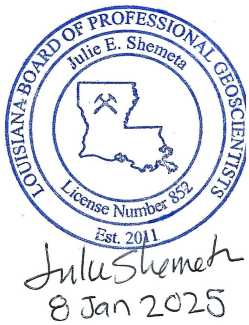
Microseismic Monitoring Report
Sulphur Mines Salt Dome
Borehole and Surface Seismic Arrays



Report Period : December 1-31, 2024
Report Date: January 8, 2025

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Using results from Baker Hughes and Nanometrics

Seismic Monitoring Update

Please take note of upcoming modifications regarding the seismic monitoring and data processing at Sulphur Mines salt dome: the borehole and surface seismic arrays data will be combined for microseismic event processing.

The following actions are underway:

- Nanometrics will continue acquisition using the surface seismic array.
- Baker Hughes will have real-time access to the surface array waveform data for integration into the borehole waveform data for processing the microseismic location and magnitude estimates.
- Baker Hughes will provide event locations and magnitudes for all seismic events at Sulphur Mines Salt Dome using the combined borehole arrays and surface array waveform data.
- Event locations using the surface array only will no longer be provided.
- Estimated date change for processing modifications- The seismic monitoring changes are anticipated to in January 2025.

Alert Level Status: Normal (Green)

1. **Summary Borehole Array Summary December 2024**

- 93 events were detected in December on the borehole seismic arrays located in PPG Well No. 006-X and PPG Well No. 020; 38 located microseismic events and 55 seismic detections.
  - The largest event in December was in the AOI near cavern LGS 02 on December 3 at 20:51:19 CST. The borehole array determined an event magnitude of -0.3, and located the event near the western side of the LGS 02 cavern at 3150 feet depth. This event was also detected and located on the surface array, which assigned a magnitude of -0.24.
- 3 events were located on the surface array, co-located on the borehole array.

a. Borehole Seismic Arrays

Baker Hughes "Microseismic Services" group operates and processes data for the borehole seismic arrays located in PPG Well No. 006-X and PPG Well No. 020. The seismic array locations are shown in Figure 1 and the sensor coordinates are listed in the Appendix, Table 2. Both of the borehole arrays were fully functional in December 2024.

