-28 06:47:53	RC02	2.1	-0.2	2017-11-16 04:24:14	RC03	6.0	-0.2
2018-05-10 02:41:22	RC02	3.9	0.1	2017-11-17 03:12:11	RC03	8.5	1.1
2018-06-04 02:23:52	RC02	8.0	0.4	2017-11-17 11:16:13	RC03	8.5	0.5
2017-08-31 02:27:19	RC03	9.1	0.5	2017-11-18 03:07:12	RC03	8.9	0.4
2017-09-04 07:47:42	RC03	11.7	0.1	2017-11-20 19:14:31	RC03	7.1	0.4
2017-09-06 02:20:56	RC03	7.7	0.5	2017-11-20 19:15:31	RC03	7.3	0.4
2017-09-08 02:09:14	RC03	9.6	0.9	2017-11-21 11:12:05	RC03	7.1	0.7
2017-09-14 02:22:18	RC03	8.2	0.6	2017-11-22 03:20:33	RC03	8.6	0.4
2017-09-15 13:36:42	RC03	10.6	0.7	2017-11-22 03:21:13	RC03	8.2	0.4
2017-09-21 02:22:22	RC03	9.9	0.4	2017-11-23 03:12:52	RC03	8.1	0.6
2017-09-25 13:27:48	RC03	4.1	0.4	2017-11-23 03:14:06	RC03	8.0	0.4
2017-09-25 15:11:12	RC03	10.4	0.0	2017-11-23 03:15:32	RC03	7.1	0.8
2017-10-03 02:12:12	RC03	7.7	0.1	2017-11-25 18:34:02	RC03	0.2	-0.6
2017-10-03 02:12:37	RC03	8.8	0.6	2017-11-25 18:47:53	RC03	0.5	0.1
2017-10-03 02:13:06	RC03	8.2	0.5	2017-11-25 20:46:17	RC03	0.5	0.2
2017-10-04 02:23:02	RC03	8.4	1.0	2017-11-28 15:29:36	RC03	8.1	0.4
2017-10-11 02:14:00	RC03	9.6	0.6	2017-11-28 15:30:40	RC03	7.5	0.3
2017-10-12 02:23:48	RC03	8.5	0.7	2017-11-29 03:15:58	RC03	8.6	0.9
2017-10-12 02:25:04	RC03	7.0	0.5	2017-11-29 11:16:24	RC03	8.5	1.1
2017-10-12 02:25:28	RC03	7.0	0.6	2017-11-29 19:23:45	RC03	8.7	0.5
2017-10-13 02:21:34	RC03	8.8	0.9	2017-11-29 19:24:16	RC03	7.7	0.6
2017-10-16 04:13:47	RC03	6.6	0.3	2017-11-30 23:09:15	RC03	7.7	0.6
2017-10-18 02:36:38	RC03	9.0	0.5	2017-11-30 23:09:41	RC03	7.4	0.8
2017-10-18 02:37:58	RC03	8.4	0.4	2017-11-30 23:10:13	RC03	6.9	0.9
2017-10-18 02:38:56	RC03	9.0	1.1	2017-12-02 03:21:12	RC03	9.8	0.6
2017-10-19 02:34:32	RC03	7.9	0.9	2017-12-02 03:21:33	RC03	9.0	0.8
2017-10-19 02:36:24	RC03	8.1	1.1	2017-12-05 05:14:18	RC03	8.3	0.3
2017-10-24 02:19:06	RC03	8.8	1.0	2017-12-05 11:17:53	RC03	6.8	1.0
2017-10-25 02:13:06	RC03	8.7	0.9	2017-12-06 11:19:39	RC03	8.8	1.0
2017-10-25 02:14:04	RC03	8.3	1.0	2017-12-06 23:44:29	RC03	8.9	0.4
2017-10-25 02:15:32	RC03	7.4	1.0	2017-12-08 02:27:59	RC03	7.0	0.9
2017-10-26 02:17:12	RC03	6.9	1.0	2017-12-08 03:05:01	RC03	4.9	0.0
2017-10-31 02:27:06	RC03	8.2	0.6	2017-12-08 11:23:19	RC03	7.3	0.9
2017-11-01 02:16:32	RC03	7.0	1.0	2017-12-09 03:01:30	RC03	7.8	-0.4
2017-11-01 08:29:43	RC03	8.3	0.8	2017-12-09 03:01:34	RC03	7.8	0.8
2017-11-01 10:17:35	RC03	9.0	1.1	2017-12-09 03:01:56	RC03	7.8	0.6
2017-11-02 10:15:33	RC03	7.9	0.4	2017-12-12 03:14:53	RC03	8.6	0.4
2017-11-02 10:16:07	RC03	7.1	0.6	2017-12-12 03:16:05	RC03	9.3	0.4
2017-11-03 02:17:09	RC03	8.1	0.8	2017-12-12 11:13:12	RC03	6.8	0.6
2017-11-03 02:18:04	RC03	8.8	1.0	2017-12-13 03:15:11	RC03	6.7	1.0
2017-11-04 02:08:04	RC03	8.1	0.4	2017-12-13 11:16:32	RC03	7.0	0.1
2017-11-07 03:25:08	RC03	8.0	0.6	2017-12-13 11:17:00	RC03	7.9	0.6
2017-11-07 03:25:23	RC03	7.1	0.8	2017-12-13 23:33:13	RC03	8.1	0.5
2017-11-08 03:22:00	RC03	8.1	0.8	2017-12-13 23:34:52	RC03	7.3	0.6
2017-11-08 03:22:24	RC03	9.3	0.7	2017-12-14 11:10:19	RC03	7.3	0.4
2017-11-08 11:16:41	RC03	9.5	0.8	2017-12-14 11:10:37	RC03	7.1	0.5
2017-11-08 19:18:41	RC03	7.8	0.4	2017-12-14 11:11:19	RC03	7.0	0.2
2017-11-08 19:19:06	RC03	8.7	0.4	2017-12-15 03:21:23	RC03	6.9	0.8
2017-11-09 11:16:00	RC03	7.8	1.0	2017-12-15 11:17:09	RC03	8.7	0.7
2017-11-09 11:16:27	RC03	6.9	1.0	2017-12-16 03:11:50	RC03	7.5	0.6
2017-11-10 03:24:08	RC03	8.3	0.9	2017-12-16 03:12:37	RC03	8.5	0.6
2017-11-10 03:25:11	RC03	8.4	0.7	2017-12-19 03:11:20	RC03	7.3	0.6
2017-11-13 05:21:08	RC03	7.5	0.7	2017-12-20 01:55:22	RC03	8.6	0.5
2017-11-14 03:33:16	RC03	7.1	1.0	2017-12-20 02:52:40	RC03	7.9	1.0
2017-11-14 11:16:18	RC03	8.0	0.5	2017-12-20 19:15:07	RC03	8.0	0.6
2017-11-14 11:16:42	RC03	8.5	0.7	2017-12-21 11:12:22	RC03	7.2	0.4
2017-11-15 11:21:08	RC03	7.0	0.7	2017-12-21 11:12:41	RC03	7.3	0.6
2017-11-16 03:12:46	RC03	7.6	0.1	2017-12-22 19:13:31	RC03	7.0	0.3

