

Paradox Valley Seismic Network (PVSN)

Status Report

December 2021

The information contained in this report is provisional and has not gone through final quality control checks or peer review.

Site Visit

No site visits were conducted during December.

Operating Status

PVSN was online throughout December. However, data transmission for 14 of the broadband seismic stations and all three strong motion stations was interrupted for more than two hours on December 1st (12/01/2021, from ~2:46 – 5:07 UTC). These data streams are relayed through radio repeater sites PV04 and PV12 and are received by a single antenna at the PVSN data communication center at Hopkins Field in Nucla, Colorado. Either a temporary hardware problem or radio interference interrupted data transmission for this radio subnet during this time period. Data transmission resumed following this short outage, and radio signal strength and signal-to-noise values have remained normal since then. The problem has not recurred.

Station PV18 went offline on 12/10/21 at approximately 17:11 UTC, and we cannot establish radio communication with the site. A site visit will likely be required to repair this station.

We have a gap in the data from station PV07 on 12/10/21, from ~1:10 to 17:12 UTC (12/9 6:10 pm to 12/10 10:12 am MST) and from station PV21 on 12/12/21, from ~12:10 to ~18:23 UTC (5:10 to 11:23 am MST). These data gaps may be due to nighttime and early morning power failures associated with low battery voltages. Such outages can occur during extended periods of cloudy weather or following the accumulation of snow on solar panels.

The monthly uptimes for individual seismic stations during the month are listed in Table 1. These values represent the percent of the month for which data from a given station were recorded; the values are rounded to the nearest percent. Of the 23 seismic stations (broadband and strong motion), 21 stations had uptimes of 99-100%. Station PV07 had an uptime of 93%, and station PV18 had an uptime of 31%.

TABLE 1: Monthly uptime of PVSN seismic stations.

Station	Monthly Station Uptime	
	November 2021	December 2021
PV01	100%	100%
PV02	100%	100%
PV03	100%	100%
PV04	100%	100%
PV05	100%	100%
PV07	98%	93%
PV10	100%	100%
PV11	100%	100%
PV12	100%	100%
PV13	100%	100%
PV14	100%	99%
PV15	100%	100%
PV16	100%	100%
PV17	100%	99%
PV18	100%	31%
PV19	100%	100%
PV20	100%	100%
PV21	100%	99%
PV22	100%	99%
PV23	100%	100%
PVEF	100%	100%
PVPP	100%	100%
PVCC	100%	100%

Seismicity

Table 2 lists the preliminary dates, times, locations, magnitudes, depths, and distances from the injection well of the local earthquakes recorded during 2021. The numbers of earthquakes and earthquake magnitudes for four location categories are summarized in Table 3. The four location categories are based on hypocenter depth and distance from the injection well:

1. Shallow near-well event: ≤ 10 km deep; ≤ 5 km from the injection well
2. Shallow intermediate-range event: ≤ 10 km deep; > 5 km and ≤ 10 km from the injection well
3. Shallow distant event: ≤ 10 km deep; > 10 km from the injection well
4. Deep event: > 10 km deep, at any distance from the well

TABLE 2: Local earthquakes recorded by PVSN during 2021.

Date	Time ¹	Latitude (deg.)	Longitude (deg.)	Elevation ² (km)	Depth ³ (km)	M _D ⁴	M _w ⁵	Horizontal Distance from Injection Well (km)
1/1/21	12:03:57	38.2753	-108.9200	-3.04	4.6	0.6	1.1	3.2
1/2/21	9:44:38	38.2777	-108.9177	-2.21	3.7	0.8	1.3	2.9
1/2/21	11:37:21	38.2772	-108.9217	-1.21	2.7	0.2	0.5	3.2
1/2/21	17:17:37	38.2695	-108.9055	1.88	-0.4	1.2	1.4	3.1
1/3/21	3:02:22	38.2780	-108.9158	-2.37	3.9	2.6	2.5	2.8
1/3/21	21:27:04	38.2785	-108.9150	-2.35	3.9	-0.1	0.8	2.7
1/4/21	8:10:40	38.4713	-108.9773	-5.79	7.3	-0.2	1.1	20.7
1/4/21	9:20:37	38.2805	-108.9135	-1.88	3.4	-0.5		2.4
1/5/21	7:15:18	38.4675	-109.0310	-2.08	3.6	-0.1		22.4
1/6/21	10:11:15	38.2778	-108.9153	-2.51	4.0	-0.5	0.5	2.7
1/8/21	6:19:02	38.2860	-108.9005	-1.93	3.5	0.0	0.9	1.3
1/8/21	8:46:48	38.2785	-108.9148	-2.21	3.7	0.7	1.2	2.7
1/8/21	14:34:03	38.2773	-108.9193	-3.15	4.7	2.3	2.0	3.0
1/9/21	3:38:39	38.4395	-108.9697	-4.02	5.5	0.4	1.1	17.2
1/9/21	9:24:45	38.2730	-108.9420	-1.57	3.1	-0.3		4.9
1/9/21	20:15:24	38.2775	-108.9193	-2.29	3.8	0.5	1.2	3.0
1/12/21	0:22:25	38.2782	-108.9205	-1.30	2.8	0.2	0.9	3.0
1/12/21	1:16:49	38.2828	-108.9053	-1.89	3.4	-0.1	0.7	1.8
1/12/21	11:42:42	38.2778	-108.9172	-2.35	3.9	1.4	1.4	2.8
1/15/21	23:37:10	38.2840	-108.9062	-1.84	3.4	-0.5	0.5	1.7
1/16/21	16:53:00	38.2775	-108.9210	-2.12	3.6	1.3	1.4	3.1
1/17/21	8:49:30	38.2852	-108.9000	-1.97	3.5	-0.3		1.3
1/17/21	11:05:07	38.2858	-108.9037	-3.31	4.8	-0.5		1.4
1/17/21	13:38:24	38.1902	-108.6937	-6.69	8.2	0.7		21.2
1/18/21	20:45:04	38.2818	-108.9085	-2.18	3.7	-0.6	0.7	2.0
1/22/21	10:52:08	38.2717	-108.9312	0.18	1.3	-0.1	0.6	4.2
1/23/21	4:23:58	38.2850	-108.9000	-1.85	3.4	0.2	0.8	1.4
1/23/21	10:25:33	38.2855	-108.9038	-2.15	3.7	0.0	1.0	1.4
1/24/21	5:06:56	38.2850	-108.8993	-1.89	3.4	0.3	1.1	1.3
1/24/21	15:21:55	38.2795	-108.8102	-2.89	4.4	0.1	0.7	7.7
1/26/21	13:47:33	38.2563	-108.9408	1.81	-0.3	0.4	1.1	6.0
1/27/21	3:05:43	38.2768	-108.9165	-2.53	4.1	0.6	1.2	2.9
1/27/21	6:56:57	38.2870	-108.8973	-2.37	3.9	0.4	1.1	1.1
1/31/21	2:55:49	38.2790	-108.9158	-2.44	4.0	1.6	1.5	2.7
1/31/21	13:40:06	38.2848	-108.9038	-2.03	3.6	-0.5		1.5
1/31/21	13:41:40	38.2903	-108.9052	-2.68	4.2	0.0		1.1
2/1/21	13:28:42	38.2788	-108.9188	-2.09	3.6	0.2	0.7	2.9
2/4/21	0:36:36	38.2852	-108.9035	-2.24	3.8	-0.5		1.5
2/4/21	7:59:12	38.2767	-108.9142	-2.35	3.9	-0.1	1.0	2.8
2/4/21	10:53:53	38.2783	-108.9173	-2.37	3.9	-0.5		2.8
2/4/21	15:01:39	38.2777	-108.9223	-2.52	4.0	1.5	1.5	3.2

