EARTHQUAKE ACTIVITY IN THE YELLOWSTONE REGION

Preliminary Epicenters

April 1 – June 30, 2019

Prepared by the University of Utah Seismograph Stations and funded by
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Foreword and Data Explanation

This report contains an epicenter map (Figure 1) and listings of earthquakes (Tables 1 and 2) detected and located in the Yellowstone region (lat. 44° 00′ – 45° 10′ N, long. 109° 45′ – 111° 30′ W). The computer program HYPOINVERSE-2000 (F. W. Klein, 2012, U.S. Geological Survey Open-File Report 02-171 revised) was used to process the earthquake data. This report also includes maps and a table of operating seismograph stations in the University of Utah's Yellowstone seismic network (Figure 2, Table 3).

The earthquake listing in Table 2 is estimated to be systematically complete above magnitude 1.5 within Yellowstone. *These data are preliminary—both the locations and magnitudes in this table are subject to revision.*

The following data are listed for each earthquake in Table 2:

- Date (yymmdd) and origin time in Coordinated Universal Time (UTC). To convert to local time, subtract seven hours for Mountain Standard Time (MST) and six hours for Mountain Daylight Time (MDT). During the report period, local time was MDT.

- Earthquake location coordinates in degrees and minutes of north latitude and west longitude, and depth in kilometers below sea level. Note that prior to October 1, 2012, the earthquake depths in these quarterly reports were computed relative to a datum of 2000 m above sea level.

- "*" indicates poor depth resolution: no recording stations within 10 km or twice the depth.

- MAG, the computed Richter local magnitude (M_L) for each earthquake. "W" indicates that peak amplitude measurements from Wood-Anderson records were used. Otherwise, the estimate is calculated from signal durations and is more correctly identified as coda magnitude (M_C). The notation "--" indicates that a reliable magnitude estimate could not be made.

- NO, the number of P and S readings used in the solution.

- GAP, the largest azimuthal separation in degrees between recording stations used in the solution.

- DMN, the epicentral distance in kilometers to the closest station.

- RMS, the weighted root-mean-square of the travel-time residuals in seconds:

$$RMS = \left(\frac{\sum_i (W_i R_i)^2}{\sum_i (W_i)^2} \right)^{\frac{1}{2}}$$

where: R_i is the observed minus the computed arrival time for the i-th P or S reading, and W_i is the relative weight given to the i-th P or S arrival time (0.0 for no weight through 1.0 for full weight).

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April 1 – June 30, 2019

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During the three-month period April 1 through June 30, 2019, the University of Utah Seismograph Stations (UUSS) located 207 earthquakes within the Yellowstone region (Figure 1). The total includes 11 earthquakes in the magnitude 2 range. The largest event to occur during this period was a magnitude 2.6 earthquake on April 29th. There were no earthquakes reported felt in the region during the report period (see Table 1, a cumulative tabulation of earthquakes that were felt in the Yellowstone region during 2019). Additional information on earthquakes within the Yellowstone region is available from the University of Utah Seismograph Stations.

Online Information

A complete copy of this report, including maps and the earthquake catalog, is available on the UUSS web site at *https://quake.utah.edu/earthquake-center/quarterly-seismicity-reports*.

Note: On October 1, 2012, UUSS began using the ANSS Quake Monitoring System (AQMS) software package for data acquisition and data processing. The primary effect on the data reported herein comes from computing the earthquake locations with a newer version of the computer program HYPOINVERSE-2000 (F. W. Klein, 2012, U.S. Geological Survey Open-File Report 02-171 revised) and a revised and expanded set of velocity models. As implemented at UUSS, this new version of the location program accounts for station elevation differences more accurately and reports focal depths relative to sea level instead of the 2000 m elevation datum used previously.

For earthquakes of magnitude 3 and larger in the Yellowstone region, the U. S. Geological Survey automatically posts a Community Internet Intensity Map (CIIM) on its "Did You Feel It?" web page at http://earthquake.usgs.gov/earthquakes/dyfi/. We encourage anyone who feels an earthquake to report their observations on this interactive web site; felt information is available by zip code on the CIIM site or can be obtained from UUSS directly.

Earthquakes of Magnitude 3.0 or Larger

None

Notable Swarm Seismicity

During the report period, there were three earthquake swarms in the Yellowstone region. For reporting purposes, we use the Mogi definition [Mogi, 1963] of a swarm and require each swarm to have ten or more earthquakes. Note that typically, around 50% of Yellowstone earthquakes occur as part of a seismic swarm [Farrell et al., 2009].

A. A swarm of 10 earthquakes ($-0.4 \leq M \leq 1.9$) occurred about 13.7 mi NE of West Yellowstone, MT on May 26th.
B. A swarm of 13 earthquakes ($-0.5 \leq M \leq 1.7$) occurred about 5.8 mi SE of West Thumb, YNP on June 12th.
C. A swarm of 10 earthquakes ($-0.1 \leq M \leq 1.8$) occurred about 5.9 mi SE of West Thumb, YNP on June 19th.

These swarms are labeled in Figure 1.