Appendix C. Continued

Origin Time (UTC)	Station	Distance	Magnitude	Origin Time (UTC)	Station	Distance	Magnitude
2017-12-22 19:14:10	RC03	6.9	0.6	2018-02-20 03:07:35	RC03	9.3	0.5
2017-12-23 03:06:11	RC03	7.8	0.5	2018-02-21 03:22:07	RC03	8.3	0.8
2017-12-23 03:08:10	RC03	7.2	0.6	2018-02-21 03:22:57	RC03	7.8	0.9
2017-12-27 08:35:14	RC03	8.1	0.7	2018-02-21 19:16:41	RC03	7.6	0.7
2017-12-28 03:12:35	RC03	7.4	0.6	2018-02-21 20:53:14	RC03	7.1	0.7
2017-12-28 03:13:21	RC03	8.3	0.8	2018-02-22 11:19:19	RC03	8.1	0.4
2017-12-28 03:15:49	RC03	8.2	0.9	2018-02-22 11:19:42	RC03	8.4	0.5
2017-12-29 03:19:11	RC03	6.8	1.0	2018-02-22 11:20:31	RC03	9.5	0.5
2017-12-29 11:16:32	RC03	7.4	0.9	2018-02-22 19:12:05	RC03	8.9	0.7
2018-01-04 03:24:17	RC03	9.2	0.6	2018-02-23 11:19:53	RC03	7.3	0.7
2018-01-05 03:19:57	RC03	8.8	0.1	2018-02-23 11:20:55	RC03	6.9	0.6
2018-01-05 03:20:18	RC03	8.3	0.0	2018-02-26 11:12:49	RC03	7.1	0.7
2018-01-05 03:20:37	RC03	7.6	0.2	2018-02-27 03:19:20	RC03	8.0	0.4
2018-01-05 11:10:01	RC03	8.2	0.3	2018-02-27 03:20:07	RC03	7.4	0.4
2018-01-06 03:02:36	RC03	8.8	0.4	2018-02-27 03:20:28	RC03	8.3	0.5
2018-01-06 03:03:18	RC03	8.1	0.5	2018-02-27 19:19:27	RC03	6.8	0.6
2018-01-09 11:13:59	RC03	8.2	0.2	2018-02-28 03:21:32	RC03	7.3	0.6
2018-01-10 11:11:39	RC03	9.3	0.1	2018-02-28 19:25:43	RC03	8.2	0.5
2018-01-10 11:11:39	RC03	8.1	0.2	2018-02-28 19:26:25	RC03	9.0	0.5
2018-01-10 11:12:42	RC03	7.7	0.6	2018-02-28 19:28:05	RC03	7.7	0.2
2018-01-11 03:22:29	RC03	7.0	0.3	2018-03-01 03:20:37	RC03	7.3	0.3
2018-01-12 11:18:11	RC03	7.7	0.4	2018-03-01 19:25:52	RC03	8.1	1.0
2018-01-16 03:20:28	RC03	7.1	0.2	2018-03-01 19:29:44	RC03	7.2	0.5
2018-01-16 03:20:54	RC03	8.4	0.2	2018-03-01 19:30:21	RC03	7.7	0.4
2018-01-16 03:22:18	RC03	7.3	0.3	2018-03-07 03:19:00	RC03	8.2	0.4
2018-01-16 03:22:50	RC03	8.1	0.2	2018-03-07 03:19:15	RC03	6.2	0.2
2018-01-17 11:19:04	RC03	8.9	0.4	2018-03-08 19:19:39	RC03	7.0	0.8
2018-01-18 19:13:09	RC03	7.2	0.0	2018-03-08 19:20:23	RC03	6.6	0.6
2018-01-23 11:18:24	RC03	7.7	0.1	2018-03-09 11:21:04	RC03	7.2	1.1
2018-01-24 03:16:35	RC03	8.9	0.2	2018-03-10 01:18:22	RC03	9.1	0.7
2018-01-24 03:17:04	RC03	8.2	0.4	2018-03-13 02:22:06	RC03	7.4	1.1
2018-01-24 03:19:01	RC03	9.7	0.7	2018-03-13 10:18:07	RC03	7.6	0.7
2018-01-25 03:18:29	RC03	8.1	0.0	2018-03-14 10:18:20	RC03	8.6	0.5
2018-01-25 03:19:36	RC03	8.4	0.4	2018-03-14 10:18:54	RC03	7.5	0.4
2018-01-25 11:23:34	RC03	7.7	0.4	2018-03-14 18:17:10	RC03	7.1	0.4
2018-01-25 11:23:59	RC03	11.3	0.6	2018-03-15 02:18:36	RC03	7.3	0.5
2018-02-01 03:19:55	RC03	8.9	0.2	2018-03-16 02:18:11	RC03	7.9	0.6
2018-02-01 03:20:34	RC03	8.7	0.4	2018-03-16 10:16:07	RC03	8.2	0.7
2018-02-01 19:53:34	RC03	7.9	0.6	2018-03-16 10:18:19	RC03	8.7	0.9
2018-02-02 03:21:33	RC03	8.3	0.4	2018-03-20 10:23:15	RC03	6.7	0.0
2018-02-02 11:18:30	RC03	7.4	0.4	2018-03-20 10:23:33	RC03	6.9	0.2
2018-02-06 03:14:01	RC03	8.3	0.5	2018-03-20 18:21:47	RC03	8.0	0.6
2018-02-06 03:14:45	RC03	8.3	0.4	2018-03-20 18:23:40	RC03	6.8	0.6
2018-02-06 19:15:14	RC03	7.7	0.4	2018-03-21 10:18:12	RC03	6.7	0.4
2018-02-07 03:15:07	RC03	7.6	0.7	2018-03-21 10:18:32	RC03	7.6	0.4
2018-02-07 03:16:38	RC03	8.0	0.7	2018-03-22 02:20:44	RC03	6.8	0.4
2018-02-07 15:20:14	RC03	7.3	0.6	2018-03-22 02:22:15	RC03	7.9	0.7
2018-02-08 11:26:14	RC03	8.6	0.1	2018-03-23 02:19:58	RC03	7.7	0.4
2018-02-08 11:26:21	RC03	6.9	0.4	2018-03-23 02:20:33	RC03	7.7	0.5
2018-02-08 11:26:45	RC03	8.6	0.6	2018-03-23 10:16:50	RC03	9.3	0.4
2018-02-13 11:22:49	RC03	7.3	0.7	2018-03-23 10:17:55	RC03	7.4	0.4
2018-02-13 23:20:38	RC03	8.4	0.5	2018-03-23 10:18:34	RC03	8.4	0.4
2018-02-13 23:21:25	RC03	7.8	0.5	2018-03-27 02:15:21	RC03	7.1	0.4
2018-02-14 11:19:12	RC03	6.8	0.4	2018-03-27 18:22:09	RC03	7.2	0.5
2018-02-14 11:19:39	RC03	8.3	0.6	2018-03-28 02:18:54	RC03	8.7	0.4
2018-02-14 19:16:40	RC03	8.1	0.6	2018-03-28 06:44:58	RC03	7.6	0.4
2018-02-15 07:08:47	RC03	8.0	0.0	2018-03-28 18:19:54	RC03	7.0	0.6
2018-02-15 07:09:09	RC03	8.4	0.5	2018-03-29 02:17:49	RC03	6.8	0.5
2018-02-15 19:22:50	RC03	8.9	0.5	2018-03-29 02:18:28	RC03	7.6	0.8
2018-02-20 03:06:48	RC03	8.2	0.5	2018-03-29 02:20:18	RC03	7.1	0.7