Date	Time ¹	Latitude (deg.)	Longitude (deg.)	Elevation ² (km)	Depth ³ (km)	M _D ⁴	M _W ⁵	Horizontal Distance from Injection Well (km)
2/9/21	6:27:39	38.2792	-108.9143	-2.31	3.8	0.3	1.0	2.6
2/10/21	5:56:31	38.2813	-108.9063	-2.36	3.9	0.0	0.8	2.0
2/11/21	10:04:13	38.2778	-108.9150	-2.53	4.1	-0.2	0.5	2.7
2/11/21	12:58:42	38.2787	-108.9178	-1.09	2.6	-0.2		2.8
2/13/21	22:17:39	38.2860	-108.9037	-2.40	3.9	0.0	1.1	1.4
2/14/21	5:34:58	38.4052	-108.8858	-2.93	4.5	1.0	1.8	12.1
2/15/21	0:39:50	38.4017	-108.8820	-2.94	4.5	1.0	1.4	11.7
2/15/21	1:43:42	38.4052	-108.8832	-3.13	4.7	0.3	1.0	12.1
2/17/21	22:05:23	38.2783	-108.9155	-2.04	3.6	-0.3	0.4	2.7
2/19/21	11:29:51	38.3625	-108.8302	-12.17	13.7	-0.5		9.3
2/20/21	16:41:13	38.2843	-108.9028	-1.88	3.4	-0.3		1.5
2/21/21	10:32:18	38.2837	-108.9122	-2.41	3.9	-0.4	0.6	2.1
2/21/21	10:48:28	38.2848	-108.9062	-2.08	3.6	1.2	1.5	1.6
2/21/21	11:23:36	38.2838	-108.9058	-1.92	3.4	-0.5		1.7
2/21/21	11:28:30	38.2833	-108.9067	-1.92	3.4	-0.7		1.8
2/21/21	11:46:28	38.2837	-108.9060	-1.90	3.4	-0.2	1.0	1.7
2/21/21	22:38:33	38.2852	-108.9043	-2.17	3.7	-0.5		1.5
2/23/21	8:40:05	38.2788	-108.9187	-2.01	3.5	0.0	0.8	2.9
2/25/21	15:34:31	38.2667	-108.8655	-1.47	3.0	-0.5		4.2
2/28/21	8:41:03	38.2765	-108.9253	-0.96	2.5	-0.4		3.5
3/1/21	7:07:39	38.2843	-108.9000	-1.63	3.2	0.4	0.9	1.4
3/1/21	12:29:33	38.2833	-108.9038	-2.10	3.6	-0.4		1.7
3/1/21	17:56:19	38.2763	-108.9227	-2.42	3.9	1.1	1.4	3.3
3/2/21	18:10:43	38.2758	-108.9225	-1.88	3.4	-0.1	0.9	3.3
3/5/21	4:53:59	38.2780	-108.8313	-2.58	4.1	1.3	1.3	5.9
3/5/21	12:21:03	38.2840	-108.9060	-1.86	3.4	-0.6		1.7
3/7/21	18:39:05	38.2752	-108.9230	-2.76	4.3	0.8	1.4	3.4
3/9/21	16:00:59	38.2822	-108.9218	-2.43	4.0	-0.3	0.9	2.8
3/10/21	21:43:21	38.3887	-108.9748	-2.37	3.9	0.6	1.4	12.4
3/12/21	15:30:57	38.2873	-108.8977	-2.23	3.8	0.1	0.8	1.0
3/13/21	8:11:50	38.2785	-108.9152	-2.43	4.0	-0.1		2.7
3/14/21	21:20:58	38.2752	-108.9322	-1.14	2.7	0.4	1.3	4.0
3/15/21	15:21:45	38.2850	-108.8950	-2.03	3.6	0.8	1.2	1.3
3/16/21	7:16:13	38.2750	-108.9313	-0.71	2.2	0.1	0.7	4.0
3/16/21	7:29:28	38.2750	-108.9317	-1.06	2.6	-0.1		4.0
3/16/21	7:31:28	38.2752	-108.9337	-1.36	2.9	-0.7		4.1
3/16/21	7:31:59	38.2745	-108.9333	-1.20	2.7	-0.6		4.2
3/17/21	2:02:35	38.2845	-108.9067	-2.21	3.7	-0.1		1.7
3/17/21	9:03:10	38.2862	-108.8993	-2.38	3.9	-0.4		1.2
3/17/21	19:15:40	38.2855	-108.9017	-2.02	3.5	-0.4		1.4
3/21/21	11:18:59	38.2857	-108.9093	-2.06	3.6	1.0	1.0	1.7
3/22/21	4:25:55	38.2668	-108.8665	-1.31	2.8	-0.3		4.1

Date	Time ¹	Latitude (deg.)	Longitude (deg.)	Elevation ² (km)	Depth ³ (km)	M _D ⁴	M _W ⁵	Horizontal Distance from Injection Well (km)
3/22/21	8:18:45	38.2852	-108.8990	-1.73	3.3	0.1		1.3
3/22/21	9:25:18	38.2693	-108.8650	-1.99	3.5	0.0	0.9	4.0
3/22/21	9:25:32	38.2687	-108.8648	-1.62	3.1	-1.1		4.1
3/23/21	1:32:20	38.2667	-108.8647	-1.58	3.1	-0.6		4.2
3/25/21	5:01:48	38.2797	-108.9202	-1.87	3.4	-0.4	0.6	2.9
3/25/21	6:05:44	38.3143	-108.9652	-1.10	2.6	0.3	0.8	6.4
3/26/21	9:26:48	38.2728	-108.8830	-0.73	2.3	0.6	1.1	2.8
3/26/21	10:01:09	38.2775	-108.9308	-1.08	2.6	1.0	1.5	3.8
3/26/21	10:18:08	38.2752	-108.9300	-0.93	2.5	-0.5	0.7	3.9
3/26/21	10:18:23	38.2758	-108.9297	-1.37	2.9	-1.1		3.8
3/27/21	15:47:21	38.2657	-108.8708	-1.11	2.6	-0.6		4.0
3/27/21	19:44:21	38.2773	-108.8315	-2.35	3.9	0.6	1.2	5.9
3/29/21	0:22:47	38.2787	-108.9190	-1.08	2.6	0.2	0.9	2.9
3/30/21	7:49:05	38.2860	-108.9053	-1.07	2.6	-0.2		1.5
4/2/21	1:44:50	38.2872	-108.8990	-2.17	3.7	-0.6		1.1
4/3/21	16:30:13	38.2837	-108.9065	-1.99	3.5	-0.1		1.7
4/5/21	8:14:44	38.2838	-108.8928	-2.50	4.0	-1.0		1.4
4/8/21	5:40:27	38.2858	-108.8982	-1.90	3.4	0.3	0.9	1.2
4/9/21	5:44:39	38.2832	-108.9072	-1.75	3.3	-0.7		1.8
4/10/21	11:09:41	38.3645	-108.7203	-8.01	9.5	0.2		17.0
4/10/21	11:25:56	38.3650	-108.7205	-7.72	9.2	0.4		17.1
4/10/21	17:40:48	38.3658	-108.7203	-7.09	8.6	-0.5		17.1
4/10/21	17:42:37	38.3513	-108.7008	-5.87	7.4	-0.5		18.0
4/10/21	18:11:58	38.3575	-108.7210	-7.39	8.9	-0.2		16.7
4/10/21	18:13:19	38.3645	-108.7190	-6.73	8.3	0.3		17.1
4/10/21	18:13:37	38.3572	-108.7097	-6.82	8.3	-0.4		17.6
4/10/21	19:49:32	38.3640	-108.7200	-6.97	8.5	0.9	1.5	17.0
4/10/21	19:51:27	38.3643	-108.7182	-6.22	7.7	-0.1		17.2
4/10/21	23:53:13	38.3645	-108.7210	-6.90	8.4	-0.1		17.0
4/11/21	0:13:45	38.3578	-108.7147	-7.39	8.9	0.7		17.2
4/11/21	0:14:33	38.3617	-108.7210	-6.94	8.5	0.1		16.8
4/11/21	0:16:32	38.3633	-108.7197	-6.82	8.3	0.0		17.0
4/11/21	0:38:35	38.3632	-108.7203	-7.33	8.9	1.0	1.5	17.0
4/11/21	7:54:34	38.3632	-108.7200	-7.20	8.7	1.4	1.5	17.0
4/11/21	7:58:19	38.3597	-108.7218	-7.34	8.9	0.3		16.7
4/11/21	7:58:35	38.3612	-108.7157	-6.95	8.5	-0.2		17.2
4/11/21	8:11:53	38.3642	-108.7207	-7.63	9.2	0.7		17.0
4/11/21	8:55:42	38.3587	-108.7217	-6.36	7.9	-0.1	0.5	16.7
4/11/21	8:56:20	38.3620	-108.7168	-7.03	8.6	0.5		17.2
4/12/21	6:30:26	38.2863	-108.8978	-1.87	3.4	-0.2		1.2
4/15/21	9:04:53	38.4027	-108.9308	-4.41	5.9	0.1	1.0	12.2
4/16/21	8:40:08	38.2780	-108.9207	-1.97	3.5	-0.9		3.0