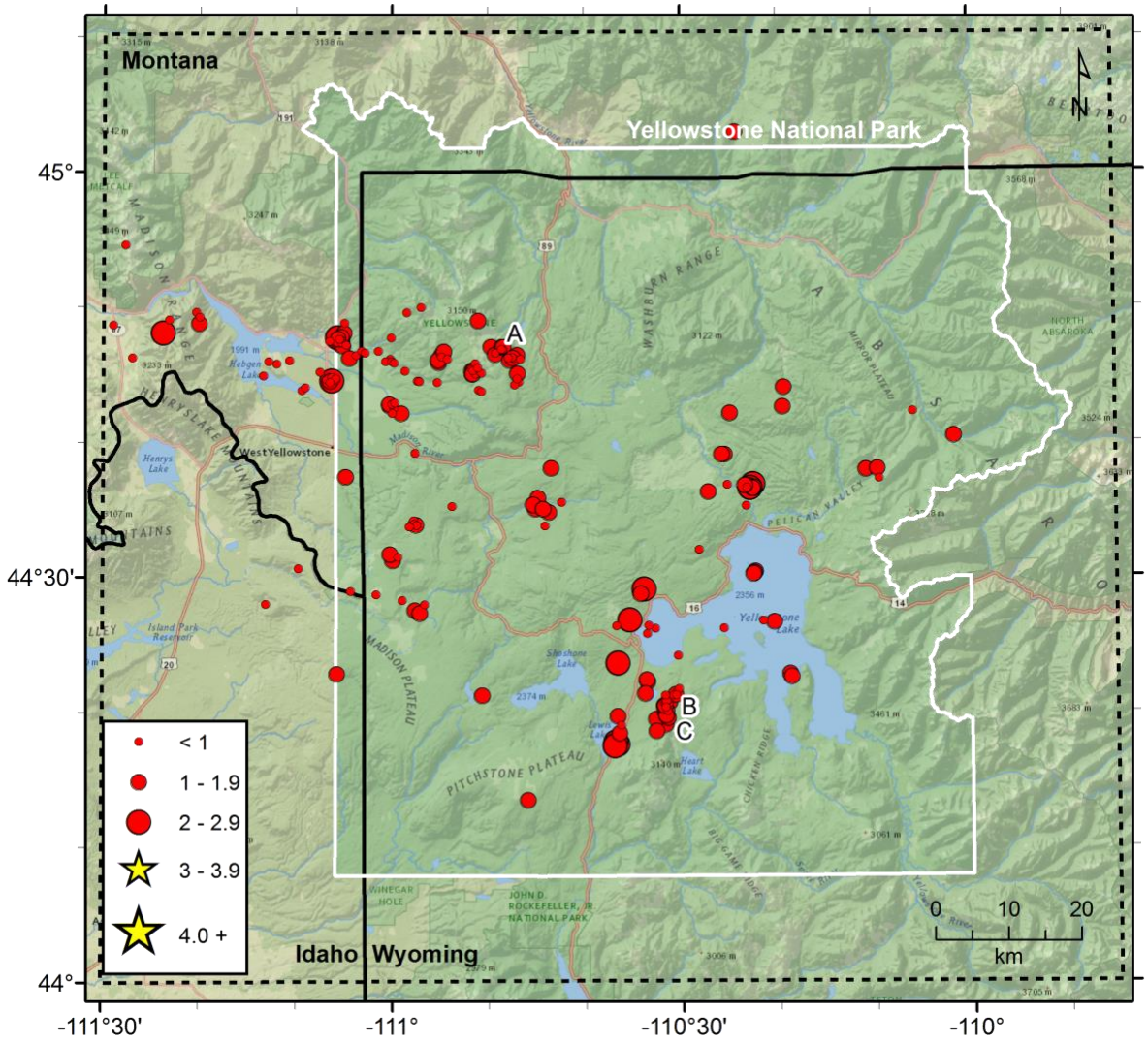

Figure 1. Epicenters of earthquakes located by the University of Utah Seismograph Stations, April 1, 2019, through June 30, 2019. Earthquake swarms (labeled A–C) are discussed in the text.

Table 1

EARTHQUAKES FELT IN THE YELLOWSTONE REGION
January 1, 2019 to June 30, 2019

Date	Time†	Felt Information‡	Latitude	Longitude	Magnitude§
February 16	14:22 MST 21:22 UTC	Yellowstone. Felt (III) at West Yellowstone, MT.	44º 27.90′	111º 00.43′	M_L 3.1

† Times are listed both as Local Time—Mountain Standard Time (MST) or Mountain Daylight Time (MDT)—and as Coordinated Universal Time (UTC).
? Indicates on-line reports that appear questionable given the distance from the source
‡ *CIIM* indicates the availability of a Community Internet Intensity Map (http://earthquake.usgs.gov/earthquakes/dyfi), compiled by the U.S. Geological Survey (USGS); *ShakeMap* indicates the availability of computer-generated maps of ground-shaking (*https://quake.utah.edu*), produced by the University of Utah Seismograph Stations (UUSS). Roman numerals correspond to the Modified Mercalli intensity scale. Unless otherwise indicated, felt information is from the USGS (1) CIIM reports and/or (2) PDE Monthly (or) Weekly Listing Files (http://earthquake.usgs.gov/data/pde.php).
§ Richter local magnitude (M_L) or coda magnitude (M_C) determined by UUSS. If labeled "NEIC," data are from the National Earthquake Information Center of the USGS.