Appendix C. Continued

Origin Time (UTC)	Station	Distance	Magnitude	Origin Time (UTC)	Station	Distance	Magnitude
2018-04-02 18:21:28	RC03	7.2	-0.4	2018-06-09 02:10:52	RC03	7.4	0.2
2018-04-02 18:23:18	RC03	7.8	-0.2	2018-06-09 02:11:29	RC03	6.9	0.3
2018-04-02 18:23:53	RC03	6.6	-0.2	2018-06-09 02:12:26	RC03	7.4	0.0
2018-04-04 10:18:06	RC03	7.7	0.4	2018-06-12 02:19:35	RC03	7.4	0.2
2018-04-04 18:27:12	RC03	7.2	-0.2	2018-06-12 02:20:52	RC03	7.2	0.5
2018-04-05 07:05:52	RC03	7.2	0.3	2018-06-13 02:10:05	RC03	7.0	0.4
2018-04-05 18:41:45	RC03	7.4	0.6	2018-06-13 02:12:07	RC03	7.8	0.1
2018-04-09 18:20:23	RC03	7.3	0.2	2018-06-13 18:19:25	RC03	7.2	0.7
2018-04-11 02:17:29	RC03	7.3	0.3	2018-06-14 10:18:37	RC03	6.6	0.7
2018-04-11 10:21:03	RC03	7.9	0.5	2018-06-15 01:51:28	RC03	3.8	0.2
2018-04-11 18:30:29	RC03	7.5	0.2	2018-06-15 10:44:47	RC03	6.6	-0.2
2018-04-11 18:31:13	RC03	7.7	0.3	2018-06-21 10:17:42	RC03	7.3	0.0
2018-04-12 06:49:29	RC03	2.9	-0.2	2018-06-21 10:17:57	RC03	7.1	0.3
2018-04-12 10:18:57	RC03	7.0	-0.4	2018-06-22 02:20:32	RC03	10.5	0.2
2018-04-12 10:19:45	RC03	7.8	0.5	2018-06-22 18:17:25	RC03	6.5	0.2
2018-04-17 18:17:33	RC03	7.2	0.0	2018-06-26 02:17:16	RC03	7.5	0.4
2018-04-19 02:26:15	RC03	6.9	0.4	2018-06-26 02:18:35	RC03	7.3	0.5
2018-04-21 18:13:57	RC03	7.3	0.4	2018-06-27 00:26:58	RC03	2.0	-0.4
2018-04-21 18:14:24	RC03	7.4	0.4	2018-06-27 10:20:37	RC03	7.1	0.0
2018-04-24 02:18:06	RC03	7.6	0.1	2018-06-27 10:21:02	RC03	7.1	0.4
2018-04-24 02:18:34	RC03	7.6	0.4	2018-06-28 10:14:01	RC03	7.3	0.2
2018-04-24 06:54:14	RC03	7.8	0.1	2018-06-28 10:19:52	RC03	7.6	0.3
2018-04-26 02:19:34	RC03	7.7	0.2	2017-07-30 08:29:42	RN01	4.9	0.6
2018-04-26 02:20:04	RC03	8.0	0.4	2017-08-06 06:37:34	RN01	4.1	0.4
2018-04-26 18:13:30	RC03	7.1	1.2	2017-08-06 11:37:30	RN01	4.5	-0.4
2018-04-27 02:14:09	RC03	7.7	0.2	2017-08-12 07:25:45	RN01	5.5	-0.2
2018-04-27 10:28:12	RC03	7.0	0.4	2017-08-13 17:39:39	RN01	5.2	0.1
2018-04-27 10:30:58	RC03	7.6	0.4	2017-08-16 09:05:48	RN01	5.8	-0.4
2018-04-27 10:31:22	RC03	7.2	0.7	2017-08-19 13:49:35	RN01	4.9	-0.2
2018-04-28 02:07:39	RC03	7.6	0.1	2017-08-21 06:05:01	RN01	5.2	0.3
2018-04-28 02:13:27	RC03	7.5	0.2	2017-08-22 08:26:09	RN01	6.8	-0.2
2018-05-01 02:19:13	RC03	7.3	0.0	2017-08-24 02:33:32	RN01	5.0	0.0
2018-05-01 02:19:52	RC03	6.5	0.0	2017-08-24 22:10:13	RN01	3.8	0.4
2018-05-01 02:20:40	RC03	7.8	0.4	2017-08-29 13:20:06	RN01	4.8	0.0
2018-05-02 02:19:35	RC03	8.7	0.1	2017-08-29 16:04:37	RN01	4.7	-0.2
2018-05-03 18:14:34	RC03	7.6	0.5	2017-08-30 03:16:15	RN01	4.7	0.0
2018-05-03 18:16:15	RC03	7.6	0.4	2017-08-30 12:44:20	RN01	2.3	-0.2
2018-05-04 10:23:33	RC03	7.6	0.3	2017-08-31 02:39:08	RN01	4.7	0.0
2018-05-06 22:01:10	RC03	7.2	-0.6	2017-09-02 15:49:07	RN01	4.9	-0.6
2018-05-08 18:19:56	RC03	7.0	0.4	2017-09-05 05:02:56	RN01	3.3	0.4
2018-05-09 18:19:27	RC03	7.4	0.7	2017-09-06 21:19:45	RN01	4.8	-0.4
2018-05-09 18:20:17	RC03	7.1	0.4	2017-09-07 01:38:09	RN01	7.6	0.4
2018-05-11 10:14:40	RC03	7.6	0.4	2017-09-07 01:45:21	RN01	4.5	-0.2
2018-05-11 10:15:23	RC03	7.0	0.4	2017-09-07 11:04:44	RN01	4.9	0.1
2018-05-14 10:15:10	RC03	8.2	0.4	2017-09-07 21:51:18	RN01	5.0	-0.2
2018-05-16 18:18:49	RC03	7.7	0.6	2017-09-10 09:12:36	RN01	5.2	0.2
2018-05-17 02:24:10	RC03	7.7	0.4	2017-09-10 09:20:24	RN01	5.9	0.0
2018-05-17 10:13:28	RC03	7.1	0.6	2017-09-10 17:49:47	RN01	4.9	-0.2
2018-05-18 09:48:06	RC03	7.8	0.2	2017-09-12 16:19:25	RN01	8.0	0.0
2018-05-26 02:07:33	RC03	7.7	0.5	2017-09-13 15:31:17	RN01	9.4	0.0
2018-05-26 02:07:33	RC03	7.3	0.4	2017-09-14 09:48:02	RN01	5.5	0.1
2018-05-30 02:18:48	RC03	7.5	0.1	2017-09-15 03:01:43	RN01	4.4	1.0
2018-05-30 02:19:41	RC03	7.1	0.2	2017-09-15 09:29:50	RN01	5.1	-0.2
2018-05-30 10:23:15	RC03	7.3	0.8	2017-09-16 05:15:32	RN01	4.9	0.2
2018-06-01 02:16:50	RC03	7.4	0.6	2017-09-16 23:24:42	RN01	5.8	0.2
2018-06-01 10:13:44	RC03	8.1	0.5	2017-09-18 10:46:52	RN01	3.4	0.7
2018-06-02 02:02:51	RC03	7.7	0.6	2017-09-19 09:10:06	RN01	5.1	0.2
2018-06-07 08:59:24	RC03	11.7	0.4	2017-09-19 11:30:22	RN01	8.3	0.4
2018-06-07 10:23:37	RC03	8.0	0.3	2017-09-23 06:11:54	RN01	4.4	-0.4
2018-06-08 02:15:37	RC03	7.6	0.2	2017-09-25 15:28:22	RN01	2.3	0.4

Appendix C. Continued

Origin Time (UTC)	Station	Distance	Magnitude	Origin Time (UTC)	Station	Distance	Magnitude
2017-09-26 03:54:08	RN01	4.8	0.0	2017-12-21 11:19:33	RN01	4.0	0.3
2017-09-27 01:20:23	RN01	4.5	0.4	2017-12-21 16:15:55	RN01	4.7	-0.4
2017-09-27 02:23:27	RN01	4.7	0.2	2017-12-22 23:59:27	RN01	4.9	0.4
2017-10-02 14:31:37	RN01	4.8	0.2	2017-12-23 01:18:55	RN01	4.8	0.5
2017-10-05 04:55:49	RN01	4.8	0.3	2017-12-25 05:33:52	RN01	4.7	0.0
2017-10-05 06:23:02	RN01	2.6	-0.2	2018-01-12 07:24:44	RN01	5.6	-0.4
2017-10-07 08:36:00	RN01	4.7	0.3	2018-01-12 07:47:29	RN01	4.6	-0.4
2017-10-07 13:23:09	RN01	4.5	0.6	2018-01-17 17:18:07	RN01	5.0	-0.2
2017-10-08 13:22:32	RN01	4.8	0.5	2018-01-25 06:50:41	RN01	5.0	0.4
2017-10-09 09:23:13	RN01	4.5	0.3	2018-01-26 15:46:32	RN01	3.0	0.3
2017-10-11 08:53:20	RN01	4.7	-0.2	2018-01-26 18:26:30	RN01	4.8	0.2
2017-10-20 23:26:20	RN01	4.6	0.6	2018-02-02 05:28:12	RN01	4.6	0.0
2017-10-22 20:15:26	RN01	4.7	0.6	2018-02-05 04:42:27	RN01	5.9	0.2
2017-10-24 00:13:03	RN01	4.7	0.4	2018-02-05 08:16:38	RN01	4.8	0.4
2017-10-29 01:01:27	RN01	4.9	0.3	2018-02-05 08:55:18	RN01	4.9	0.6
2017-10-29 01:02:12	RN01	4.8	0.4	2018-02-05 09:04:17	RN01	4.6	0.7
2017-10-29 02:16:55	RN01	5.1	0.6	2018-02-05 09:26:48	RN01	4.8	0.5
2017-10-29 08:54:35	RN01	4.9	0.4	2018-02-05 09:29:46	RN01	4.9	0.1
2017-10-29 09:41:21	RN01	4.9	0.3	2018-02-05 09:56:49	RN01	5.0	0.4
2017-10-29 23:02:01	RN01	4.9	0.6	2018-02-05 10:33:53	RN01	4.9	0.8
2017-10-30 00:58:42	RN01	4.8	0.2	2018-02-05 13:02:23	RN01	4.8	0.6
2017-10-30 05:28:52	RN01	4.9	0.2	2018-02-05 15:24:59	RN01	4.9	0.3
2017-11-03 09:19:40	RN01	4.8	0.7	2018-02-05 15:26:46	RN01	4.9	0.5
2017-11-04 14:38:22	RN01	4.6	0.8	2018-02-06 15:13:59	RN01	4.9	0.6
2017-11-07 08:31:24	RN01	4.8	0.8	2018-02-06 18:26:45	RN01	4.8	0.2
2017-11-07 09:55:13	RN01	4.9	0.5	2018-02-06 20:28:10	RN01	4.6	0.6
2017-11-07 23:30:22	RN01	4.7	0.9	2018-02-07 01:55:10	RN01	5.1	0.4
2017-11-09 10:05:18	RN01	5.0	0.2	2018-02-07 06:20:27	RN01	4.8	0.3
2017-11-11 03:01:47	RN01	4.9	0.8	2018-02-07 06:20:37	RN01	4.9	0.4
2017-11-11 03:36:05	RN01	4.7	0.4	2018-02-07 06:30:28	RN01	4.9	0.2
2017-11-12 05:29:36	RN01	5.0	0.4	2018-02-07 06:57:24	RN01	4.8	0.7
2017-11-13 07:10:16	RN01	4.7	0.5	2018-02-07 07:19:31	RN01	4.9	0.9
2017-11-14 20:40:57	RN01	3.5	0.1	2018-02-07 09:21:03	RN01	4.8	0.8
2017-11-18 18:27:44	RN01	4.4	0.6	2018-02-07 09:51:52	RN01	4.5	0.4
2017-11-20 21:30:41	RN01	2.4	-0.4	2018-02-07 09:52:40	RN01	5.0	0.4
2017-11-24 14:38:24	RN01	4.9	0.3	2018-02-07 13:25:57	RN01	4.7	0.5
2017-11-24 20:24:07	RN01	4.1	0.2	2018-02-08 07:30:16	RN01	4.6	0.7
2017-11-25 04:41:29	RN01	4.8	1.1	2018-02-08 13:33:17	RN01	4.7	0.3
2017-11-27 16:57:49	RN01	4.9	1.0	2018-02-10 00:02:27	RN01	4.8	0.7
2017-11-27 22:59:45	RN01	4.7	0.6	2018-02-10 05:27:50	RN01	4.8	0.4
2017-11-29 07:14:46	RN01	4.4	0.3	2018-02-10 23:38:55	RN01	4.7	0.3
2017-11-29 21:10:03	RN01	4.5	0.3	2018-02-11 12:19:12	RN01	4.9	0.9
2017-11-30 03:27:50	RN01	4.8	0.8	2018-02-14 09:09:34	RN01	4.9	0.1
2017-12-03 09:47:33	RN01	5.0	0.5	2018-02-14 13:17:52	RN01	4.9	0.1
2017-12-06 09:58:55	RN01	4.9	0.3	2018-02-16 20:04:36	RN01	4.9	0.0
2017-12-06 13:41:51	RN01	7.2	0.3	2018-02-17 02:39:19	RN01	4.5	0.3
2017-12-06 21:57:30	RN01	4.6	-0.4	2018-02-18 15:28:02	RN01	5.0	0.6
2017-12-08 12:05:14	RN01	7.8	0.3	2018-02-20 05:02:30	RN01	4.8	-0.2
2017-12-12 01:25:37	RN01	4.9	0.0	2018-02-20 06:15:50	RN01	4.8	0.4
2017-12-12 01:54:55	RN01	4.8	0.6	2018-02-20 11:58:15	RN01	4.8	0.2
2017-12-14 05:28:03	RN01	4.5	0.2	2018-02-20 13:54:28	RN01	4.9	1.0
2017-12-14 23:07:31	RN01	4.7	-0.2	2018-02-23 00:50:37	RN01	4.8	0.3
2017-12-16 02:38:03	RN01	5.0	0.6	2018-02-28 12:48:06	RN01	3.5	0.4
2017-12-16 02:51:32	RN01	5.0	0.6	2018-03-01 20:10:19	RN01	1.4	-0.9
2017-12-16 05:20:57	RN01	4.9	0.0	2018-03-01 20:45:41	RN01	4.8	0.1
2017-12-16 05:31:50	RN01	4.2	0.3	2018-03-01 23:26:57	RN01	4.8	0.0
2017-12-16 05:34:46	RN01	3.4	0.0	2018-03-02 00:31:39	RN01	5.1	0.1
2017-12-17 01:07:44	RN01	4.8	0.0	2018-03-02 00:38:18	RN01	4.9	0.6
2017-12-17 23:46:16	RN01	5.0	0.4	2018-03-02 02:10:53	RN01	4.7	0.1
2017-12-19 12:25:57	RN01	5.0	0.4	2018-03-02 02:22:20	RN01	4.9	0.6