Date	Time ¹	Latitude (deg.)	Longitude (deg.)	Elevation ² (km)	Depth ³ (km)	M _D ⁴	M _W ⁵	Horizontal Distance from Injection Well (km)
4/16/21	18:04:59	38.2782	-108.9203	-2.20	3.7	1.3	1.5	3.0
4/16/21	23:25:08	38.2777	-108.8642	-1.18	2.7	0.0	0.9	3.4
4/17/21	7:28:31	38.2842	-108.9058	-2.54	4.1	-0.3		1.7
4/17/21	7:49:00	38.2775	-108.9208	-2.44	4.0	0.3	1.0	3.1
4/20/21	18:57:27	38.3147	-108.9653	-0.99	2.5	-0.6	0.8	6.5
4/21/21	9:46:18	38.2742	-108.7995	-2.40	3.9	-0.3		8.7
4/21/21	9:46:47	38.2742	-108.8005	-2.52	4.0	-0.9		8.6
4/22/21	2:23:38	38.2842	-108.8998	-1.58	3.1	-0.6		1.4
4/23/21	2:26:33	38.2752	-108.9198	-3.05	4.6	-0.7		3.2
4/23/21	15:53:37	38.3145	-108.9662	-1.10	2.6	-0.6		6.5
4/24/21	13:30:57	38.4043	-109.0143	-4.09	5.6	-0.2	1.0	15.9
4/29/21	10:26:55	38.2832	-108.9107	-1.78	3.3	0.8	1.2	2.0
4/29/21	16:27:22	38.4095	-108.9418	-3.53	5.1	0.8	1.4	13.2
4/30/21	0:07:06	38.2847	-108.9002	-1.65	3.2	-0.6		1.4
5/1/21	7:30:22	38.2842	-108.9043	-2.10	3.6	2.5	2.2	1.6
5/1/21	7:46:23	38.2842	-108.9055	-2.07	3.6	-0.7		1.7
5/1/21	9:04:03	38.2840	-108.9057	-2.00	3.5	-0.4		1.7
5/1/21	11:10:46	38.2857	-108.9040	-2.25	3.8	0.9	1.2	1.4
5/1/21	11:23:52	38.2835	-108.9048	-1.98	3.5	-0.2		1.7
5/1/21	11:26:18	38.2838	-108.9047	-2.06	3.6	1.0	1.1	1.6
5/1/21	11:56:29	38.2820	-108.9088	-1.78	3.3	-0.2		2.0
5/1/21	12:36:22	38.2838	-108.9055	-2.01	3.5	1.3	1.4	1.7
5/1/21	12:52:35	38.2825	-108.9055	-1.66	3.2	0.2		1.8
5/1/21	12:54:23	38.3122	-108.7403	-5.54	7.1	1.7	1.6	13.6
5/1/21	13:42:16	38.2828	-108.9053	-1.88	3.4	-0.1	0.8	1.8
5/1/21	16:57:28	38.2777	-108.9158	-2.32	3.8	-0.7	0.7	2.8
5/1/21	19:12:14	38.2835	-108.9027	-1.80	3.3	-0.6		1.6
5/2/21	4:07:11	38.2752	-108.9353	-0.66	2.2	0.5	0.9	4.3
5/2/21	14:37:16	38.2842	-108.9097	-2.06	3.6	-0.1	0.9	1.9
5/2/21	14:38:23	38.2832	-108.9067	-1.89	3.4	-0.5		1.8
5/2/21	14:38:23	38.2830	-108.9087	-1.72	3.2	-0.3		1.9
5/2/21	21:09:08	38.2847	-108.9068	-2.04	3.6	-0.3		1.7
5/2/21	21:37:20	38.2783	-108.9147	-2.21	3.7	0.8	1.3	2.7
5/3/21	17:47:21	38.2857	-108.9058	-2.19	3.7	-0.4		1.5
5/3/21	18:18:42	38.3220	-108.6908	-6.78	8.3	0.0		18.1
5/3/21	23:24:42	38.2435	-108.8668	0.07	1.5	-0.4	0.7	6.4
5/4/21	1:45:48	38.2822	-108.9065	-1.74	3.3	-0.6		1.9
5/4/21	8:57:32	38.3188	-108.6903	-7.29	8.8	1.4	1.5	18.1
5/7/21	0:57:35	38.2823	-108.9040	-1.71	3.2	-0.4		1.8
5/8/21	9:26:38	38.2765	-108.9187	-2.83	4.4	1.8	1.7	3.0
5/19/21	5:44:11	38.2792	-108.9240	-2.75	4.3	-0.1	0.8	3.2
5/22/21	10:34:30	38.2783	-108.9225	-3.05	4.6	0.4	1.0	3.1