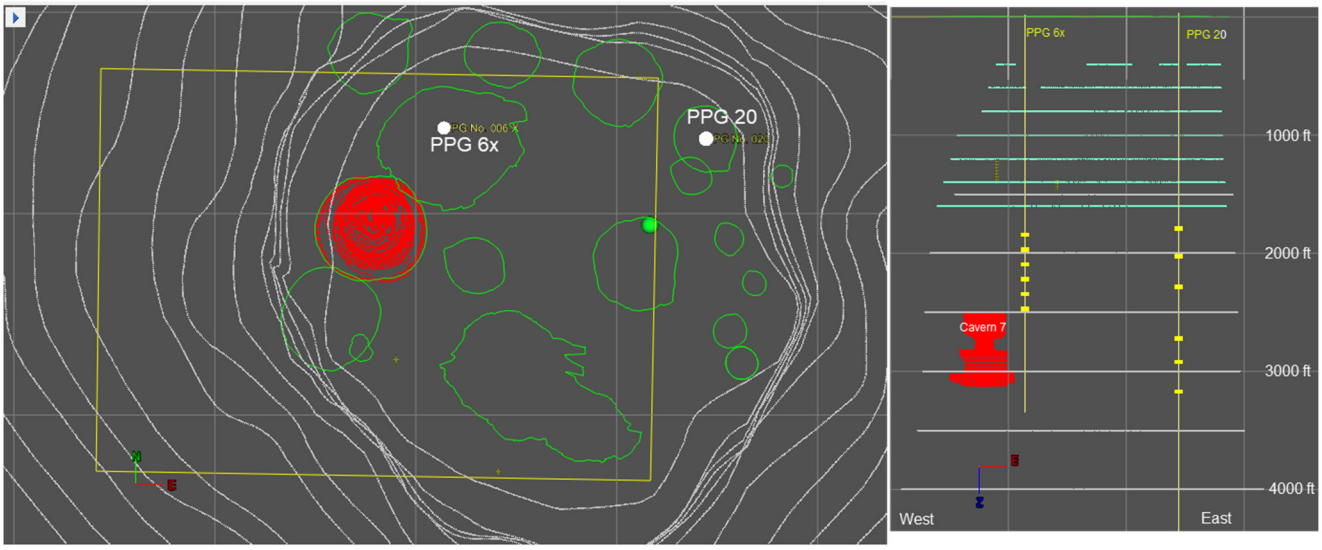

Figure 1. Map (left) and West-East cross section (looking from south) of the Sulphur Mines Salt Dome. The salt boundary is indicated by gray contour lines in map and side view. The borehole microseismic arrays are labeled and the various cavern are outlined in green in map view. In cross section the wellbores with the borehole array sensors are marked by yellow vertical line and yellow markers show the geophone positions in depth for PPG No. 006X and PPG No. 020. Cavern 7 is shown by a red sonar survey in both figures. The proposed AOI is indicated in map view by the yellow square. The grid is 1000 feet.

b. December 2024 Microseismic Activity (using the borehole seismic arrays).

93 seismic events were detected in December 2024 using the borehole seismic arrays. 39 events had waveforms with adequate signal to noise levels to compute an event location and magnitude. The December 2024 microseismic event catalog is listed in the Appendix in Table 4. The remaining event-detected waveforms are too poor quality to determine an event location and magnitude.

Each seismic detection is classified as shallow or deep, depending on where the seismic energy arrives along the array. Seismic energy arriving from below the array is classified as a "deep" detection and energy arriving from above the array as "shallow" detection.

The December 2024 temporal distribution of located and detected microseismic events is shown in Figure 2. Two clusters of microseismic activity occurred in December, one near PPG 02 cavern, with seven events on December 1nd from 22:19-22:19, depths ranging from 2710 to 2922 feet and median magnitude -1.5; and a second on December 30th, 4 events on the ESE flank of the dome outside the AOI at 10:51 with median magnitude -1.2, the depths are estimated from about 3650 to 4042 ft.

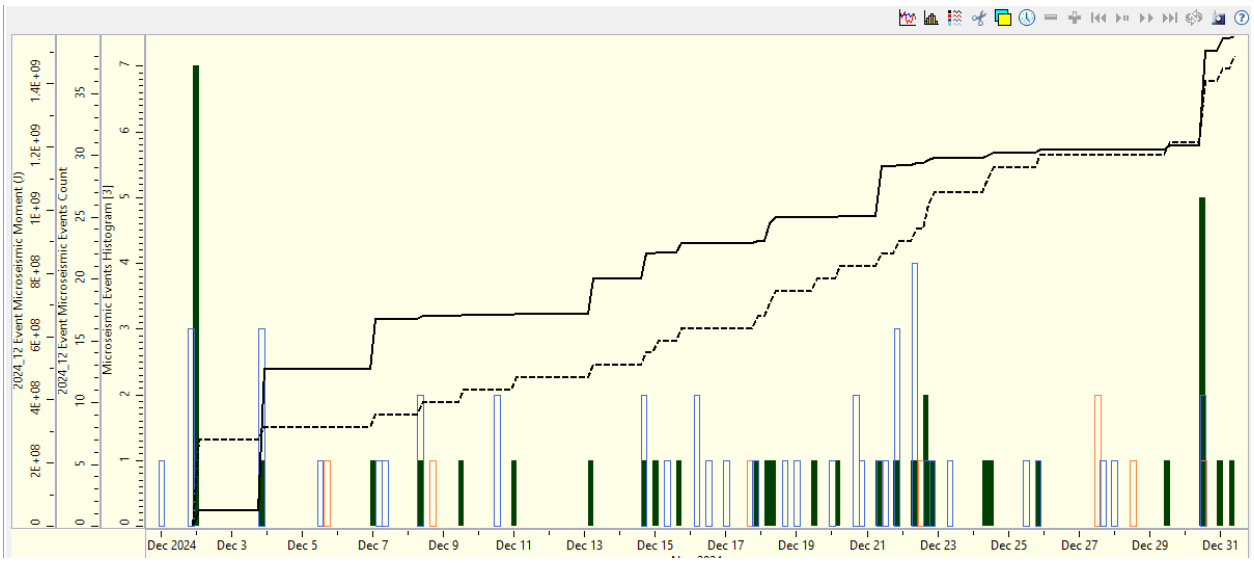

Figure 2. Temporal distribution of microseismic detections and locations in December 2024 recorded at Sulphur Mines salt dome with the borehole arrays. The histograms indicate the number of events in a four-hour time window. The event detections are unfilled boxes, where blue indicates a deep detection (seismic energy is emulating from below the seismic array) and orange indicates is a shallow event detection (seismic energy is coming from above the seismic array). The located events time distribution is indicated by filled dark green boxes. Black line shows the cumulative seismic moment and the black dotted line is cumulative number of the located seismic events.