Appendix C. Continued

Origin Time (UTC)	Station	Distance	Magnitude	Origin Time (UTC)	Station	Distance	Magnitude
2018-03-02 02:26:05	RN01	4.9	0.6	2018-03-08 11:06:03	RN01	4.9	0.7
2018-03-02 02:35:19	RN01	4.8	0.2	2018-03-08 11:07:44	RN01	4.9	0.8
2018-03-02 02:48:59	RN01	5.0	0.5	2018-03-08 11:10:17	RN01	4.9	0.3
2018-03-02 03:10:25	RN01	5.0	0.1	2018-03-08 11:48:46	RN01	4.9	0.5
2018-03-02 03:10:31	RN01	4.9	-0.2	2018-03-08 11:55:45	RN01	4.8	0.0
2018-03-02 03:20:23	RN01	4.8	0.2	2018-03-08 12:09:10	RN01	4.9	0.3
2018-03-02 03:45:43	RN01	4.9	0.4	2018-03-08 12:17:12	RN01	4.9	0.2
2018-03-02 04:09:52	RN01	4.9	0.3	2018-03-08 12:31:34	RN01	4.7	0.4
2018-03-02 04:51:34	RN01	4.8	0.5	2018-03-08 12:43:39	RN01	4.9	0.7
2018-03-02 05:26:09	RN01	4.9	0.4	2018-03-08 12:50:36	RN01	4.9	0.7
2018-03-02 07:40:29	RN01	4.9	0.3	2018-03-08 13:50:16	RN01	4.8	0.2
2018-03-02 07:52:09	RN01	4.9	1.0	2018-03-08 14:40:00	RN01	4.7	0.1
2018-03-02 08:59:00	RN01	5.1	0.4	2018-03-08 15:10:20	RN01	5.0	0.0
2018-03-02 09:33:53	RN01	4.7	0.4	2018-03-08 17:46:33	RN01	4.8	0.2
2018-03-02 12:35:20	RN01	4.9	0.5	2018-03-08 17:54:36	RN01	4.8	0.8
2018-03-02 12:51:40	RN01	4.8	0.3	2018-03-08 19:33:07	RN01	4.8	0.0
2018-03-02 12:58:39	RN01	4.9	0.6	2018-03-08 20:01:19	RN01	5.0	0.3
2018-03-02 14:25:19	RN01	4.8	0.4	2018-03-08 20:40:49	RN01	4.9	0.2
2018-03-02 21:15:27	RN01	4.8	0.1	2018-03-08 21:10:22	RN01	4.6	0.3
2018-03-02 21:27:41	RN01	4.8	0.0	2018-03-08 22:53:15	RN01	4.9	-0.2
2018-03-02 22:48:22	RN01	4.5	0.4	2018-03-08 23:40:14	RN01	10.1	0.5
2018-03-03 00:59:43	RN01	5.0	0.1	2018-03-09 08:48:12	RN01	5.0	0.3
2018-03-03 01:14:18	RN01	4.9	0.4	2018-03-09 11:39:04	RN01	11.8	0.7
2018-03-03 02:29:55	RN01	4.8	0.2	2018-03-09 12:56:34	RN01	4.9	0.1
2018-03-03 02:30:05	RN01	4.7	-0.2	2018-03-09 14:50:58	RN01	4.0	0.1
2018-03-03 02:59:57	RN01	4.8	0.4	2018-03-09 15:12:46	RN01	4.6	0.1
2018-03-03 03:17:54	RN01	4.8	0.8	2018-03-09 17:43:22	RN01	4.8	0.0
2018-03-03 03:43:54	RN01	4.8	0.1	2018-03-09 20:49:38	RN01	4.5	0.3
2018-03-03 03:51:01	RN01	4.9	0.7	2018-03-09 21:32:36	RN01	4.5	0.0
2018-03-03 04:40:14	RN01	4.8	0.0	2018-03-09 21:33:54	RN01	4.7	0.1
2018-03-03 06:00:11	RN01	4.2	0.1	2018-03-09 21:35:03	RN01	4.8	0.0
2018-03-03 14:44:23	RN01	4.7	0.0	2018-03-09 21:50:55	RN01	5.1	0.1
2018-03-03 19:11:49	RN01	4.9	0.1	2018-03-10 01:11:27	RN01	4.9	0.2
2018-03-04 05:30:52	RN01	4.8	0.0	2018-03-10 01:45:21	RN01	4.9	0.1
2018-03-05 11:15:27	RN01	5.2	-0.2	2018-03-10 04:56:56	RN01	4.9	0.4
2018-03-05 11:21:04	RN01	4.8	0.4	2018-03-10 07:47:26	RN01	5.0	0.4
2018-03-05 12:52:18	RN01	4.9	0.6	2018-03-10 09:50:03	RN01	4.8	0.4
2018-03-05 16:53:50	RN01	4.9	0.1	2018-03-10 12:19:56	RN01	4.8	0.4
2018-03-05 16:54:08	RN01	4.8	-0.4	2018-03-10 13:24:28	RN01	5.1	0.4
2018-03-06 03:11:25	RN01	4.9	0.1	2018-03-10 15:05:34	RN01	4.8	0.1
2018-03-06 04:14:08	RN01	4.8	0.3	2018-03-10 15:29:10	RN01	4.8	0.4
2018-03-06 05:27:32	RN01	4.9	0.4	2018-03-10 15:55:49	RN01	3.4	0.2
2018-03-06 08:06:22	RN01	4.8	0.0	2018-03-10 16:18:57	RN01	4.9	0.2
2018-03-06 21:17:06	RN01	4.9	0.8	2018-03-11 02:22:55	RN01	4.8	0.8
2018-03-07 02:36:52	RN01	4.8	0.4	2018-03-11 04:33:26	RN01	5.0	0.2
2018-03-07 03:28:39	RN01	4.8	0.4	2018-03-11 22:00:19	RN01	4.9	0.8
2018-03-07 03:58:31	RN01	5.0	0.7	2018-03-12 02:03:35	RN01	5.0	0.3
2018-03-07 04:27:41	RN01	4.9	0.7	2018-03-12 02:23:19	RN01	4.9	0.4
2018-03-07 05:37:16	RN01	4.8	0.0	2018-03-12 09:32:24	RN01	4.8	0.3
2018-03-07 06:27:34	RN01	4.9	0.3	2018-03-12 11:14:18	RN01	4.8	0.5
2018-03-07 10:07:47	RN01	4.8	0.1	2018-03-12 11:27:18	RN01	5.0	0.9
2018-03-08 02:11:21	RN01	4.9	0.4	2018-03-12 12:41:15	RN01	4.7	0.6
2018-03-08 03:41:19	RN01	4.8	0.4	2018-03-12 13:08:09	RN01	4.7	0.7
2018-03-08 03:44:23	RN01	4.9	0.1	2018-03-12 13:08:09	RN01	4.6	0.4
2018-03-08 10:49:41	RN01	4.7	-0.2	2018-03-12 15:44:52	RN01	4.9	0.2
2018-03-08 10:49:59	RN01	4.8	0.3	2018-03-12 15:55:41	RN01	4.8	-0.4
2018-03-08 10:55:20	RN01	4.8	0.2	2018-03-12 19:11:48	RN01	4.8	0.1
2018-03-08 10:56:41	RN01	4.7	0.5	2018-03-12 19:50:19	RN01	4.9	0.4
2018-03-08 10:57:31	RN01	5.0	0.9	2018-03-13 01:31:40	RN01	4.9	0.1
2018-03-08 11:03:33	RN01	3.3	0.3	2018-03-13 02:29:52	RN01	11.8	0.4