Date	Time ¹	Latitude (deg.)	Longitude (deg.)	Elevation ² (km)	Depth ³ (km)	M _D ⁴	M _W ⁵	Horizontal Distance from Injection Well (km)
5/25/21	8:19:02	38.4180	-108.9313	-6.01	7.5	1.1	1.3	13.9
5/25/21	23:26:09	38.2768	-108.9202	-1.98	3.5	0.0	0.9	3.1
5/27/21	18:26:01	38.2765	-108.9185	-2.77	4.3	-0.7	0.9	3.0
5/28/21	19:09:17	38.2695	-109.0570	-0.37	1.9	-0.5		14.5
5/29/21	12:19:38	38.2838	-108.9053	-1.76	3.3	1.0	1.1	1.7
6/2/21	20:27:14	38.2862	-108.9005	-1.89	3.4	-0.6		1.2
6/6/21	12:05:17	38.2770	-108.9318	-1.08	2.6	0.3	1.0	3.9
6/6/21	12:17:40	38.2750	-108.9318	-1.74	3.3	-0.1		4.0
6/6/21	22:18:37	38.2748	-108.9303	-1.71	3.2	-0.6		3.9
6/10/21	4:57:06	38.2857	-108.9025	-2.23	3.8	-0.5		1.4
6/10/21	9:33:31	38.2648	-108.9455	-0.54	2.1	-0.6	0.6	5.6
6/11/21	16:35:48	38.2828	-108.9103	-1.82	3.3	-0.3		2.0
6/11/21	18:23:27	38.2832	-108.9085	-2.05	3.6	-0.4		1.9
6/12/21	4:03:37	38.2783	-108.9202	-2.14	3.7	0.4	1.0	3.0
6/12/21	18:45:29	38.2648	-108.8732	-0.72	2.2	-0.7		4.0
6/15/21	15:14:01	38.2783	-108.9212	-2.44	4.0	0.3	1.1	3.1
6/18/21	6:39:47	38.2833	-108.9082	-1.53	3.1	-0.7		1.9
6/18/21	13:04:20	38.2848	-108.9057	-2.39	3.9	0.0	0.7	1.6
6/19/21	15:16:44	38.2850	-108.8993	-2.32	3.8	1.0	1.2	1.3
6/21/21	8:33:35	38.2835	-108.9058	-1.88	3.4	-0.5		1.7
6/21/21	11:40:12	38.2772	-108.9223	-2.07	3.6	0.5	1.1	3.2
6/21/21	13:47:44	38.3023	-108.9207	-2.98	4.5	-0.6		2.3
6/22/21	4:54:35	38.2628	-108.8725	0.61	0.9	0.3	0.6	4.2
6/25/21	4:42:43	38.2837	-108.9083	-2.37	3.9	2.2	1.9	1.8
6/25/21	5:32:11	38.2818	-108.9102	-1.78	3.3	-0.8		2.1
6/26/21	8:50:40	38.2770	-108.9197	-2.20	3.7	-0.1	0.6	3.1
6/28/21	9:05:07	38.2803	-108.9005	-2.64	4.2	1.9	1.7	1.9
6/30/21	3:44:38	38.2847	-108.8988	-1.66	3.2	-0.5		1.4
6/30/21	8:27:30	38.2835	-108.9078	-1.62	3.1	0.6	1.0	1.8
6/30/21	22:49:56	38.2762	-108.9293	-1.62	3.1	-0.6	0.5	3.8
7/1/21	10:50:28	38.2752	-108.9315	-1.86	3.4	0.1		4.0
7/2/21	5:48:27	38.2778	-108.9178	-1.03	2.6	0.4	0.8	2.9
7/2/21	10:44:32	38.2775	-108.9165	-2.62	4.1	-0.4		2.8
7/3/21	12:55:51	38.2830	-108.9072	-2.15	3.7	-0.6		1.8
7/4/21	6:26:29	38.2842	-108.9055	-2.23	3.8	1.1	1.2	1.7
7/6/21	1:02:04	38.2822	-108.9053	-2.10	3.6	-0.1	0.8	1.8
7/6/21	20:49:26	38.2713	-109.0568	-10.30	11.8	0.6	1.3	14.4
7/8/21	8:10:32	38.2808	-108.9222	-2.14	3.7	-0.1	0.8	2.9
7/9/21	4:33:57	38.2778	-108.9218	-1.91	3.4	-0.6		3.1
7/11/21	4:00:28	38.2857	-108.8975	-1.02	2.5	0.0	0.8	1.2
7/13/21	3:18:15	38.2803	-108.9220	-2.73	4.3	-0.7	0.7	3.0
7/15/21	17:47:58	38.2852	-108.8982	-1.52	3.0	-0.5		1.3

Date	Time ¹	Latitude (deg.)	Longitude (deg.)	Elevation ² (km)	Depth ³ (km)	M _D ⁴	M _W ⁵	Horizontal Distance from Injection Well (km)
7/16/21	6:42:38	38.2858	-108.8980	-1.70	3.2	0.3	0.8	1.2
7/16/21	7:33:27	38.2788	-108.9238	-2.08	3.6	-0.5		3.2
7/17/21	16:46:20	38.2847	-108.9003	-2.32	3.8	-0.3		1.4
7/17/21	20:26:23	38.3147	-108.9673	-1.27	2.8	-0.1	0.9	6.6
7/18/21	15:56:28	38.2798	-108.9217	-2.51	4.0	0.2	1.0	3.0
7/19/21	8:02:42	38.2790	-108.9183	-1.55	3.1	0.9	1.3	2.8
7/19/21	8:36:23	38.2783	-108.9192	-1.19	2.7	-0.6		2.9
7/20/21	6:48:56	38.2788	-108.9233	-1.78	3.3	0.1	0.8	3.2
7/22/21	16:31:06	38.2830	-108.8917	-2.60	4.1	-0.4		1.5
7/22/21	17:15:36	38.2788	-108.9192	-2.16	3.7	-0.5	0.6	2.9
7/23/21	18:37:40	38.2868	-108.9023	-1.94	3.5	0.0	0.8	1.3
8/2/21	8:44:49	38.2787	-108.9185	-1.61	3.1	1.4	1.50	2.9
8/2/21	8:45:54	38.2763	-108.9193	-1.65	3.2	-1.2		3.1
8/2/21	10:36:38	38.2813	-108.9118	-1.37	2.9	0.1	0.69	2.2
8/4/21	6:50:26	38.2830	-108.9052	-1.82	3.3	-0.4		1.7
8/4/21	6:50:38	38.2850	-108.9038	-1.95	3.5	-1.0		1.5
8/4/21	11:05:41	38.2832	-108.9028	-2.02	3.5	-0.4		1.6
8/5/21	9:18:18	38.4025	-108.8648	-3.83	5.4	0.1	0.78	12.1
8/5/21	23:57:41	38.2737	-108.9362	-0.43	2.0	-0.1	0.61	4.4
8/9/21	1:01:53	38.2870	-108.8940	-1.89	3.4	-0.2	0.77	1.1
8/9/21	23:32:48	38.2815	-108.9125	-1.83	3.4	-1.1		2.3
8/11/21	7:46:15	38.2783	-108.9203	-1.85	3.4	-0.7		3.0
8/12/21	11:21:42	38.2843	-108.9042	-1.89	3.4	-0.3		1.6
8/12/21	14:30:01	38.2845	-108.9052	-1.80	3.3	-0.5		1.6
8/12/21	17:14:25	38.2785	-108.9232	-2.45	4.0	-0.8		3.2
8/13/21	20:31:54	38.3970	-108.8637	-3.98	5.5	-0.3		11.5
8/14/21	6:53:14	38.2767	-108.9320	-1.41	2.9	-0.7		3.9
8/15/21	6:34:52	38.2848	-108.8968	-1.82	3.3	-0.4	0.64	1.3
8/15/21	11:32:26	38.2833	-108.8952	-1.10	2.6	-0.6		1.5
8/16/21	4:24:23	38.4452	-109.0362	-4.70	6.2	0.7	1.09	20.6
8/18/21	14:44:19	38.5213	-109.0095	-11.28	12.8	0.2		26.9
8/20/21	4:18:20	38.2788	-108.9195	-1.08	2.6	-0.2	0.57	2.9
8/21/21	0:01:35	38.2825	-108.9080	-2.04	3.6	-0.6		1.9
8/21/21	2:45:33	38.2820	-108.9082	-2.14	3.7	2.6	2.20	2.0
8/21/21	2:49:39	38.2817	-108.9087	-1.80	3.3	-0.6		2.0
8/21/21	7:00:53	38.2832	-108.9077	-1.80	3.3	-0.5		1.9
8/21/21	7:33:49	38.2823	-108.9087	-2.10	3.6	1.7	1.61	2.0
8/21/21	12:05:42	38.2817	-108.9070	-1.77	3.3	-0.4		2.0
8/21/21	13:37:42	38.2827	-108.9090	-1.90	3.4	-0.7		2.0
8/23/21	3:13:35	38.2607	-108.9857	0.32	1.2	-0.3		8.9
8/24/21	6:28:59	38.2815	-108.9083	-1.82	3.3	-0.2	0.61	2.0
8/24/21	12:31:24	38.2722	-108.8897	-0.76	2.3	-0.2	0.54	2.7