Yellowstone Seismic Network
June 30, 2019

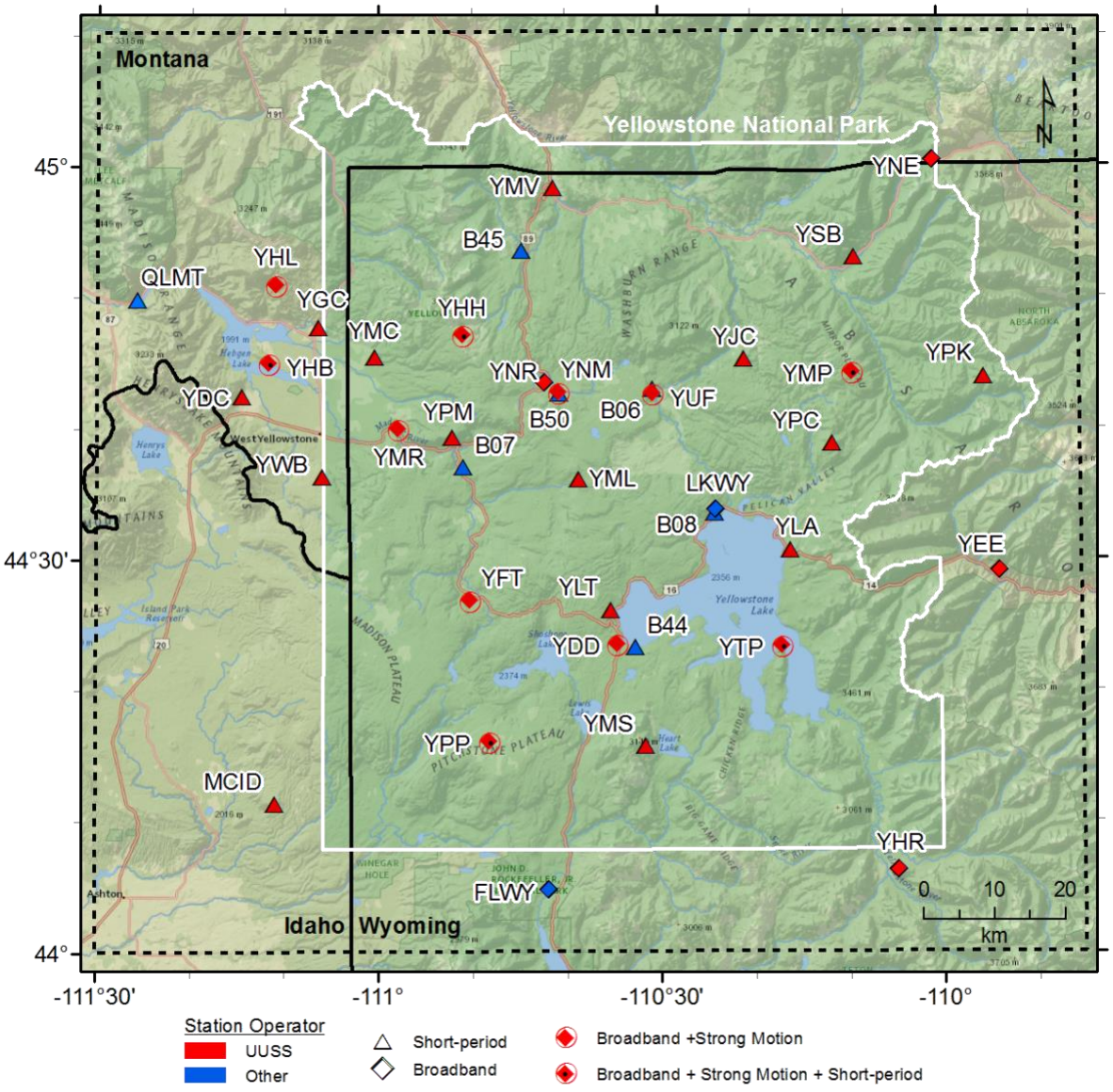

Figure 2. Seismograph stations of the Yellowstone Seismic Network as of June 30, 2019.

Table 2. Earthquakes in the Yellowstone Region: April 1–June 30, 2019

DATE	ORIGIN TIME	LATITUDE	LONGITUDE	DEPTH	MAG	NO	GAP	DMN	RMS
190401	07:58:55.44	44º54.60’	111º27.76’	6.4	0.8	13	187	9	0.10
190402	09:12:15.41	44º42.25’	110º05.98’	7.1	0.8	8	134	6	0.17
190403	02:37:24.45	44º45.99’	111º12.84’	11.5	0.2	13	95	2	0.17
190403	04:53:39.05	44º33.88’	110º57.49’	12.8	0.4	11	89	11	0.10
190403	17:39:08.19	44º47.81’	111º05.66’	9.9	2.4W	25	94	1	0.16
190404	01:30:05.20	44º47.32’	111º05.45’	8.4	1.8W	18	112	1	0.16
190404	06:43:59.97	44º47.55’	111º05.23’	8.6	1.9W	21	116	2	0.15
190406	07:52:17.27	44º50.03’	110º57.00’	5.6	-0.1	13	205	9	0.16
190410	00:18:41.21	44º33.79’	110º58.22’	5.0*	0.2	10	150	11	0.16
190410	18:22:24.50	44º42.18’	110º59.09’	6.8	1.0	11	124	4	0.11
190411	17:36:06.13	44º31.54’	110º59.43’	14.3	0.0	10	113	12	0.24
190411	17:45:12.26	44º31.30’	110º59.93’	10.1	1.0	13	199	12	0.12
190411	17:54:43.52	44º31.73’	111º00.22’	12.8	1.0W	15	118	12	0.16
190412	08:07:01.43	44º46.01’	111º00.03’	8.4	0.1	14	135	1	0.17
190412	09:03:38.34	44º46.00’	111º00.69’	9.0	0.2	12	144	1	0.12
190412	19:00:20.98	44º35.59’	110º42.43’	10.9	0.3	13	79	5	0.10
190412	21:01:08.68	44º28.74’	111º01.68’	16.8	0.0	11	136	15	0.15
190413	06:40:51.59	44º46.18’	110º46.68’	4.4	0.6	9	197	6	0.14
190413	08:13:56.03	44º46.51’	110º47.03’	4.7	1.6W	17	93	5	0.15
190414	08:13:27.78	44º36.64’	110º23.23’	4.4	0.9	15	113	6	0.17
190415	16:46:53.87	44º48.66’	111º29.00’	14.5	0.5	7	104	5	0.07
190419	03:30:58.97	44º49.05’	110º51.07’	4.5	1.5W	17	125	3	0.25
190419	04:29:52.50	44º33.84’	110º44.18’	3.8	0.1	10	90	9	0.12
190419	07:51:27.29	44º33.90’	110º57.48’	13.4	0.3	15	88	11	0.15
190420	11:26:44.29	44º46.94’	110º48.63’	4.7	0.2	14	103	3	0.15
190420	11:41:49.81	44º47.09’	110º48.62’	4.6	1.2W	20	98	3	0.19
190420	11:41:49.82	44º47.08’	110º48.43’	4.9	1.2W	14	105	3	0.16
190421	11:43:50.39	44º45.84’	111º11.99’	13.0	0.4W	10	159	1	0.14
190423	09:12:45.80	44º39.24’	110º57.62’	5.2	0.6	10	143	2	0.18
190423	18:41:23.71	44º45.25’	111º07.50’	9.1	0.0	8	116	6	0.13
190423	23:12:53.76	44º22.86’	110º18.84’	5.6	1.1	9	184	3	0.14
190424	23:33:26.03	44º22.65’	110º18.68’	10.4	1.0	7	155	3	0.13
190425	17:14:13.93	44º43.90’	110º51.04’	2.9	0.5	9	97	6	0.08
190425	17:14:24.17	44º45.15’	110º50.72’	2.1	0.3	9	112	4	0.20
190428	03:05:30.81	44º36.87’	110º25.24’	2.6	0.9	7	162	6	0.10
190428	04:27:19.16	44º29.01’	111º04.34’	8.4	0.5	12	155	14	0.22
190429	05:18:28.74	44º17.69’	110º36.70’	3.0*	2.6W	20	124	12	0.16
190429	05:20:26.12	44º19.74’	110º36.69’	5.1	1.7W	8	234	8	0.11
190429	05:20:56.69	44º17.85’	110º36.88’	3.8*	2.3W	15	125	11	0.11
190429	05:21:41.64	44º19.07’	110º36.36’	2.1	0.2	8	238	9	0.14
190429	05:21:55.78	44º44.59’	110º57.41’	6.2	0.7	7	115	4	0.13
190429	05:22:09.24	44º44.53’	110º57.20’	6.0	0.6	7	108	5	0.10
190429	05:22:16.16	44º26.44’	110º36.78’	7.0	0.5	6	187	6	0.22
190429	05:22:22.95	44º25.84’	110º33.62’	4.2	-0.1	6	203	4	0.01
190429	05:24:40.18	44º45.90’	110º59.82’	9.1	-0.4	7	133	1	0.11