The location of the microseismicity located in December is shown in Figures 3 (map view) and Figure 4 (cross section view). In general, the microseismicity scatter on the flanks of the northern, southern and eastern dome flanks. One event is located to about 2000 feet south of the dome edge (Figure 3). Interior to the Sulphur Mines salt dome, caverns with proximal seismic activity in December are:

- PPG 02 eight events
- LGS 02 three events, including the largest event located in Dec., a magnitude -0.3 event.
- PPG 06 two events

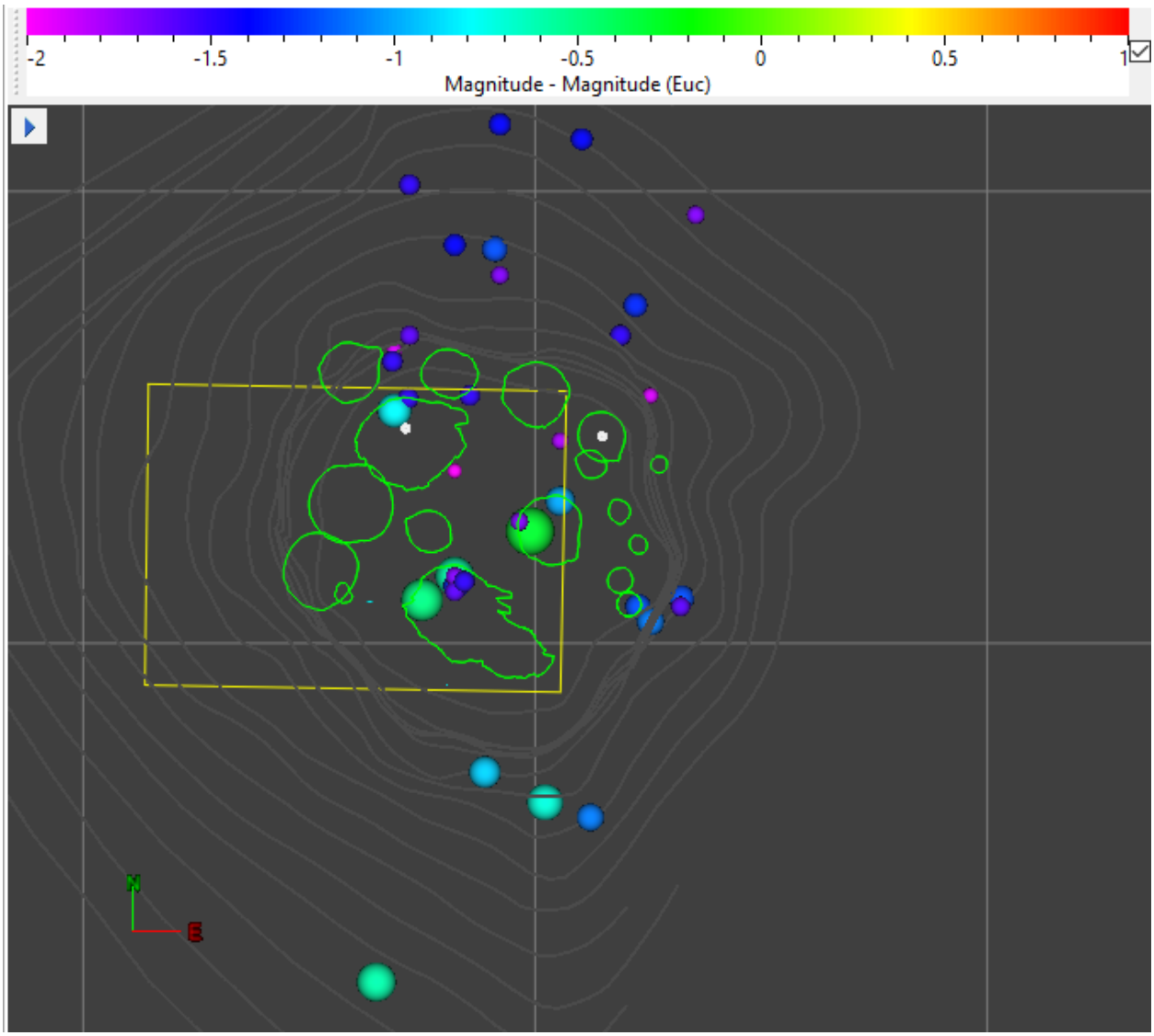

Figure 3. Map of the December 2024 borehole microseismic events colored and sized by magnitude. The locations and magnitudes were computed using data from the borehole seismic arrays in PPG No. 006X and PPG No. 020 (labeled). Grid is 3000 ft. The yellow box is the proposed AOI, the light gray lines are the salt dome contours.