Date	Time ¹	Latitude (deg.)	Longitude (deg.)	Elevation ² (km)	Depth ³ (km)	M _D ⁴	M _W ⁵	Horizontal Distance from Injection Well (km)
8/26/21	7:45:49	38.2775	-108.8320	-2.30	3.8	0.1	0.53	5.9
8/28/21	11:35:48	38.1913	-108.7308	-4.12	5.6	0.2	0.41	18.5
8/28/21	15:44:10	38.2077	-108.7223	-4.70	6.2	0.2		18.0
8/29/21	1:15:22	38.2890	-108.9232	-1.68	3.2	0.1	0.96	2.6
8/30/21	2:20:02	38.2785	-108.9192	-1.09	2.6	0.1	0.63	2.9
8/30/21	20:17:56	38.1958	-108.7213	-7.24	8.8	-0.3		18.9
8/31/21	6:56:50	38.2770	-108.9170	-2.64	4.2	1.4	1.33	2.9
8/31/21	7:34:33	38.2767	-108.9200	-2.92	4.4	2.0	1.78	3.1
8/31/21	13:10:53	38.2005	-108.7195	-4.04	5.6	0.0		18.7
9/1/21	1:38:47	38.2845	-108.8950	-1.95	3.5	1.2	1.20	1.3
9/2/21	4:22:08	38.2017	-108.7257	-4.46	6.0	1.0		18.2
9/2/21	12:55:03	38.2840	-108.9035	-1.90	3.4	0.1	0.81	1.6
9/4/21	11:04:43	38.4415	-108.9718	-4.89	6.4	1.2	1.06	17.4
9/4/21	12:00:50	38.2743	-108.9360	0.07	1.5	1.6	1.61	4.4
9/4/21	12:33:27	38.2763	-108.9307	-1.31	2.8	1.1	1.27	3.8
9/4/21	12:35:17	38.2770	-108.9310	-1.38	2.9	-0.2		3.8
9/4/21	14:12:00	38.2847	-108.9055	-1.89	3.4	-0.3		1.6
9/5/21	3:26:26	38.2773	-108.9228	-2.64	4.2	1.7	1.61	3.2
9/5/21	9:42:43	38.2748	-108.9315	-1.68	3.2	0.2	0.98	4.0
9/6/21	3:09:46	38.2767	-108.9248	-2.38	3.9	1.3	1.33	3.4
9/6/21	14:07:18	38.2045	-108.7200	-4.17	5.7	-0.1		18.4
9/6/21	17:10:02	38.2852	-108.9007	-2.05	3.6	-0.6		1.4
9/6/21	21:02:50	38.2112	-108.7225	-4.36	5.9	-0.3	0.84	17.8
9/7/21	5:33:44	38.2818	-108.9082	-1.41	2.9	-0.7		2.0
9/7/21	16:09:37	38.2883	-108.9017	-1.92	3.4	-1.2		1.1
9/7/21	16:09:37	38.2860	-108.9030	-2.10	3.6	-0.5		1.4
9/7/21	17:02:26	38.2788	-108.9195	-2.01	3.5	-0.6	0.67	2.9
9/7/21	21:42:36	38.2850	-108.8983	-1.66	3.2	0.0	0.84	1.3
9/10/21	1:41:51	38.3433	-108.8858	-3.80	5.3	-0.2		5.3
9/10/21	10:12:39	38.2830	-108.9035	-2.93	4.5	-0.5		1.7
9/10/21	15:15:45	38.1987	-108.7232	-4.01	5.5	0.0		18.5
9/12/21	21:03:05	38.2777	-108.9222	-2.42	3.9	-0.6		3.2
9/15/21	3:43:31	38.2760	-108.9185	-2.99	4.5	-0.2	0.81	3.1
9/18/21	15:41:53	38.2040	-108.7232	-4.29	5.8	1.1	0.96	18.2
9/18/21	15:48:31	38.2020	-108.7217	-4.26	5.8	0.0		18.4
9/19/21	10:52:49	38.2762	-108.9163	-3.03	4.6	0.0		2.9
9/19/21	13:15:45	38.2775	-108.9237	-2.40	3.9	2.3	2.16	3.3
9/30/21	4:24:56	38.2747	-108.9170	-2.34	3.9	-1.2		3.1
10/1/21	13:12:52	38.2780	-108.9123	-1.43	3.0	-0.1	0.74	2.6
10/1/21	13:14:22	38.2780	-108.9115	-1.52	3.0	-0.7		2.5
10/5/21	12:08:35	38.2783	-108.9200	-1.82	3.3	0.0	0.94	3.0
10/5/21	17:06:56	38.2865	-108.8992	-1.74	3.3	-0.6		1.2

Date	Time ¹	Latitude (deg.)	Longitude (deg.)	Elevation ² (km)	Depth ³ (km)	M _D ⁴	M _W ⁵	Horizontal Distance from Injection Well (km)
10/5/21	17:30:57	38.2783	-108.9215	-1.91	3.4	0.1	0.86	3.1
10/6/21	19:11:11	38.2850	-108.8920	-2.13	3.7	-0.7		1.3
10/7/21	5:23:40	38.2858	-108.8963	-1.60	3.1	-1.2		1.2
10/8/21	4:22:11	38.2783	-108.9210	-1.87	3.4	0.6	1.07	3.0
10/9/21	4:30:02	38.2870	-108.8925	-2.08	3.6	0.0	1.09	1.1
10/10/21	2:28:36	38.2052	-108.7238	-4.54	6.1	1.1	1.19	18.1
10/10/21	2:29:01	38.2023	-108.7252	-4.46	6.0	0.5	1.19	18.2
10/10/21	3:10:41	38.2848	-108.9030	-1.95	3.5	-0.5		1.5
10/10/21	4:17:06	38.2042	-108.7242	-4.48	6.0	0.0		18.1
10/10/21	7:10:30	38.2780	-108.9202	-1.83	3.4	0.0	0.87	3.0
10/11/21	9:03:04	38.2022	-108.7225	-4.41	5.9	0.7	0.81	18.4
10/15/21	15:23:54	38.2838	-108.9047	-1.80	3.3	0.0		1.6
10/16/21	12:57:57	38.2773	-108.9208	-1.77	3.3	-0.3	0.88	3.1
10/16/21	14:01:34	38.2790	-108.9192	-2.01	3.5	-0.4	0.86	2.9
10/16/21	19:22:15	38.2793	-108.9195	-1.71	3.2	0.2	0.92	2.9
10/19/21	7:08:42	38.2865	-108.9037	-2.14	3.7	-0.4		1.3
10/22/21	1:34:44	38.2820	-108.9013	-1.78	3.3	0.0	0.99	1.7
10/23/21	6:52:04	38.2758	-108.9262	-2.59	4.1	-0.7		3.6
10/24/21	5:06:03	38.2888	-108.8983	-2.10	3.6	-0.5		0.9
10/24/21	19:27:32	38.2797	-108.9198	-2.21	3.7	0.0	1.04	2.9
10/27/21	7:26:02	38.2808	-108.9077	-1.80	3.3	-0.5		2.1
10/28/21	10:45:10	38.2805	-108.9217	-2.35	3.9	-0.4		2.9
10/28/21	12:01:38	38.2850	-108.9050	-2.10	3.6	0.0		1.6
10/30/21	5:32:17	38.2785	-108.9185	-2.20	3.7	0.3	0.89	2.9
10/30/21	20:05:22	38.2835	-108.9022	-2.08	3.6	-0.1		1.6
11/3/21	11:36:18	38.3907	-109.0188	-6.35	7.9	1.1	1.24	15.1
11/3/21	23:39:44	38.2852	-108.8947	-2.44	4.0	-0.4		1.3
11/3/21	23:47:01	38.3117	-108.7317	-9.18	10.7	1.5	1.66	14.4
11/5/21	3:56:24	38.2798	-108.9118	-1.43	3.0	-0.7		2.4
11/5/21	6:36:12	38.3978	-108.8958	-0.28	1.8	1.2	1.55	11.2
11/5/21	6:45:40	38.4043	-108.9063	-0.08	1.6	0.1	0.55	12.0
11/6/21	5:18:17	38.2795	-108.9208	-2.37	3.9	0.4	1.00	2.9
11/6/21	5:19:03	38.2802	-108.9218	-2.24	3.8	-0.3		3.0
11/15/21	5:54:22	38.2625	-108.8702	-1.09	2.6	-0.2	0.82	4.4
11/20/21	9:17:27	38.2778	-108.9215	-2.31	3.8	0.0	0.89	3.1
11/21/21	10:33:04	38.2767	-108.9197	-2.86	4.4	1.9	1.81	3.1
11/21/21	14:08:57	38.2842	-108.9032	-2.53	4.1	0.0	1.05	1.5
11/21/21	14:09:13	38.2845	-108.9053	-2.49	4.0	-0.8		1.6
11/22/21	1:07:48	38.3420	-108.8875	-3.94	5.5	1.7	1.63	5.1
11/22/21	11:12:19	38.2850	-108.9022	-2.40	3.9	-0.4		1.4
11/22/21	11:12:36	38.2867	-108.9017	-2.19	3.7	-1.3		1.2
11/22/21	23:43:00	38.4030	-109.0140	-3.48	5.0	0.3	0.92	15.7