Table 2. Earthquakes in the Yellowstone Region: April 1–June 30, 2019

DATE	ORIGIN TIME	LATITUDE	LONGITUDE	DEPTH	MAG	NO	GAP	DMN	RMS
190429	05:24:42.00	44º17.56’	110º36.98’	2.8*	2.1W	12	126	12	0.13
190429	05:36:01.99	44º18.48’	110º36.51’	2.0	1.3W	10	242	10	0.31
190429	12:06:29.05	44º46.18’	111º00.21’	7.9	0.9W	14	137	1	0.11
190429	19:17:33.89	44º39.11’	110º25.52’	2.4	1.5W	12	142	10	0.16
190430	15:24:05.52	44º35.30’	110º53.78’	10.1	0.8W	16	78	5	0.14
190430	20:06:39.54	44º35.12’	110º44.34’	2.4	1.1	11	146	8	0.09
190430	20:09:47.72	44º35.21’	110º44.61’	7.1	1.3W	17	87	8	0.16
190430	20:11:34.08	44º35.11’	110º45.17’	9.2	1.2W	13	93	8	0.19
190430	20:11:58.95	44º35.41’	110º45.40’	7.3	1.1W	13	91	8	0.18
190430	20:15:46.56	44º35.38’	110º44.78’	6.9	1.4W	25	69	8	0.19
190430	20:18:39.57	44º35.91’	110º44.88’	8.6	1.2W	16	82	8	0.16
190430	20:30:51.80	44º34.85’	110º43.79’	2.1	1.4W	12	84	7	0.15
190501	21:47:05.83	44º26.72’	110º20.45’	9.6	1.1	11	107	7	0.20
190501	21:47:27.20	44º26.80’	110º21.58’	2.7	0.1	9	112	9	0.13
190503	07:52:52.22	44º39.11’	110º25.81’	4.7	1.5W	12	129	9	0.09
190503	12:09:03.17	44º28.35’	110º58.95’	5.7*	0.1	6	227	12	0.22
190503	18:31:33.59	44º23.68’	110º36.64’	1.8	2.1W	10	195	3	0.15
190504	13:25:25.91	44º29.17’	110º33.92’	3.1	2.4	13	75	6	0.16
190504	13:29:56.66	44º28.83’	110º34.26’	7.7	1.6W	20	66	5	0.14
190507	01:04:26.71	44º48.11’	111º23.78’	7.6	2.8W	28	85	4	0.16
190507	09:11:08.87	44º47.55’	111º05.23’	4.3	0.8W	15	140	2	0.15
190507	14:54:26.33	44º49.07’	111º23.15’	7.8	0.4	9	157	4	0.17
190508	10:38:41.65	44º44.51’	110º46.83’	5.5	0.6W	10	155	8	0.07
190508	10:40:23.32	44º44.29’	110º47.26’	4.1	0.2	10	147	7	0.07
190508	12:19:29.36	44º45.13’	110º46.97’	5.7	1.1W	14	106	7	0.16
190508	12:35:30.52	44º44.73’	110º47.05’	2.7	-0.3	7	158	7	0.13
190508	23:55:50.21	44º42.17’	110º24.95’	6.6	1.3W	10	134	8	0.17
190509	07:22:04.34	44º27.60’	110º57.65’	4.9	1.6W	18	115	10	0.18
190509	07:25:54.04	44º28.02’	110º56.68’	1.3	0.6W	8	111	9	0.10
190510	03:58:46.55	44º44.06’	110º19.36’	5.3	1.5W	15	80	3	0.20
190510	04:20:03.35	44º42.62’	110º19.46’	0.5	1.3	10	71	5	0.13
190510	07:17:52.43	44º44.59’	110º57.25’	5.0	0.9	13	114	4	0.17
190511	11:17:00.13	44º47.72’	111º05.62’	9.2	1.2W	18	116	1	0.15
190512	05:27:04.56	44º46.24’	111º26.98’	12.3	0.8	18	95	7	0.12
190512	13:28:56.24	44º38.11’	110º43.53’	9.9	1.4W	17	56	7	0.14
190513	02:26:09.33	44º30.69’	111º09.74’	14.8	0.3	14	162	12	0.20
190513	05:22:48.60	44º28.03’	111º13.10’	18.9	0.9	12	164	18	0.17
190513	06:41:08.00	44º44.07’	111º09.01’	12.4	0.2	12	86	4	0.10
190513	18:32:49.90	44º20.94’	110º31.77’	4.9	0.2	9	249	5	0.11
190513	18:33:11.87	44º18.65’	110º32.66’	4.6	1.5	14	129	9	0.14
190513	18:37:02.57	44º19.52’	110º32.72’	5.0	1.7	13	184	7	0.12
190514	18:40:37.16	44º46.65’	111º02.79’	8.0	0.2	11	137	4	0.14
190515	04:02:03.43	44º46.29’	110º47.46’	6.9	1.0W	14	110	5	0.22
190515	15:32:33.22	44º47.67’	111º05.49’	8.8	0.1	10	140	1	0.11
190515	16:59:34.59	44º49.28’	111º20.02’	9.0	0.3	10	156	8	0.19