Appendix C. Continued

Origin Time (UTC)	Station	Distance	Magnitude	Origin Time (UTC)	Station	Distance	Magnitude
2018-03-13 11:39:01	RN01	4.7	0.4	2018-03-23 01:32:36	RN01	5.0	0.4
2018-03-13 12:30:50	RN01	4.9	0.1	2018-03-23 02:06:32	RN01	2.9	-0.6
2018-03-13 18:39:59	RN01	4.7	0.3	2018-03-23 03:45:52	RN01	4.8	0.4
2018-03-13 19:00:51	RN01	4.7	0.1	2018-03-23 08:49:43	RN01	5.1	0.1
2018-03-13 19:15:10	RN01	4.6	0.4	2018-03-23 08:52:12	RN01	5.2	0.1
2018-03-13 20:46:02	RN01	4.5	0.4	2018-03-23 11:25:51	RN01	4.9	0.4
2018-03-13 23:49:09	RN01	5.0	0.4	2018-03-23 13:45:18	RN01	4.6	0.1
2018-03-14 00:00:19	RN01	3.9	0.3	2018-03-24 00:32:10	RN01	6.7	0.6
2018-03-14 13:15:53	RN01	4.8	0.0	2018-03-24 17:17:21	RN01	5.0	0.9
2018-03-14 13:16:21	RN01	4.9	0.4	2018-03-24 23:35:24	RN01	5.1	0.4
2018-03-14 13:57:31	RN01	4.9	0.5	2018-03-27 09:06:48	RN01	5.1	0.4
2018-03-14 14:34:03	RN01	5.0	0.4	2018-03-27 09:30:34	RN01	4.7	0.5
2018-03-14 17:00:24	RN01	4.9	0.3	2018-03-27 09:31:05	RN01	4.8	0.1
2018-03-15 12:31:15	RN01	4.8	0.4	2018-03-27 13:18:45	RN01	4.7	0.6
2018-03-16 10:08:23	RN01	4.3	-0.4	2018-03-28 11:38:42	RN01	4.7	0.2
2018-03-16 16:06:33	RN01	5.1	0.0	2018-03-28 11:55:42	RN01	4.7	0.5
2018-03-17 04:48:12	RN01	4.9	0.1	2018-03-28 12:57:44	RN01	11.0	0.0
2018-03-17 11:00:53	RN01	4.9	0.1	2018-03-28 19:17:09	RN01	4.8	0.4
2018-03-17 12:11:36	RN01	4.7	0.2	2018-03-29 07:52:42	RN01	4.8	0.1
2018-03-17 13:49:46	RN01	4.8	0.4	2018-03-31 07:27:13	RN01	5.0	0.1
2018-03-17 14:15:08	RN01	4.6	-0.4	2018-03-31 10:08:13	RN01	4.9	-0.2
2018-03-17 14:57:10	RN01	4.8	-0.2	2018-03-31 14:00:11	RN01	4.9	0.6
2018-03-17 16:41:26	RN01	11.3	0.2	2018-04-02 07:07:15	RN01	5.0	0.4
2018-03-17 18:59:47	RN01	4.4	0.2	2018-04-02 11:28:57	RN01	4.6	0.0
2018-03-18 02:22:44	RN01	4.6	0.6	2018-04-03 03:46:20	RN01	5.0	-0.4
2018-03-18 02:24:15	RN01	4.3	0.0	2018-04-03 04:38:05	RN01	5.0	-0.2
2018-03-18 02:24:31	RN01	4.9	0.1	2018-04-03 04:53:22	RN01	5.0	0.2
2018-03-18 02:25:10	RN01	4.9	-0.2	2018-04-03 07:38:01	RN01	4.5	0.0
2018-03-18 02:30:25	RN01	4.8	0.6	2018-04-03 09:21:58	RN01	4.8	0.6
2018-03-18 02:39:19	RN01	3.4	0.2	2018-04-03 09:24:30	RN01	4.9	0.1
2018-03-18 02:41:11	RN01	2.6	0.1	2018-04-03 09:35:55	RN01	4.8	0.0
2018-03-18 02:45:19	RN01	4.9	0.2	2018-04-03 09:36:12	RN01	4.9	0.0
2018-03-18 02:55:07	RN01	5.0	0.6	2018-04-03 09:52:48	RN01	5.0	0.0
2018-03-18 03:51:21	RN01	4.8	0.1	2018-04-03 09:58:05	RN01	4.9	0.1
2018-03-18 04:04:04	RN01	4.8	0.0	2018-04-03 09:59:54	RN01	5.0	-0.4
2018-03-18 05:21:39	RN01	4.8	0.4	2018-04-03 10:00:13	RN01	6.0	0.2
2018-03-18 05:38:38	RN01	4.9	0.6	2018-04-03 10:14:40	RN01	5.1	-0.6
2018-03-18 06:49:51	RN01	4.8	0.5	2018-04-03 10:14:49	RN01	5.0	-0.2
2018-03-18 08:17:33	RN01	4.6	0.0	2018-04-03 10:40:12	RN01	5.0	-0.2
2018-03-18 08:39:02	RN01	4.8	0.4	2018-04-03 12:44:02	RN01	5.0	-0.2
2018-03-18 17:00:52	RN01	4.7	0.1	2018-04-03 19:51:42	RN01	5.0	0.3
2018-03-18 17:14:53	RN01	4.7	0.4	2018-04-03 21:36:57	RN01	5.0	-0.4
2018-03-18 17:16:47	RN01	3.5	0.1	2018-04-04 02:09:30	RN01	5.1	0.2
2018-03-19 02:49:20	RN01	4.8	0.1	2018-04-04 04:13:40	RN01	4.8	0.3
2018-03-19 04:54:10	RN01	4.8	0.7	2018-04-04 13:24:21	RN01	1.6	0.0
2018-03-19 07:24:28	RN01	5.8	1.2	2018-04-05 06:42:29	RN01	5.0	0.0
2018-03-20 08:58:31	RN01	4.9	0.6	2018-04-06 00:10:45	RN01	7.0	1.2
2018-03-20 13:40:14	RN01	5.0	1.0	2018-04-06 01:09:08	RN01	5.0	0.3
2018-03-21 00:13:07	RN01	4.8	0.5	2018-04-06 01:44:46	RN01	4.8	0.4
2018-03-21 00:24:02	RN01	4.5	0.3	2018-04-06 03:22:14	RN01	5.1	0.3
2018-03-21 00:57:17	RN01	4.5	0.3	2018-04-07 05:51:05	RN01	5.1	0.3
2018-03-21 00:57:50	RN01	4.9	0.0	2018-04-07 11:59:01	RN01	4.8	0.4
2018-03-21 01:15:02	RN01	5.0	0.3	2018-04-07 12:37:13	RN01	2.6	0.6
2018-03-21 01:33:34	RN01	4.8	0.1	2018-04-07 13:03:12	RN01	1.5	0.2
2018-03-21 03:34:31	RN01	4.9	0.4	2018-04-07 19:34:51	RN01	5.0	-0.6
2018-03-21 08:33:31	RN01	4.8	0.8	2018-04-07 20:44:21	RN01	5.2	-0.4
2018-03-22 03:27:21	RN01	4.7	-0.4	2018-04-07 23:10:20	RN01	4.7	0.1
2018-03-22 03:34:06	RN01	4.7	0.3	2018-04-07 23:10:50	RN01	5.0	0.2
2018-03-22 08:29:38	RN01	4.8	0.4	2018-04-07 23:11:46	RN01	4.8	0.0
2018-03-22 10:56:09	RN01	4.9	0.5	2018-04-07 23:21:50	RN01	10.4	0.7