Date	Time ¹	Latitude (deg.)	Longitude (deg.)	Elevation ² (km)	Depth ³ (km)	M _D ⁴	M _W ⁵	Horizontal Distance from Injection Well (km)
11/25/21	21:34:12	38.2832	-108.9080	-1.96	3.5	-0.5		1.9
11/27/21	2:05:15	38.2572	-108.8733	-0.32	1.8	-0.1	0.65	4.8
11/28/21	9:14:20	38.2777	-108.9220	-2.46	4.0	1.9	1.71	3.2
11/29/21	9:01:09	38.2775	-108.9218	-2.11	3.6	-0.3		3.2
12/2/21	13:28:44	38.2840	-108.9068	-1.41	2.9	-0.7		1.7
12/2/21	13:41:16	38.2832	-108.9065	-1.56	3.1	-0.6		1.8
12/2/21	20:00:48	38.2848	-108.9062	-2.04	3.6	0.6	1.08	1.6
12/5/21	12:35:31	38.3143	-108.9658	-1.21	2.7	0.4		6.5
12/8/21	10:01:01	38.2835	-108.9065	-1.75	3.3	-0.9		1.8
12/9/21	3:09:31	38.3523	-108.6902	-8.59	10.1	1.5	1.68	19.0
12/11/21	6:24:31	38.3407	-108.8938	-4.03	5.6	0.7	1.23	4.9
12/12/21	1:33:37	38.4385	-108.9717	-3.84	5.4	1.1	1.35	17.1
12/12/21	18:39:57	38.2695	-109.0500	-0.70	2.2	-0.3		13.9
12/13/21	4:08:15	38.2872	-108.9000	-2.06	3.6	0.1		1.1
12/14/21	14:53:13	38.2825	-108.9207	-2.18	3.7	-0.7		2.7
12/17/21	0:53:09	38.2898	-108.8990	-2.23	3.8	-0.4		0.8
12/17/21	0:53:40	38.2875	-108.9008	-2.24	3.8	-0.7		1.1
12/17/21	22:30:01	38.2833	-108.9088	-1.86	3.4	0.1		1.9
12/18/21	9:12:01	38.2678	-108.8638	-1.46	3.0	-0.5	0.69	4.2
12/20/21	21:43:09	38.2790	-108.9230	-1.98	3.5	-0.4		3.1
12/22/21	9:08:07	38.2817	-108.9057	-2.50	4.0	-0.4		1.9
12/26/21	6:44:44	38.2732	-108.9280	-0.35	1.9	-0.4	0.82	3.9
12/27/21	7:09:25	38.2978	-108.7332	-7.06	8.6	0.2		14.2

¹ Time listed is Coordinated Universal Time, UTC (Mountain Standard Time = UTC – 7 hours; Mountain Daylight Savings Time = UTC – 6 hours)

² Elevation is given with respect to mean sea level.

³ Depth is referenced to the surveyed ground elevation at the injection wellhead, 1.524 km.

⁴ Reclamation-computed duration magnitude

⁵ Reclamation-computed moment magnitude

TABLE 3: Earthquake summary for 2021

Location Category	Number of Earthquakes	Magnitude Range (M _D)	
		M _{min}	M _{max}
Shallow near-well	275	-1.3	2.6
Shallow intermediate	17	-0.9	1.7
Shallow distant	61	-0.5	1.7
Deep	5	-0.5	1.5
TOTAL SHALLOW	353	-1.3	2.6
TOTAL	358	-1.3	2.6

PVSN recorded 19 local earthquakes during December: 14 shallow events (depth ≤ 10 km) within 5 km of the injection well, one shallow event between 5 and 10 km from the well, three shallow events more than 10 km from the well, and one event with depth > 10 km (Table 2, Figure 1). Four of the earthquakes have duration magnitude (M_D) ≥ 0.5 , the approximate PVSN detection completeness threshold. The maximum earthquake magnitude observed during the month was M_D 1.5. (Maximum moment magnitude was M_W 1.7.)

The magnitudes of the 14 near-well events range from M_D -0.9 to M_D 0.7. Only two of these events have $M_D \geq 0.5$. Most of the near-well events recorded during December occurred either in the immediate vicinity of March 2019 M_W 4.5 earthquake rupture plane or 1 to 2 km southwest of the rupture plane (in an area that experienced increased seismicity rates and magnitudes in late 2020; Figure 2). One of the earthquakes occurred 4.9 km north of the injection well, beneath central Paradox Valley (Figure 1). This event occurred at an estimated depth of 5.6 km and has a computed duration magnitude of M_D 0.7.

The single shallow event at an intermediate distance from the injection well occurred 6.5 km northwest of the injection well (Figure 2). This event has a depth estimate of 2.7 km and magnitude of M_D 0.4.

The three shallow events more than 10 km from the injection well occurred at various azimuths from the well (Figure 1). An event with a magnitude of M_D -0.3 occurred 13.9 km west of the well, at an estimated depth of 2.2 km. An event with a magnitude of M_D 1.1 occurred 17.1 km northwest of the well (north of Paradox Valley), at an estimated depth of 5.4. The third shallow event in this distance range occurred 14.2 km east of the injection well. This event has a magnitude of M_D 0.2 and depth estimate of 8.6 km.

The single event with a depth > 10 km occurred 19.0 km east of the injection well (east of Paradox Valley; Figure 1). This event has a magnitude of M_D 1.5 and depth estimate of 10.1 km.