Table 2. Earthquakes in the Yellowstone Region: April 1–June 30, 2019

DATE	ORIGIN TIME	LATITUDE	LONGITUDE	DEPTH	MAG	NO	GAP	DMN	RMS
190516	00:45:47.16	44º47.54’	111º06.54’	8.6	-0.3	8	132	9	0.13
190516	11:01:25.93	44º49.63’	111º20.34’	10.5	0.9W	16	91	7	0.12
190516	16:29:36.22	44º48.79’	111º20.04’	7.5	1.1	13	145	8	0.09
190516	22:02:26.03	44º46.79’	111º03.17’	8.0	0.9W	14	114	4	0.11
190518	04:17:29.70	44º46.88’	110º48.50’	4.7	0.7W	12	201	3	0.13
190518	09:50:30.98	44º46.46’	110º54.89’	8.9	1.3W	22	76	5	0.17
190518	10:03:43.65	44º46.77’	110º54.61’	7.6	1.0W	15	147	5	0.16
190518	10:03:43.75	44º46.12’	110º55.21’	8.1	1.0W	18	110	6	0.15
190518	10:53:21.40	44º46.19’	110º54.27’	7.4	0.3	16	109	5	0.15
190518	11:52:35.54	44º46.36’	110º54.88’	8.7	0.6	11	172	5	0.15
190518	13:03:40.30	44º45.96’	110º55.17’	7.7	1.9W	21	103	6	0.15
190519	14:42:29.13	44º27.38’	110º57.15’	4.4	1.0W	13	118	9	0.13
190520	13:38:08.07	44º46.25’	111º04.43’	9.0	1.2W	10	127	6	0.13
190521	23:19:33.39	44º22.32’	110º33.59’	2.8	1.4	11	208	2	0.18
190521	23:23:23.87	44º22.44’	110º33.70’	3.2	1.3	10	208	2	0.12
190523	10:05:56.63	44º36.61’	110º22.53’	4.4	1.9W	17	68	6	0.13
190523	10:09:34.57	44º36.90’	110º22.60’	4.9	2.5W	23	67	6	0.15
190523	10:10:43.00	44º36.62’	110º22.87’	4.4	2.0W	18	66	6	0.15
190523	10:53:32.03	44º36.58’	110º22.66’	3.8	1.3	16	68	6	0.08
190523	10:54:39.93	44º36.77’	110º22.96’	4.3	1.7W	15	66	6	0.07
190523	10:56:48.87	44º36.82’	110º23.44’	3.9	1.2	10	115	6	0.11
190523	11:01:59.12	44º36.67’	110º22.50’	4.8	1.6W	14	68	6	0.08
190525	12:51:10.17	45º02.97’	110º24.32’	15.9	1.1	18	133	27	0.18
190525	13:53:55.90	44º40.42’	110º01.72’	13.1	1.1	10	151	13	0.18
190525	17:57:15.56	44º26.88’	110º35.43’	3.7	2.3W	28	102	1	0.19
190526	01:50:53.46	44º45.35’	110º51.71’	4.9	1.9W	23	81	4	0.21
190526	01:51:46.54	44º45.31’	110º51.60’	3.0	1.8W	18	78	4	0.19
190526	07:15:26.48	44º45.54’	110º51.13’	4.8	-0.4	13	107	3	0.18
190526	07:15:30.84	44º45.35’	110º51.61’	1.9	0.7W	10	100	4	0.10
190526	07:55:58.23	44º43.80’	110º50.75’	2.6	--	8	122	6	0.11
190526	10:43:04.05	44º45.09’	110º51.68’	4.8	1.7W	22	77	4	0.15
190526	12:19:33.63	44º45.88’	110º51.36’	4.9	0.7W	12	102	3	0.12
190526	14:55:09.96	44º45.14’	110º51.62’	4.6	1.9W	18	76	4	0.19
190526	16:37:58.83	44º45.43’	110º51.70’	4.7	0.8	11	81	4	0.11
190526	20:20:11.99	44º45.11’	110º51.37’	4.3	0.8W	9	100	4	0.12
190527	13:48:13.39	44º46.46’	111º03.74’	8.7	0.9W	14	132	5	0.20
190528	00:46:20.74	44º26.45’	110º33.46’	3.5	-0.3	10	129	2	0.18
190528	00:46:33.57	44º26.23’	110º32.76’	2.0	0.4	9	75	3	0.10
190529	22:02:12.11	44º46.29’	110º47.94’	4.6	0.6	11	106	4	0.18
190530	00:25:58.03	44º46.31’	110º47.58’	4.2	0.8W	18	109	5	0.22
190530	00:54:05.43	44º46.27’	110º47.73’	5.4	1.3W	16	88	5	0.20
190530	01:24:41.02	44º46.13’	110º47.83’	4.8	1.0W	17	89	5	0.19
190530	02:00:54.50	44º46.24’	110º47.43’	4.8	0.9W	10	110	5	0.12
190530	03:06:42.94	44º45.31’	110º58.69’	8.7	0.8W	21	106	2	0.17
190601	02:10:05.20	44º49.63’	110º58.48’	5.9	0.3	7	193	8	0.08

Table 2. Earthquakes in the Yellowstone Region: April 1–June 30, 2019

DATE	ORIGIN TIME	LATITUDE	LONGITUDE	DEPTH	MAG	NO	GAP	DMN	RMS
190601	03:41:32.69	44º46.08’	111º10.67’	8.4	0.0	9	140	2	0.15
190602	11:17:28.75	44º36.35’	110º27.22’	5.5	1.4W	18	48	7	0.16
190602	13:35:14.61	44º47.85’	111º05.27’	6.8	1.4W	17	119	1	0.14
190605	23:44:03.59	44º48.12’	111º04.98’	6.1	1.5W	16	149	2	0.13
190606	03:25:22.47	44º26.23’	110º25.65’	18.0	0.7	7	128	11	0.11
190607	04:30:20.83	44º47.76’	111º00.09’	8.4	0.4	12	160	4	0.13
190608	12:46:22.03	44º44.94’	111º13.39’	9.1	0.6	12	178	2	0.21
190610	21:47:41.14	44º44.46’	110º55.30’	9.5	0.7	16	112	7	0.17
190612	06:36:33.70	44º20.91’	110º31.55’	5.3	0.0	12	220	5	0.13
190612	06:36:47.96	44º21.28’	110º31.77’	5.5	-0.2	11	217	4	0.15
190612	06:36:56.53	44º19.62’	110º31.51’	5.9	1.7W	17	115	7	0.20
190612	06:44:52.28	44º20.60’	110º31.61’	5.0	0.0	12	223	5	0.13
190612	06:45:19.67	44º20.12’	110º31.53’	5.2	0.8	14	183	6	0.15
190612	06:45:35.01	44º19.90’	110º31.71’	6.4	1.5	14	183	7	0.18
190612	06:45:43.65	44º24.22’	110º30.42’	4.0	0.5	6	193	3	0.16
190612	07:03:06.36	44º20.39’	110º31.74’	5.0	-0.5	13	180	6	0.13
190612	07:03:12.73	44º21.36’	110º30.68’	2.5	1.3	8	216	5	0.22
190612	07:03:50.50	44º20.68’	110º31.77’	5.3	0.5	12	223	5	0.14
190612	07:04:04.26	44º21.46’	110º30.72’	3.6	0.3	10	232	4	0.16
190612	07:06:57.71	44º21.29’	110º30.93’	3.7	-0.1	11	216	4	0.12
190612	07:07:13.40	44º21.31’	110º30.64’	2.3	-0.5	9	234	5	0.12
190612	07:07:31.54	44º20.75’	110º31.92’	5.2	0.7	12	221	5	0.16
190612	08:01:57.19	44º22.87’	111º05.74’	13.9	1.3W	12	144	22	0.14
190612	08:35:23.14	44º21.28’	110º50.69’	3.6*	1.2	12	157	11	0.18
190614	08:24:29.04	44º44.58’	111º06.45’	10.9	1.5W	14	65	6	0.12
190614	08:25:47.05	44º44.60’	111º06.26’	13.6	2.0W	15	65	6	0.13
190614	08:27:00.29	44º44.64’	111º05.87’	11.1	0.4	11	104	7	0.13
190615	10:15:36.97	44º30.29’	110º22.55’	2.8	1.1	8	102	6	0.09
190615	10:16:07.14	44º30.33’	110º22.49’	2.8	1.8	9	103	6	0.07
190615	10:16:19.61	44º30.46’	110º22.35’	3.2	1.9	9	93	6	0.07
190615	18:56:46.54	44º46.78’	111º01.44’	8.3	0.4	12	142	3	0.15
190615	22:30:46.55	44º42.75’	111º00.26’	11.5	1.6W	17	65	5	0.16
190615	22:54:02.29	44º42.20’	110º59.98’	9.8	0.6	10	146	6	0.15
190616	00:31:01.58	44º42.57’	110º59.86’	9.6	0.8	18	65	6	0.13
190616	07:43:01.79	44º42.85’	111º00.04’	10.3	0.6	16	64	5	0.12
190616	07:52:24.61	44º42.86’	111º00.31’	11.2	1.6W	19	56	5	0.13
190617	02:44:26.36	44º42.96’	110º59.73’	11.2	0.4	8	83	5	0.07
190619	05:53:20.75	44º19.15’	110º31.76’	6.8	1.8	13	116	8	0.15
190619	05:53:42.83	44º20.86’	110º31.67’	4.6	-0.1	8	221	5	0.16
190619	05:54:14.95	44º20.15’	110º31.66’	4.8	1.1	12	182	6	0.08
190619	05:54:48.85	44º19.82’	110º31.71’	5.0	1.1	9	184	7	0.05
190619	05:59:28.14	44º20.17’	110º31.82’	4.8	1.3	10	226	6	0.09
190619	05:59:38.18	44º21.78’	110º30.36’	2.5	0.3	6	224	4	0.11
190619	06:00:01.02	44º20.70’	110º31.44’	4.2	0.0	9	222	5	0.11
190619	06:11:15.92	44º20.53’	110º31.86’	5.0	1.6W	13	179	5	0.11