Appendix C. Continued

Origin Time (UTC)	Station	Distance	Magnitude	Origin Time (UTC)	Station	Distance	Magnitude
2018-04-07 23:48:25	RN01	2.1	0.0	2018-04-18 02:15:55	RN01	4.7	0.1
2018-04-08 03:04:39	RN01	4.8	0.5	2018-04-18 02:17:12	RN01	4.9	0.6
2018-04-08 03:07:29	RN01	4.6	0.4	2018-04-18 02:20:29	RN01	5.0	-0.2
2018-04-08 09:46:54	RN01	5.0	0.2	2018-04-18 02:47:06	RN01	5.1	0.4
2018-04-08 23:21:05	RN01	4.7	0.0	2018-04-18 05:29:26	RN01	4.7	0.1
2018-04-08 23:41:56	RN01	4.9	0.5	2018-04-18 09:50:21	RN01	4.8	0.0
2018-04-09 00:08:54	RN01	5.0	0.2	2018-04-18 20:33:21	RN01	4.5	0.5
2018-04-09 08:07:54	RN01	5.0	0.1	2018-04-18 20:35:07	RN01	4.6	0.0
2018-04-09 08:14:44	RN01	4.8	0.1	2018-04-18 20:36:09	RN01	4.6	0.0
2018-04-09 09:05:02	RN01	5.3	-0.4	2018-04-19 03:50:29	RN01	5.0	0.0
2018-04-09 09:11:00	RN01	4.8	0.2	2018-04-19 05:31:54	RN01	4.5	0.1
2018-04-09 09:52:22	RN01	3.6	-0.9	2018-04-19 06:50:01	RN01	4.8	0.5
2018-04-09 09:52:27	RN01	4.7	0.0	2018-04-19 09:53:31	RN01	4.6	0.7
2018-04-09 10:50:21	RN01	4.7	0.1	2018-04-19 13:00:24	RN01	4.8	0.1
2018-04-09 12:49:42	RN01	5.3	0.1	2018-04-19 17:20:55	RN01	4.4	0.1
2018-04-09 13:18:36	RN01	4.9	0.1	2018-04-19 21:21:10	RN01	4.8	-0.2
2018-04-09 13:20:12	RN01	5.0	-0.2	2018-04-19 21:51:41	RN01	4.7	-0.2
2018-04-09 14:09:10	RN01	4.8	-0.2	2018-04-19 22:44:53	RN01	4.8	0.4
2018-04-09 19:35:24	RN01	4.9	-0.2	2018-04-20 03:06:35	RN01	4.5	-0.2
2018-04-09 20:46:15	RN01	4.8	-0.2	2018-04-20 03:45:55	RN01	4.4	0.6
2018-04-10 05:26:34	RN01	7.0	0.2	2018-04-20 04:24:27	RN01	5.2	0.0
2018-04-10 15:44:01	RN01	4.8	0.1	2018-04-20 07:28:52	RN01	4.6	0.3
2018-04-11 11:00:10	RN01	4.7	0.0	2018-04-20 10:08:36	RN01	4.9	0.2
2018-04-13 21:31:02	RN01	4.8	-0.4	2018-04-20 10:10:04	RN01	5.2	-0.2
2018-04-14 02:14:02	RN01	3.8	-0.6	2018-04-20 10:10:32	RN01	4.5	0.1
2018-04-14 03:06:56	RN01	3.7	-0.4	2018-04-20 20:07:35	RN01	4.7	0.0
2018-04-14 03:21:51	RN01	4.7	-0.4	2018-04-21 00:27:37	RN01	6.1	0.0
2018-04-14 03:23:54	RN01	4.9	0.0	2018-04-21 07:12:12	RN01	4.7	-0.2
2018-04-14 03:27:17	RN01	5.5	-0.4	2018-04-21 09:06:35	RN01	5.2	0.2
2018-04-14 03:52:59	RN01	5.1	0.0	2018-04-21 20:06:51	RN01	5.0	-0.4
2018-04-14 11:31:18	RN01	5.0	-0.2	2018-04-22 01:19:57	RN01	8.9	0.4
2018-04-15 00:14:08	RN01	5.2	-0.2	2018-04-22 10:23:42	RN01	4.9	-0.2
2018-04-15 02:21:37	RN01	5.1	0.1	2018-04-22 12:08:19	RN01	5.1	0.2
2018-04-15 06:35:59	RN01	4.9	0.1	2018-04-22 19:56:29	RN01	5.7	0.6
2018-04-15 14:11:29	RN01	4.9	0.0	2018-04-22 23:38:30	RN01	5.0	-0.2
2018-04-15 14:59:59	RN01	5.3	-0.4	2018-04-23 04:57:04	RN01	5.1	0.6
2018-04-15 16:54:41	RN01	5.1	0.0	2018-04-23 11:02:35	RN01	5.6	0.4
2018-04-15 18:48:04	RN01	5.0	0.6	2018-04-23 16:00:40	RN01	5.0	0.0
2018-04-15 18:55:26	RN01	5.1	-0.4	2018-04-24 02:57:26	RN01	6.8	0.2
2018-04-15 19:20:29	RN01	4.9	-0.4	2018-04-24 03:00:07	RN01	5.1	-0.2
2018-04-15 21:22:59	RN01	5.2	-0.6	2018-04-24 06:08:47	RN01	5.2	0.1
2018-04-16 16:29:48	RN01	4.0	0.4	2018-04-24 10:26:24	RN01	4.9	0.1
2018-04-17 09:39:52	RN01	2.4	-0.6	2018-04-24 14:55:00	RN01	4.8	-0.6
2018-04-17 11:26:57	RN01	2.3	-0.4	2018-04-25 14:27:12	RN01	5.3	-0.2
2018-04-17 16:05:07	RN01	5.1	-0.2	2018-04-26 00:09:50	RN01	4.7	0.1
2018-04-17 23:07:34	RN01	4.8	0.1	2018-04-26 04:21:57	RN01	5.1	0.1
2018-04-17 23:11:33	RN01	4.7	-0.6	2018-04-26 04:51:38	RN01	5.1	0.0
2018-04-17 23:11:41	RN01	5.0	-0.4	2018-04-26 07:37:57	RN01	5.1	0.4
2018-04-17 23:11:49	RN01	5.2	-0.4	2018-04-26 10:00:58	RN01	5.0	0.1
2018-04-17 23:13:53	RN01	4.8	0.2	2018-04-26 10:01:08	RN01	4.8	0.0
2018-04-17 23:14:49	RN01	5.9	0.0	2018-04-26 11:40:10	RN01	5.0	0.8
2018-04-17 23:16:43	RN01	4.7	-0.2	2018-04-26 11:51:57	RN01	3.7	0.0
2018-04-17 23:20:04	RN01	5.0	-0.2	2018-04-26 12:02:32	RN01	2.2	-0.2
2018-04-17 23:41:14	RN01	4.8	-0.2	2018-04-26 12:03:15	RN01	3.3	-0.6
2018-04-17 23:59:09	RN01	5.1	0.3	2018-04-26 21:13:18	RN01	4.9	-0.2
2018-04-18 00:00:59	RN01	4.6	0.2	2018-04-26 21:51:18	RN01	6.5	0.2
2018-04-18 00:11:24	RN01	4.8	0.0	2018-04-27 02:33:46	RN01	4.7	0.1
2018-04-18 00:16:57	RN01	4.7	0.3	2018-04-27 12:42:49	RN01	4.8	-0.4
2018-04-18 00:33:51	RN01	4.6	0.4	2018-04-27 15:32:30	RN01	4.9	0.2
2018-04-18 00:59:22	RN01	5.0	0.0	2018-04-28 01:17:41	RN01	4.8	0.2