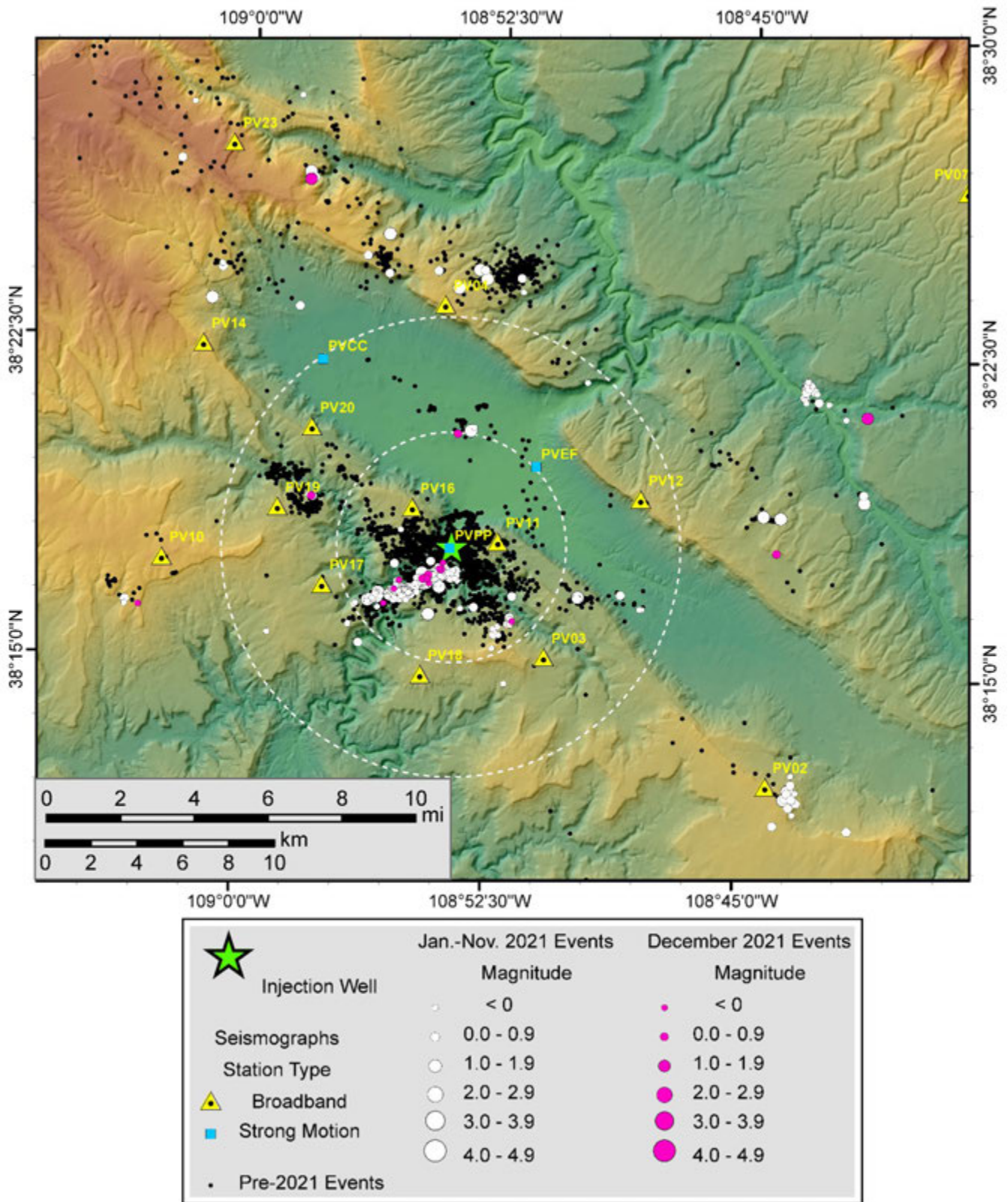


Figure 1: Regional map of PVSN seismicity. The dashed white circles indicate radial distances of 5 km and 10 km from the injection well.

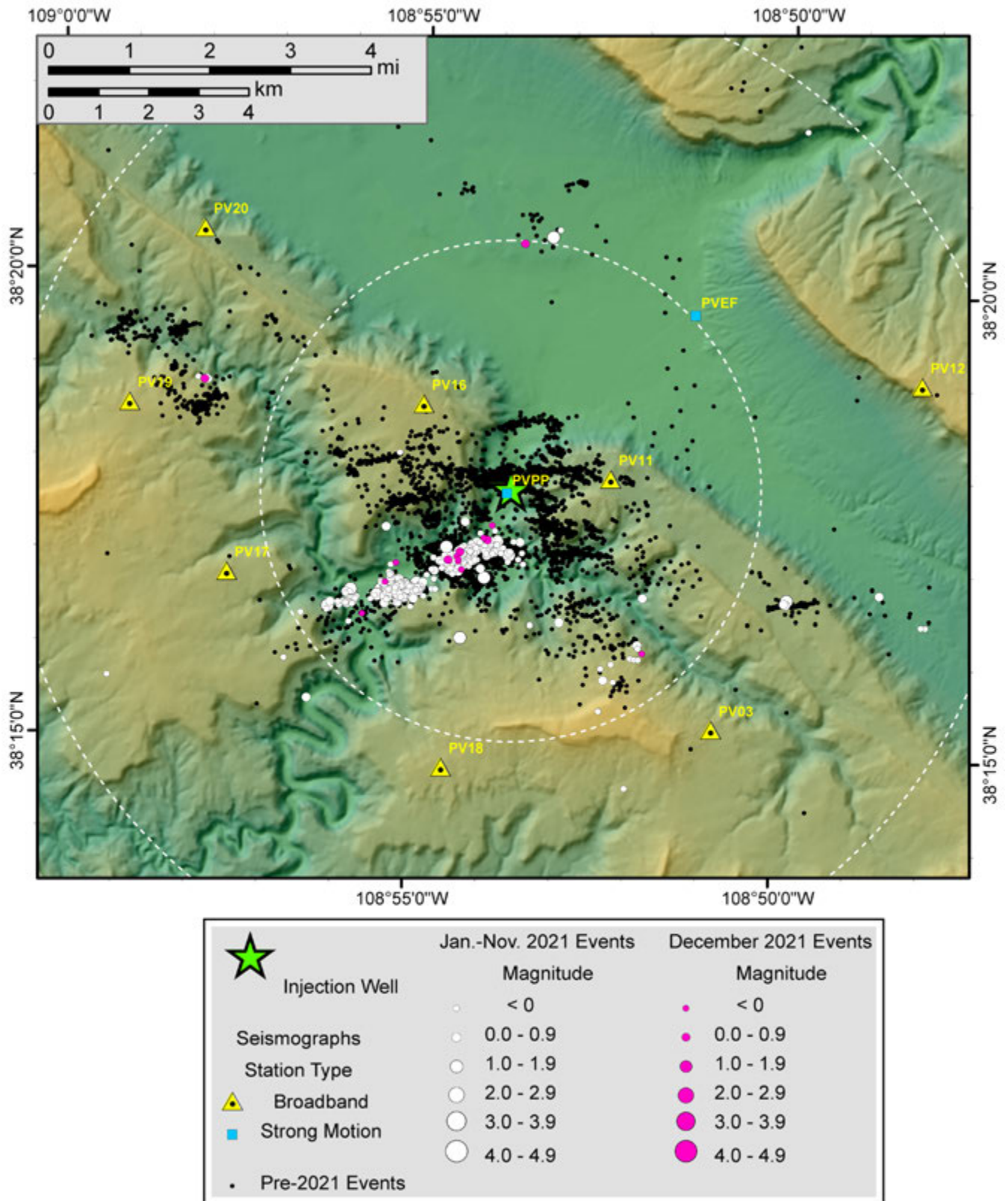


Figure 2: Near-wellbore map of PVSN seismicity. The dashed white circles indicate radial distances of 5 km and 10 km from the injection well.