Table 2. Earthquakes in the Yellowstone Region: April 1–June 30, 2019

DATE	ORIGIN TIME	LATITUDE	LONGITUDE	DEPTH	MAG	NO	GAP	DMN	RMS
190619	06:11:35.96	44º20.79’	110º31.34’	5.7	1.5	10	221	5	0.14
190619	06:18:53.11	44º20.51’	110º31.81’	5.0	1.0	10	223	5	0.11
190621	12:20:09.42	44º43.88’	111º09.38’	8.0	0.6	10	67	4	0.14
190623	15:40:55.95	44º47.10’	110º49.71’	5.9	1.4W	17	103	2	0.19
190624	13:24:31.79	44º44.76’	111º05.87’	11.7	0.1	13	83	6	0.16
190624	13:32:44.18	44º44.63’	111º05.91’	12.3	0.6	16	81	6	0.19
190625	00:00:17.01	44º44.46’	111º06.44’	8.6	-0.2	8	129	7	0.13
190625	02:16:33.21	44º34.25’	110º57.80’	11.5	0.6	10	148	11	0.15
190625	04:30:29.13	44º33.98’	110º57.78’	14.1	0.7	15	89	11	0.14
190626	01:14:06.81	44º33.93’	110º57.56’	13.5	1.0	16	88	11	0.16
190626	09:45:46.82	44º33.98’	110º57.73’	14.6	0.5	12	89	11	0.10
190626	14:14:59.65	44º47.19’	111º05.12’	7.8	1.6W	18	112	2	0.17
190626	14:18:18.61	44º46.65’	110º49.28’	4.9	0.8	13	96	3	0.21
190626	15:46:30.21	44º44.86’	111º06.27’	12.6	0.5	10	82	5	0.10
190626	15:58:13.07	44º44.69’	111º06.81’	12.2	0.6	13	71	6	0.15
190626	16:32:23.68	44º47.37’	111º05.19’	8.4	0.8	14	115	2	0.14
190626	16:33:11.03	44º47.26’	111º04.80’	8.3	-0.1	7	138	7	0.14
190627	02:21:12.05	44º37.49’	111º04.82’	6.8	1.2W	15	89	3	0.17
190627	04:08:39.13	44º21.42’	110º33.85’	3.5	1.1	11	170	4	0.13
190627	06:22:17.32	44º46.54’	110º49.29’	4.8	1.2W	16	96	3	0.16
190627	08:32:49.62	44º37.28’	110º09.51’	2.8	0.6	5	216	4	0.08
190627	08:33:02.01	44º37.97’	110º10.89’	2.8	1.5	6	199	2	0.05
190627	08:55:31.90	44º38.02’	110º09.70’	3.8	1.4	8	125	3	0.08
190627	14:40:55.85	44º48.86’	111º04.93’	11.1	0.7	12	160	3	0.10
190628	12:57:22.32	44º35.31’	110º23.32’	4.3	0.8	12	122	3	0.12
190629	16:05:14.30	44º13.57’	110º45.97’	5.8*	1.3	9	105	24	0.19
190630	07:22:26.64	44º32.07’	110º28.19’	8.7	0.6	9	107	14	0.11

number of earthquakes = 207
* indicates poor depth control
W indicates Wood-Anderson data used for magnitude calculation

Table 3
UNIVERSITY OF UTAH YELLOWSTONE SEISMIC NETWORK
Operating Seismograph Stations
June 30, 2019