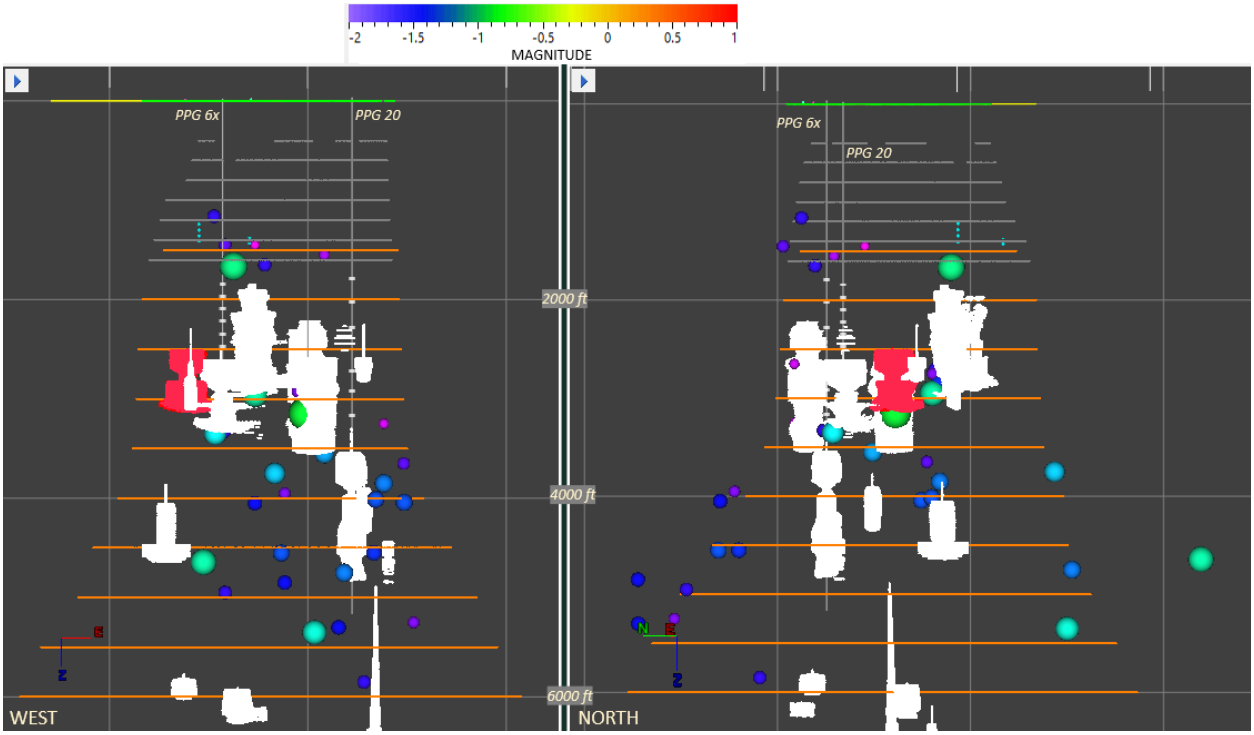

Figure 4. The December 2024 microseismic locations shown in depth view. The cross sections W-E (left), looking from south; and N-S (right), looking from west. The microseismic events are sized and colored by magnitude. The salt (dark orange) and caprock (gray) boundaries are indicated by dots. The various salt caverns as mapped by sonar are shown within the salt. Geophone locations are indicated by hash marks, PPG 20 and PPG 6x well labeled. Grid is 2000 ft.

The December microseismic magnitudes range from -2.0 to -0.3 with a median magnitude of -1.5 (Figure 5). The largest event was on Dec. 3 at 20:51, near the western side of LGS 02 cavern at 3150 ft depth, the LGS 02 event is one of the largest magnitude events recorded on the borehole array, a June event near Cavern 6 has the same borehole magnitude and a slightly larger surface array magnitude.