Appendix C. Continued

Origin Time (UTC)	Station	Distance	Magnitude	Origin Time (UTC)	Station	Distance	Magnitude
2018-05-02 20:54:06	RN01	2.8	-0.2	2018-06-21 10:56:04	RN01	1.6	-1.5
2018-05-03 12:42:49	RN01	5.1	0.2	2018-06-21 11:44:52	RN01	3.9	0.0
2018-05-03 17:36:38	RN01	5.4	0.3	2018-06-21 16:51:52	RN01	4.5	0.0
2018-05-04 04:13:44	RN01	7.0	0.4	2018-06-22 06:35:43	RN01	4.9	-0.4
2018-05-05 20:51:03	RN01	5.8	0.1	2018-06-23 08:54:59	RN01	5.1	0.2
2018-05-07 10:35:42	RN01	4.6	0.0	2018-06-24 11:52:53	RN01	4.4	0.0
2018-05-07 17:05:26	RN01	6.1	0.1	2018-06-25 15:02:57	RN01	4.9	0.0
2018-05-08 00:34:28	RN01	5.0	0.1	2018-06-25 15:04:09	RN01	5.2	0.0
2018-05-09 02:58:32	RN01	4.8	0.6	2018-06-26 02:43:54	RN01	5.2	0.1
2018-05-10 01:16:27	RN01	5.0	0.2	2018-06-27 00:34:11	RN01	5.3	0.2
2018-05-12 00:33:45	RN01	5.4	0.4	2018-06-27 19:12:42	RN01	4.8	0.0
2018-05-12 05:34:37	RN01	4.8	0.0	2018-06-28 00:21:34	RN01	5.6	-0.4
2018-05-13 10:52:55	RN01	5.0	0.2	2018-06-30 10:03:42	RN01	5.1	0.5
2018-05-13 19:44:25	RN01	4.9	-0.2	2018-06-30 21:55:02	RN01	3.1	-0.4
2018-05-13 20:06:01	RN01	5.0	0.5	2018-06-30 23:08:53	RN01	3.2	-0.4
2018-05-13 20:38:03	RN01	4.9	0.0	2017-08-16 04:21:33	RN02	8.9	-0.2
2018-05-13 20:38:14	RN01	4.8	0.2	2017-08-28 11:27:31	RN02	2.7	-0.6
2018-05-13 21:00:15	RN01	5.3	0.2	2017-09-13 08:05:10	RN02	2.0	-0.4
2018-05-14 01:56:58	RN01	4.8	-0.6	2017-09-22 07:22:18	RN02	3.3	-0.9
2018-05-14 05:51:00	RN01	5.0	0.5	2017-09-26 04:43:52	RN02	9.2	0.9
2018-05-14 11:49:29	RN01	5.1	0.5	2017-09-27 04:46:30	RN02	9.3	0.0
2018-05-15 03:26:23	RN01	5.1	0.4	2017-09-27 04:48:07	RN02	8.8	0.1
2018-05-17 19:09:52	RN01	4.9	0.1	2017-09-28 05:47:42	RN02	8.3	-0.4
2018-05-22 04:01:10	RN01	5.1	1.1	2017-09-28 05:48:29	RN02	10.2	-0.2
2018-05-22 04:04:53	RN01	6.5	0.2	2017-09-30 23:29:44	RN02	2.9	-0.4
2018-05-26 12:00:42	RN01	4.7	0.1	2017-10-01 20:12:01	RN02	1.1	-0.9
2018-05-27 13:41:27	RN01	5.1	0.4	2017-10-08 01:03:24	RN02	1.8	-0.2
2018-05-29 23:54:53	RN01	5.1	0.4	2017-10-11 05:37:06	RN02	9.4	0.8
2018-05-30 02:37:27	RN01	5.2	1.3	2017-10-11 05:38:31	RN02	9.8	0.7
2018-05-31 17:41:48	RN01	5.5	0.0	2017-10-12 04:53:11	RN02	8.8	0.6
2018-05-31 21:38:22	RN01	5.2	0.0	2017-10-12 04:55:53	RN02	9.1	0.8
2018-06-01 04:24:57	RN01	4.9	0.0	2017-10-13 03:38:16	RN02	4.8	0.2
2018-06-02 00:03:22	RN01	7.2	0.1	2017-10-14 06:53:00	RN02	9.6	0.9
2018-06-02 00:55:35	RN01	4.8	0.0	2017-10-27 22:55:44	RN02	4.3	0.4
2018-06-02 01:28:15	RN01	4.8	0.4	2017-10-31 06:09:38	RN02	9.2	0.4
2018-06-02 02:03:11	RN01	5.3	-0.4	2017-10-31 06:09:58	RN02	8.6	0.3
2018-06-02 03:54:16	RN01	5.0	0.0	2017-11-01 04:56:55	RN02	8.9	0.3
2018-06-02 23:52:18	RN01	5.1	0.2	2017-11-01 05:00:12	RN02	9.1	0.7
2018-06-04 00:37:33	RN01	5.1	0.3	2017-11-01 05:02:38	RN02	9.2	0.8
2018-06-04 13:51:56	RN01	5.1	0.4	2017-11-01 05:04:00	RN02	11.3	0.8
2018-06-04 18:02:43	RN01	4.9	-0.2	2017-11-02 13:42:23	RN02	3.5	0.4
2018-06-07 01:43:46	RN01	4.6	0.3	2017-11-02 13:44:42	RN02	6.7	0.4
2018-06-07 02:07:29	RN01	4.7	0.2	2017-11-07 07:01:19	RN02	7.7	0.0
2018-06-07 08:09:31	RN01	4.9	0.0	2017-11-07 07:01:56	RN02	9.1	0.4
2018-06-07 11:48:21	RN01	4.7	-0.2	2017-11-07 07:03:59	RN02	6.8	1.0
2018-06-07 23:15:07	RN01	4.6	0.2	2017-11-07 07:04:32	RN02	8.8	0.3
2018-06-12 03:35:34	RN01	3.0	0.0	2017-11-07 07:05:21	RN02	9.9	0.1
2018-06-12 08:00:58	RN01	5.1	-0.4	2017-11-07 07:05:46	RN02	8.9	0.4
2018-06-13 14:56:21	RN01	5.0	0.1	2017-11-07 07:06:31	RN02	9.9	0.2
2018-06-13 16:46:55	RN01	4.5	0.2	2017-11-08 05:58:40	RN02	10.6	0.0
2018-06-13 18:07:56	RN01	4.9	-0.2	2017-11-08 05:59:21	RN02	9.9	0.3
2018-06-16 12:20:57	RN01	2.8	-0.4	2017-11-08 06:00:08	RN02	9.9	0.2
2018-06-16 12:56:57	RN01	4.7	0.0	2017-11-08 06:00:57	RN02	9.9	0.4
2018-06-18 03:11:48	RN01	4.5	0.8	2017-11-10 05:57:11	RN02	9.5	0.4
2018-06-18 13:57:45	RN01	4.6	-0.2	2017-11-10 05:57:55	RN02	9.2	0.4
2018-06-19 13:18:30	RN01	3.8	0.0	2017-11-10 05:58:43	RN02	9.5	0.4
2018-06-20 05:53:29	RN01	5.8	0.0	2017-11-14 06:15:40	RN02	9.5	0.7
2018-06-20 11:31:33	RN01	1.8	-0.6	2017-11-16 06:33:26	RN02	9.1	0.9
2018-06-20 23:01:34	RN01	5.1	0.2	2017-11-16 12:25:31	RN02	3.8	0.2
2018-06-21 07:47:15	RN01	6.2	0.2	2017-11-21 08:35:38	RN02	9.5	0.2