SEED Station	Location	SEED Channel	No. of Channels	Network Code	Latitude	Longitude	Elevation (meters)	Sensor	Digitizer	Telemetry	Sponsor
B206*	Canyon206bwy2008, Yellowstone, WY	EH[ZEN]	3	PB	44° 46.66′	110° 30.70′	2400	IESE-S2	Q330	Digital	PBO
B207*	Madisn207bwy2007, Yellowstone, WY	EH[ZEN]	3	PB	44° 37.14′	110° 50.91′	2182	IESE-S2	Q330	Digital	PBO
B208*	Lakejn208bwy2008, Yellowstone, WY	EH[ZEN]	3	PB	44° 33.61′	110° 24.09′	2406	IESE-S2	Q330	Digital	PBO
B944*	Grantt944bwy2008, Yellowstone, WY	EH[ZEN]	3	PB	44° 23.38′	110° 32.63′	2365	IESE-S2	Q330	Digital	PBO
B945*	Panthr944swy2008, Yellowstone, WY	EH[ZEN]	3	PB	44° 53.64′	110° 44.65′	2249	IESE-S2	Q330	Digital	PBO
B950*	Norris950bwy2013, Yellowstone, WY	EH[ZEN]	3	PB	44° 42.77′	110° 40.71′	2328	IESE-S2	Q330	Digital	PBO
FLWY*	Flagg Ranch, WY	BH[ZEN]	3	IW	44° 04.96′	110° 41.96′	2078	3ESP	RT-130	Digital	ANSS
IMW*	Indian Meadows, WY	BH[ZEN]	3	IW	43° 53.58′	110° 56.58′	2670	3ESP	RT-130	Digital	ANSS
LKWY*	Lake, WY	BH[ZEN]	3	US	44° 33.91′	110° 24.00′	2424	STS-2	Q330	Digital	USGS
LOHW*	National Elk Refuge, WY	BH[ZEN]	3	IW	43° 36.76′	110° 36.30′	2245	3ESP	RT-130	Digital	ANSS
MCID	Moose Creek, ID	EHZ	1	WY	44° 11.45′	111° 11.03′	2137	L4C	PSN	Analog	USGS
MOOW*	Moose Ponds, WY	BH[ZEN]	3	IW	43° 44.92′	110° 44.69′	2128	3ESP	RT-130	Digital	ANSS
QLMT*	Earthquake Lake, MT	EHZ	1	MB	44° 49.84′	111° 25.80′	2064	L4C	-	Analog	MBMT
REDW*	Red-Top Meadows, WY	BH[ZEN]	3	IW	43° 21.74′	110° 51.18′	2322	3ESP	RT-130	Digital	ANSS
SNOW*	Snow King Mountain, WY	BH[ZEN]	3	IW	43° 27.75′	110° 45.31′	2390	3ESP	RT-130	Digital	ANSS
TPAW*	Teton Pass, WY	BH[ZEN]	3	IW	43° 29.41′	110° 57.04′	2512	3ESP	RT-130	Digital	ANSS
TPMT*	Teepe Creek, MT	EHZ	1	MB	44° 43.79′	111° 39.94′	2518	L4C	-	Analog	MBMT
YDC	Denny Creek, MT	EHZ	1	WY	44° 42.51′	111° 14.60′	2025	L4C	PSN	Analog	USGS
YDD	Grant Junction, Yellowstone, WY	HH[ZEN]	3	WY	44° 24.00′	110° 34.80′	2400	STS-2	Q330	Digital	NSF
		EN[ZEN]	3					Episensor			
YEE	East Entrance (YNP), WY	HH[ZEN]	3	WY	44° 29.12′	109° 53.81′	2270	Compact	Taurus	Digital	USGS
YFT	Old Faithful (YNP), WY	HH[ZEN]	3	WY	44° 27.05′	110° 50.24′	2292	Compact	Centaur	Digital	USGS
		EN[ZEN]	3					Titan			
YGC	Grayling Creek, MT	EHZ	1	WY	44° 47.77′	111° 06.45′	2075	L4C	PSN	Analog	USGS
YHB	Horse Butte, MT	EHZ	1	WY	44° 45.07′	111° 11.71′	2157	L4C	PSN	Analog	USGS
		HH[ZEN]	3					Compact	ANSS-130	Digital	
		EN[ZEN]	3					Titan			
YHH	Holmes Hill (YNP), WY	EHZ	1	WY	44° 47.30′	110° 51.03′	2717	S13	PSN	Analog	USGS
		HH[ZEN]	3					Trillium 120	Q330	Digital	
		EN[ZEN]	3					Titan			

SEED Station	Location	SEED Channel	No. of Channels	Network Code	Latitude	Longitude	Elevation (meters)	Sensor	Digitizer	Telemetry	Sponsor
YHL	Hebgen Lake, MT	HH[ZEN]	3	WY	44° 51.05′	111° 10.98′	2691	Trillium 120	Q330	Digital	USGS
		EN[ZEN]	3					Titan			
YHR	Hawk's Rest, WY	HH[ZEN]	3	WY	44° 06.36′	110° 04.90′	2976	Trillium 120	Q330	Digital	USGS
YJC	Joseph′s Coat (YNP), WY	EH[ZEN]	3	WY	44° 45.33′	110° 20.95′	2684	S13	PSN	Analog	USGS
YLA	Lake Butte (YNP), WY	EHZ	1	WY	44° 30.76′	110° 16.12′	2580	L4C	PSN	Analog	USGS
YLT	Little Thumb Creek (YNP), WY	EHZ	1	WY	44° 26.25′	110° 35.28′	2439	L4C	PSN	Analog	USGS
YMC	Maple Creek (YNP), WY	EH[ZEN]	3	WY	44° 45.53′	111° 00.41′	2073	S13	PSN	Analog	USGS
YML	Mary Lake (YNP), WY	EH[ZEN]	3	WY	44° 36.20′	110° 38.63′	2653	S13	PSN	Analog	USGS
YMP	Mirror Plateau (YNP), WY	EHZ	1	WY	44° 44.38′	110° 09.40′	2774	S13	PSN	Analog	USGS
		HH[ZEN]	3					Trillium 120	Q330	Digital	
		EN[ZEN]	3					Titan			
YMR	Madison River (YNP), WY	HH[ZEN]	3	WY	44° 40.12′	110° 57.90′	2149	Trillium 120	Q330	Digital	USGS
		EN[ZEN]	3					Titan			
YMS	Mount Sheridan (YNP), WY	EHZ	1	WY	44° 15.84′	110° 31.67′	3106	L4C	PSN	Analog	USGS
YMV	Mammoth Vault (YNP), WY	EHZ	1	WY	44° 58.42′	110° 41.33′	1829	L4C	PSN	Analog	USGS
YNE	Northeast Entrance (YNP), WY	HH[ZEN]	3	WY	45° 00.46′	110° 00.48′	2343	Compact	ANSS-130	Digital	USGS
YNM	Norris Museum (YNP), WY	HH[ZEN]	3	WY	44° 43.59′	110° 42.22′	2311	Trillium 240	Q330	Digital	USGS
YNR	Norris Junction (YNP), WY	HH[ZEN]	3	WY	44° 42.93′	110° 40.75′	2336	Trillium 120	Q330	Digital	USGS
		EN[ZEN]	3					Titan			
YPC	Pelican Cone (YNP), WY	EHZ	1	WY	44° 38.88′	110° 11.55′	2932	L4C	PSN	Analog	USGS
YPK	Parker Peak (YNP), WY	EH[ZEN]	3	WY	44° 43.91′	109° 55.32′	2897	L4C	PSN	Analog	USGS
YPM	Purple Mountain (YNP), WY	EHZ	1	WY	44° 39.43′	110° 52.12′	2582	L4C	PSN	Analog	USGS
YPP	Pitchstone Plateau (YNP), WY	EHZ	1	WY	44° 16.26′	110° 48.27′	2707	S13	PSN	Analog	USGS
		HH[ZEN]	3					Trillium 120	Q330	Digital	
		EN[ZEN]	3					Titan			
YSB	Soda Butte (YNP), WY	EHZ	1	WY	44° 53.04′	110° 09.06′	2072	L4C	PSN	Analog	USGS
YTP	The Promontory (YNP), WY	EHZ	1	WY	44° 23.51′	110° 17.10′	2384	L4	PSN	Analog	USGS
		HH[ZEN]	3					Trillium 120	Q330	Digital	
		EN[ZEN]	3					Titan			
YUF	Upper Falls (YNP), WY	HH[ZEN]	3	WY	44° 42.76′	110° 30.71′	2394	40T	ANSS-130	Digital	USGS
		EN[ZEN]	3					Titan			
YWB	West Boundary (YNP), WY	EHZ	1	WY	44° 36.35′	111° 06.05′	2310	L4C	PSN	Analog	USGS