2020-2021 Seismicity as a Function of Date and Earthquake Magnitude

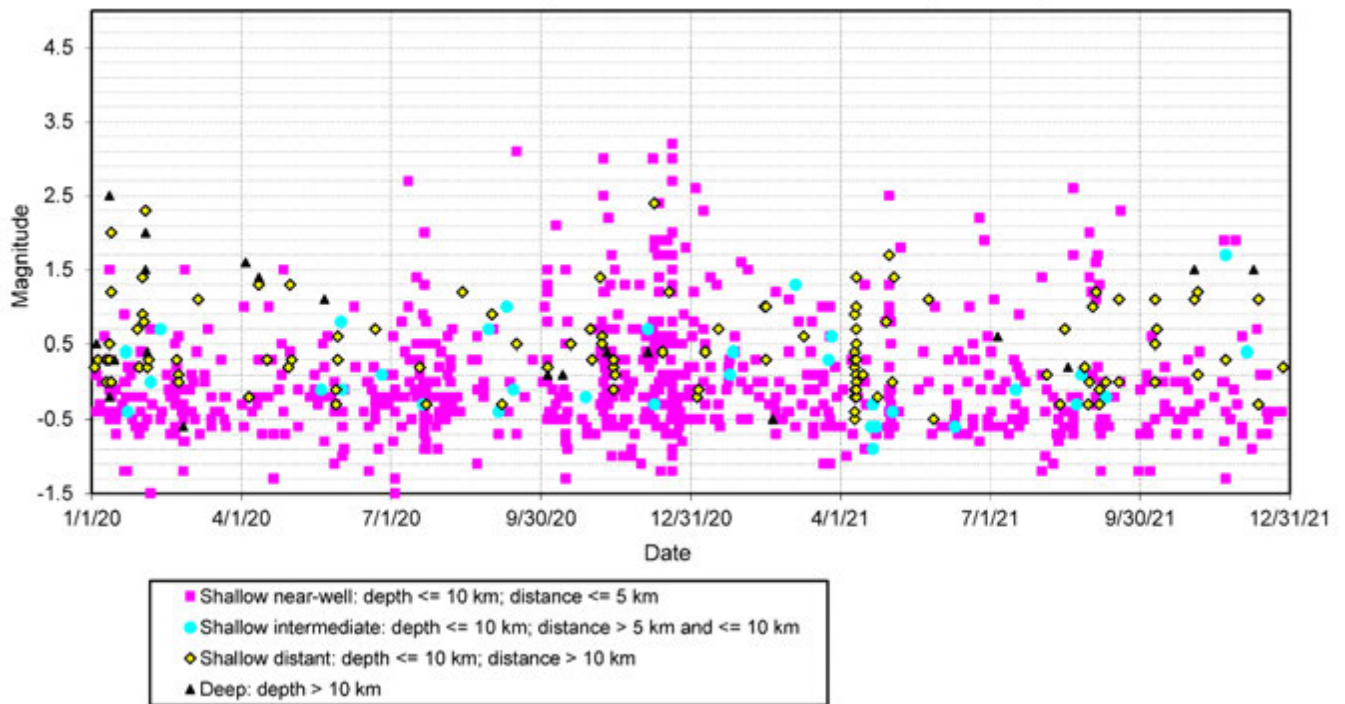


Figure 3: Seismicity recorded during 2020-2021, plotted as a function of date, earthquake magnitude, and event location category.

Running 12-Month Event Counts

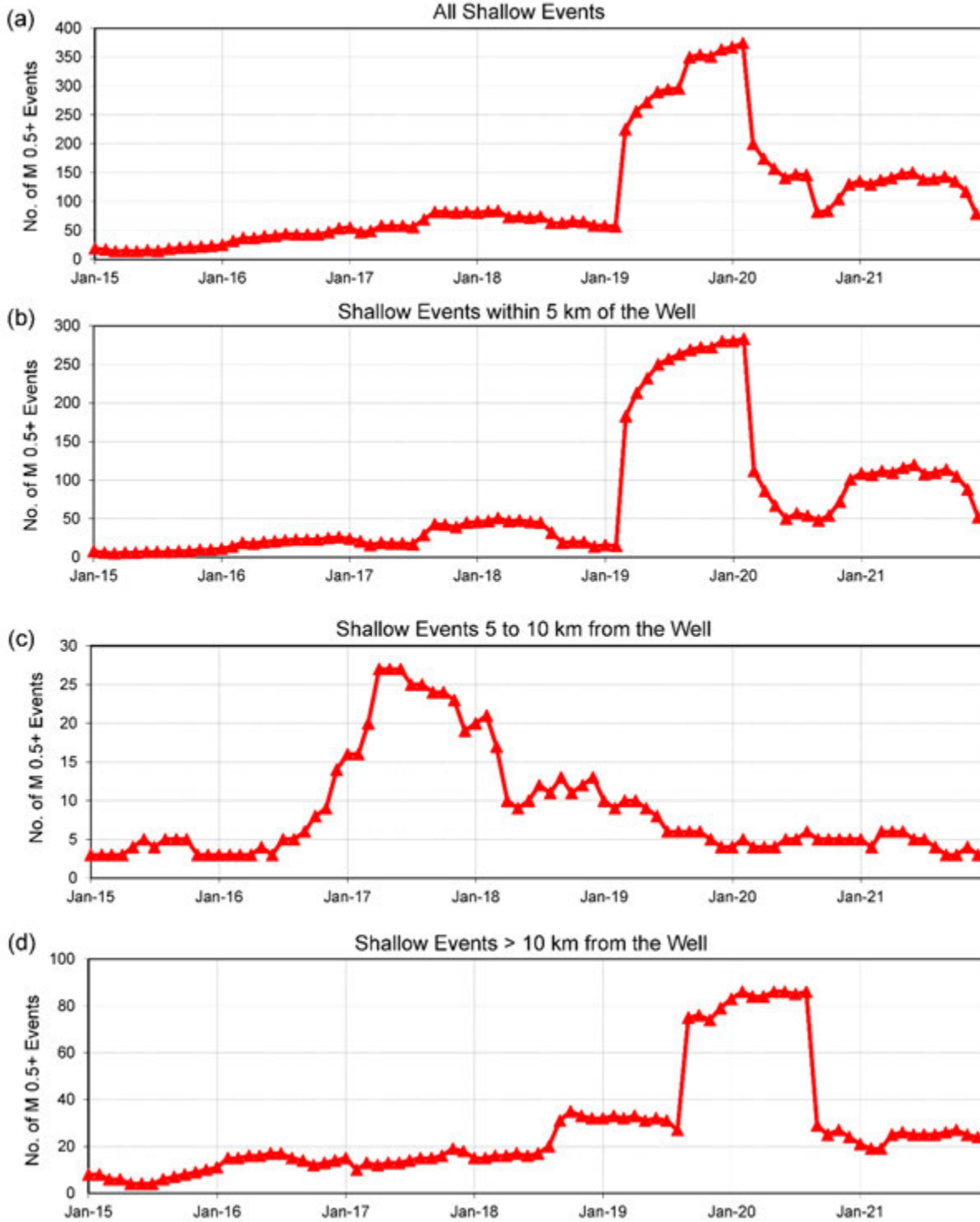


Figure 4: Annual running event counts for earthquakes with depth ≤ 10 km and magnitude ≥ 0.5 : (a) all events, (b) events ≤ 5 km from the injection wellhead, (c) events > 5 km and ≤ 10 km from the well, and (d) events > 10 km from the injection well. Each point on a graph corresponds to the number of events (with depth ≤ 10 km and $M_D \geq 0.5$) recorded in the preceding 12-month period.