Appendix C. Continued

Origin Time (UTC)	Station	Distance	Magnitude	Origin Time (UTC)	Station	Distance	Magnitude
2017-11-21 08:43:43	RN02	10.7	0.7	2018-03-06 06:00:32	RN02	8.9	0.6
2017-11-21 08:44:57	RN02	9.5	1.3	2018-03-06 06:05:54	RN02	8.2	0.4
2017-11-23 03:32:09	RN02	10.3	0.4	2018-03-09 07:15:48	RN02	8.0	0.6
2017-11-29 10:42:32	RN02	2.5	0.6	2018-03-09 07:16:51	RN02	9.2	0.4
2017-12-01 05:36:19	RN02	9.7	0.1	2018-03-09 07:20:05	RN02	9.4	0.4
2017-12-04 10:06:17	RN02	4.8	0.0	2018-03-11 02:47:51	RN02	8.6	0.6
2017-12-28 06:02:02	RN02	8.7	0.0	2018-03-13 04:56:52	RN02	8.3	0.1
2017-12-28 06:03:04	RN02	9.8	0.6	2018-03-13 04:57:35	RN02	8.6	0.2
2017-12-28 06:07:17	RN02	9.4	0.4	2018-03-13 04:58:22	RN02	9.1	0.2
2018-01-05 23:54:28	RN02	7.5	-0.2	2018-03-13 04:59:09	RN02	8.4	0.0
2018-01-12 05:55:21	RN02	10.0	0.3	2018-03-13 05:00:11	RN02	9.4	0.3
2018-01-13 05:51:48	RN02	9.1	0.2	2018-03-13 05:01:13	RN02	9.6	0.1
2018-01-13 05:54:20	RN02	9.7	-0.2	2018-03-13 05:03:47	RN02	9.4	0.3
2018-01-19 07:05:11	RN02	8.0	0.4	2018-03-13 05:04:19	RN02	9.1	0.4
2018-01-20 20:26:25	RN02	9.2	0.2	2018-03-16 04:46:48	RN02	8.8	0.4
2018-01-20 20:27:36	RN02	10.6	0.4	2018-03-19 07:25:07	RN02	2.2	0.2
2018-01-24 05:49:08	RN02	10.6	0.4	2018-03-21 04:44:13	RN02	9.0	0.3
2018-01-24 05:51:03	RN02	9.0	0.4	2018-03-21 04:49:01	RN02	9.6	0.1
2018-01-25 05:44:18	RN02	9.4	0.1	2018-03-27 04:46:38	RN02	8.9	0.0
2018-01-25 05:46:23	RN02	8.6	0.2	2018-03-28 00:16:22	RN02	8.0	0.4
2018-01-25 05:46:23	RN02	9.0	0.0	2018-03-28 04:50:34	RN02	8.1	0.0
2018-01-25 05:47:31	RN02	9.4	0.4	2018-03-28 04:51:43	RN02	9.2	-0.2
2018-01-25 05:48:23	RN02	8.4	0.3	2018-03-28 04:52:44	RN02	10.6	0.0
2018-01-25 05:49:33	RN02	8.7	0.5	2018-03-31 00:25:07	RN02	2.7	-0.6
2018-01-26 06:02:03	RN02	8.9	0.2	2018-04-02 23:32:05	RN02	9.9	0.3
2018-01-27 03:25:37	RN02	8.8	0.3	2018-04-03 04:44:52	RN02	9.2	-0.4
2018-01-27 03:27:18	RN02	9.0	0.6	2018-04-03 04:45:49	RN02	8.8	0.0
2018-01-27 17:10:34	RN02	11.9	0.4	2018-04-03 04:47:03	RN02	8.2	0.1
2018-01-27 17:11:44	RN02	10.5	0.3	2018-04-03 04:47:49	RN02	9.1	0.0
2018-02-02 07:32:33	RN02	9.2	0.1	2018-04-03 04:50:15	RN02	8.2	-0.2
2018-02-02 07:35:08	RN02	10.2	0.2	2018-04-04 04:44:42	RN02	8.4	0.1
2018-02-03 05:58:27	RN02	10.5	0.3	2018-04-04 04:48:17	RN02	8.8	0.2
2018-02-03 05:59:41	RN02	8.4	0.2	2018-04-04 04:49:20	RN02	8.9	0.0
2018-02-03 06:01:11	RN02	10.6	0.4	2018-04-05 05:00:13	RN02	8.7	0.3
2018-02-06 05:59:39	RN02	9.3	0.2	2018-04-06 05:28:50	RN02	8.7	0.2
2018-02-13 05:58:55	RN02	9.7	0.1	2018-04-07 19:25:38	RN02	9.4	0.0
2018-02-13 06:03:50	RN02	8.6	0.2	2018-04-08 05:31:41	RN02	5.5	0.2
2018-02-13 06:04:59	RN02	10.0	0.1	2018-04-10 05:31:10	RN02	9.1	0.1
2018-02-15 05:53:54	RN02	8.3	0.2	2018-04-10 05:34:13	RN02	12.0	-0.2
2018-02-17 06:02:19	RN02	9.0	0.4	2018-04-11 05:01:30	RN02	9.8	0.3
2018-02-17 06:03:40	RN02	8.5	0.0	2018-04-19 04:52:36	RN02	9.3	0.1
2018-02-20 05:55:11	RN02	9.5	0.2	2018-04-20 22:52:42	RN02	8.1	0.1
2018-02-22 07:16:21	RN02	7.5	0.4	2018-04-21 00:30:49	RN02	5.9	-0.4
2018-02-22 07:24:50	RN02	9.7	0.2	2018-04-25 14:37:30	RN02	5.0	0.3
2018-02-23 06:05:16	RN02	9.8	0.3	2018-04-26 05:10:26	RN02	4.6	0.1
2018-02-23 06:06:17	RN02	9.6	0.2	2018-05-04 05:17:50	RN02	9.7	0.3
2018-02-23 06:10:52	RN02	8.8	0.9	2018-05-05 05:07:18	RN02	9.4	0.2
2018-02-23 06:11:56	RN02	9.2	0.7	2018-05-15 04:50:10	RN02	8.7	0.4
2018-02-23 06:14:00	RN02	8.3	0.8	2018-05-22 04:14:41	RN02	9.3	0.0
2018-02-24 06:03:06	RN02	8.5	0.0	2018-05-22 04:23:26	RN02	8.4	0.2
2018-02-25 07:09:24	RN02	9.0	0.4	2018-06-01 05:05:43	RN02	8.7	0.6
2018-02-25 07:10:40	RN02	8.7	0.4	2018-06-06 08:10:26	RN02	6.8	0.0
2018-02-26 06:03:44	RN02	10.2	0.2	2018-06-06 08:22:18	RN02	2.5	-0.6
2018-02-27 07:50:03	RN02	8.2	-0.2	2018-06-07 00:48:54	RN02	3.6	-0.4
2018-02-27 07:51:56	RN02	8.4	0.2	2018-06-07 09:00:53	RN02	6.2	0.4
2018-02-28 08:03:49	RN02	9.0	0.1	2018-06-07 09:08:58	RN02	5.4	0.1
2018-03-01 07:51:19	RN02	9.1	0.4	2018-06-08 05:53:10	RN02	9.5	0.4
2018-03-01 07:54:36	RN02	8.8	0.0	2018-06-20 08:55:33	RN02	1.7	-0.6
2018-03-03 05:47:28	RN02	9.7	0.0	2018-06-23 13:58:38	RN02	1.5	-0.6
2018-03-06 05:59:22	RN02	9.1	0.5	2018-06-23 21:12:22	RN02	2.7	-0.6

Appendix C. Continued

Origin Time (UTC)	Station	Distance	Magnitude	Origin Time (UTC)	Station	Distance	Magnitude
2018-06-24 00:52:31	RN02	1.7	-0.9	2017-12-30 06:48:07	SG02	0.6	-0.6
2018-06-24 20:35:57	RN02	1.9	-0.9	2018-01-01 00:07:50	SG02	1.9	-0.4
2018-06-26 05:41:08	RN02	11.9	0.2	2018-01-01 00:12:04	SG02	0.9	-0.2
2018-06-27 05:01:37	RN02	9.5	0.0	2018-01-01 02:19:32	SG02	2.3	-0.6
2018-06-27 05:08:26	RN02	8.2	0.1	2018-01-01 05:31:42	SG02	1.5	-0.6
2018-06-27 16:18:59	RN02	2.7	-0.9	2018-01-01 05:56:18	SG02	1.2	-0.6
2018-06-30 14:17:21	RN02	2.8	-0.9	2018-01-01 06:05:22	SG02	1.0	-0.6
2017-09-13 11:19:08	SG02	11.0	0.0	2018-01-01 07:38:32	SG02	1.3	-0.6
2017-10-01 16:05:15	SG02	9.1	0.6	2018-01-01 22:49:04	SG02	0.8	-0.9
2017-10-13 05:32:44	SG02	10.6	1.0	2018-01-04 01:38:14	SG02	1.8	-0.4
2017-10-25 06:38:30	SG02	6.0	0.4	2018-01-04 02:55:29	SG02	1.5	-0.9
2017-11-12 07:15:55	SG02	10.9	0.6	2018-03-21 04:38:32	SG02	11.2	0.2
2017-12-18 04:25:10	SG02	9.0	0.3	2018-04-07 14:42:58	SG02	6.3	0.6
2017-12-26 10:00:26	SG02	1.1	-0.6				