* Station operated by another agency and recorded as part of the Yellowstone Seismic Network
Network Statistics: 150 data channels from 46 stations were being recorded at the end of this report period

EXPLANATION OF TABLE

UURSN Code: Station code formerly used in routine processing. Owing to software limitations, the station code may not be the same code used by the original operator. For multi-component stations, the vertical, east-west, and north-south high gain (low gain) components are identified by an appended Z(V), E(L), and N(M), respectively, in UUSS phase files.

Location: General description of station location. YNP = Yellowstone National Park.

SEED Station: The SEED (Standard for the Exchange of Earthquake Data) station code used by the original operator.

SEED Channel: The SEED format uses three letters to name seismic channels. See <<http://www.iris.edu/manuals/SEEDManual_V2.4.pdf>> for information about the SEED channel naming convention. Relevant sections are reproduced below. In the SEED convention, each letter describes one aspect of the instrumentation and its digitization. The first letter specifies the general sampling rate and the response band of the instrument. Band codes used in this table include:

Band Code	Band Type	Sample Rate	Corner Period
E	Extremely short period	≥ 80 Hertz	< 10 seconds
H	High broadband	≥ 80 Hertz	≥ 10 seconds
B	Broadband	≥ 10 to < 80 Hertz	≥10 seconds
S	Short period	≥ 10 to < 80 Hertz	< 10 seconds

The second letter specifies the family to which the sensor belongs. Sensor families used in this table are:

Instrument Code	Description
H	High gain seismometer
L	Low gain seismometer
N	Accelerometer

The third letter specifies the physical configuration of the members of a multiple axis instrument package. Channel orientations used in this table are:

Z E N Traditional (Vertical, East-West, North-South)

Number of Channels: Total number of waveform channels recorded.

Network Code: The FDSN (Federation of Digital Seismographic Networks) registered network code. See <<http://www.iris.edu/dms/nodes/dmc/services/network_codes>> for information about registered seismograph network codes. Network codes referenced in this table:

Network Code	Network name; Network operator or responsible organization
IE	Idaho National Laboratory Seismic Network
IU	IRIS/USGS Network; USGS Albuquerque Seismological Laboratory
IW	Intermountain West Network, U.S. Geological Survey

MB	Montana Regional Seismic Network; Montana Bureau of Mines and Geology
PB	Plate Boundary Observatory
UU	University of Utah Regional Network; University of Utah
US	US National Network; USGS National Earthquake Information Center
WY	Yellowstone Wyoming Seismic Network; University of Utah

Latitude, Longitude: Sensor location in degrees and decimal minutes; North latitude, West longitude.

Elevation: Sensor altitude in meters above sea level.

Sensor	**Description**
L4, L4C	Mark Products L4 or L4C short-period seismometer
S13, 18300	Geotech S13 or 18300 short-period seismometer
Ranger	Kinemetrics Ranger short-period seismometer
40T	Guralp CMG-40T broadband seismometer
3T	Guralp CMG-3T broadband seismometer
3ESP	Guralp CMG-3ESP broadband seismometer
STS-2	Streckheisen STS-2 broadband seismometer
FBA23	Kinemetrics FBA-23 accelerometer
EpiSensor	Kinemetrics EpiSensor accelerometer
Applied Mems	Applied Mems accelerometer
PA-23	Geotech PA-23 accelerometer
Compact	Nanometrics Compact broadband seismometer
Trillium 120	Nanometrics Trillium 120 broadband seismometer
Trillium 240	Nanometrics Trillium 240 broadband seismometer
Titan	Nanometrics Titan accelerometer
Observer	Refraction Technology (REF TEK) Model 151 Observer broadband seismometer
IESE-S2	Institute of Earth Science and Engineering S-2 model borehole seismometer

Digitizer	**Description**
K2	Kinemetrics Altus Series K2 (19-bit resolution field digitizer)
Etna	Kinemetrics Altus Series Etna (18-bit resolution field digitizer)
72A-07	Refraction Technology (REF TEK) model 72A-07 (24-bit field digitizer)
72A-08	Refraction Technology (REF TEK) model 72A-08 (24-bit field digitizer)
ANSS-130	Refraction Technology (REF TEK) model 130-ANSS/02 (24-bit resolution field digitizer)
RT-130	Refraction Technology (REF TEK) model RT-130 (24-bit resolution field digitizer)
Q330	Quanterra, Inc Q330 digitizer (24-bit resolution field digitizer)
SMART-24	Geotech SMART-24 digitizer (24-bit resolution field digitizer)
PSN	PSN-ADC-SERIAL version III (16-bit resolution field digitizer)
Basalt	Kinemetrics Basalt (24-bit resolution field digitizer)
Taurus	Nanometrics Taurus (24-bit resolution field digitizer)
Centaur	Nanometrics Centaur (24-bit resolution field digitizer)

Telemetry	Description
Analog	Data transmission is analog along part of the transmission pathway
Digital	Data are converted to digital form at the station site
None	On-site recording system

Sponsor (or Operator for stations marked by * in preceding columns)

USGS	U.S. Geological Survey
Utah	State of Utah
ANSS	Advanced National Seismic System
INL	Idaho National Laboratory
MBMT	Montana Bureau of Mines and Geology
PBO	Plate Boundary Observatory
NSF	National Science Foundation

Network Changes During April 1–June 30, 2019

None