The depth distribution in December is from 1162 to 5850 ft subsea, with a median depth of 3340 ft subsea (Figure 5).

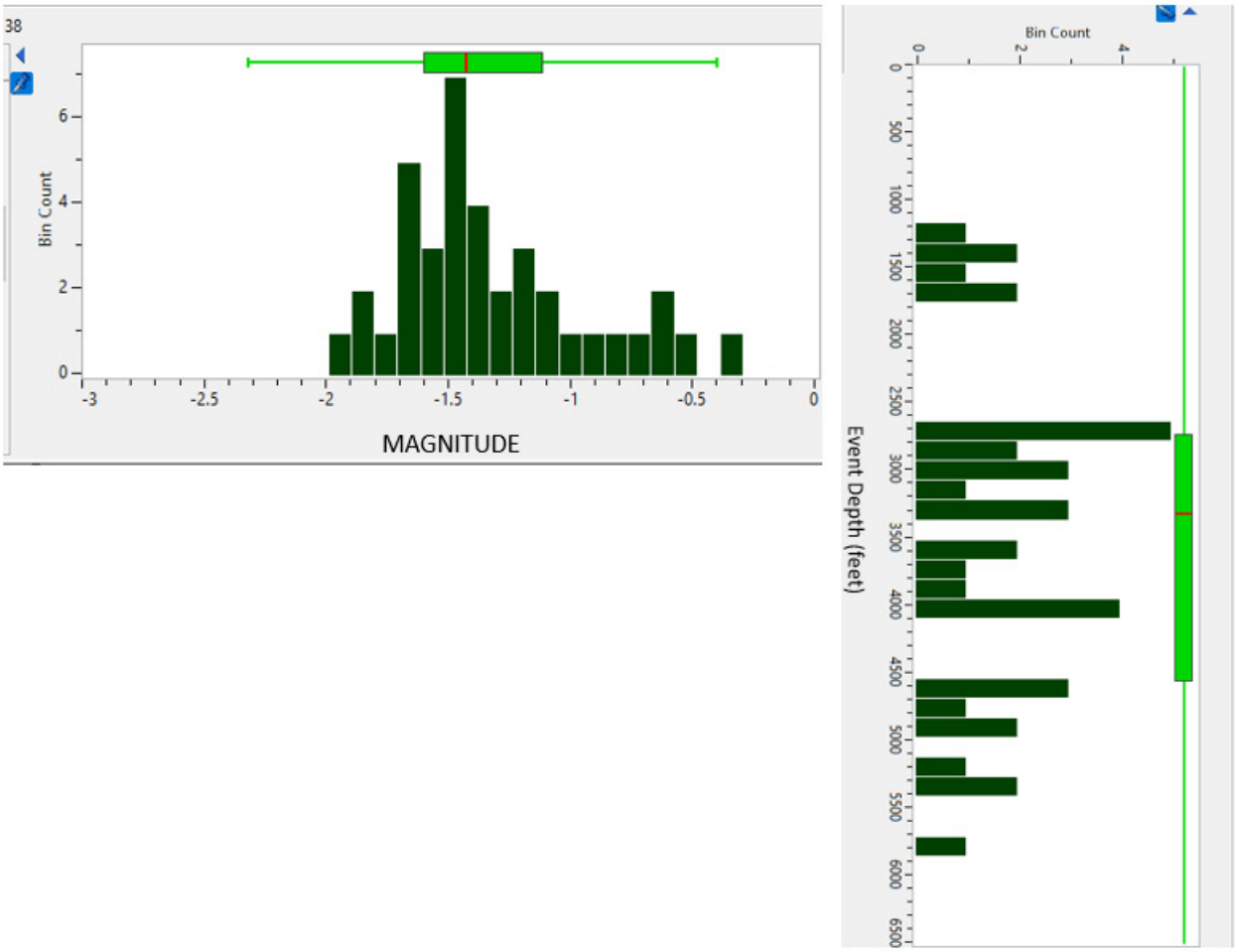

Figure 5. The magnitude distribution (left) and depth distribution (right) for microseismic activity in December 2024.

c. **AOI Microseismic activity using borehole seismic arrays.**

17 events are located in the proposed AOI in December 2024 (Figures 6 and 7). Four of the AOI events are located in cap rock. The remaining 13 AOI events were in proximity to salt caverns: PPG 02 (8 events), LGS 02 (3 events), and 2 events near PPG 06. The microseismic activity near PPG 02 and LGS 02 is discussed below.

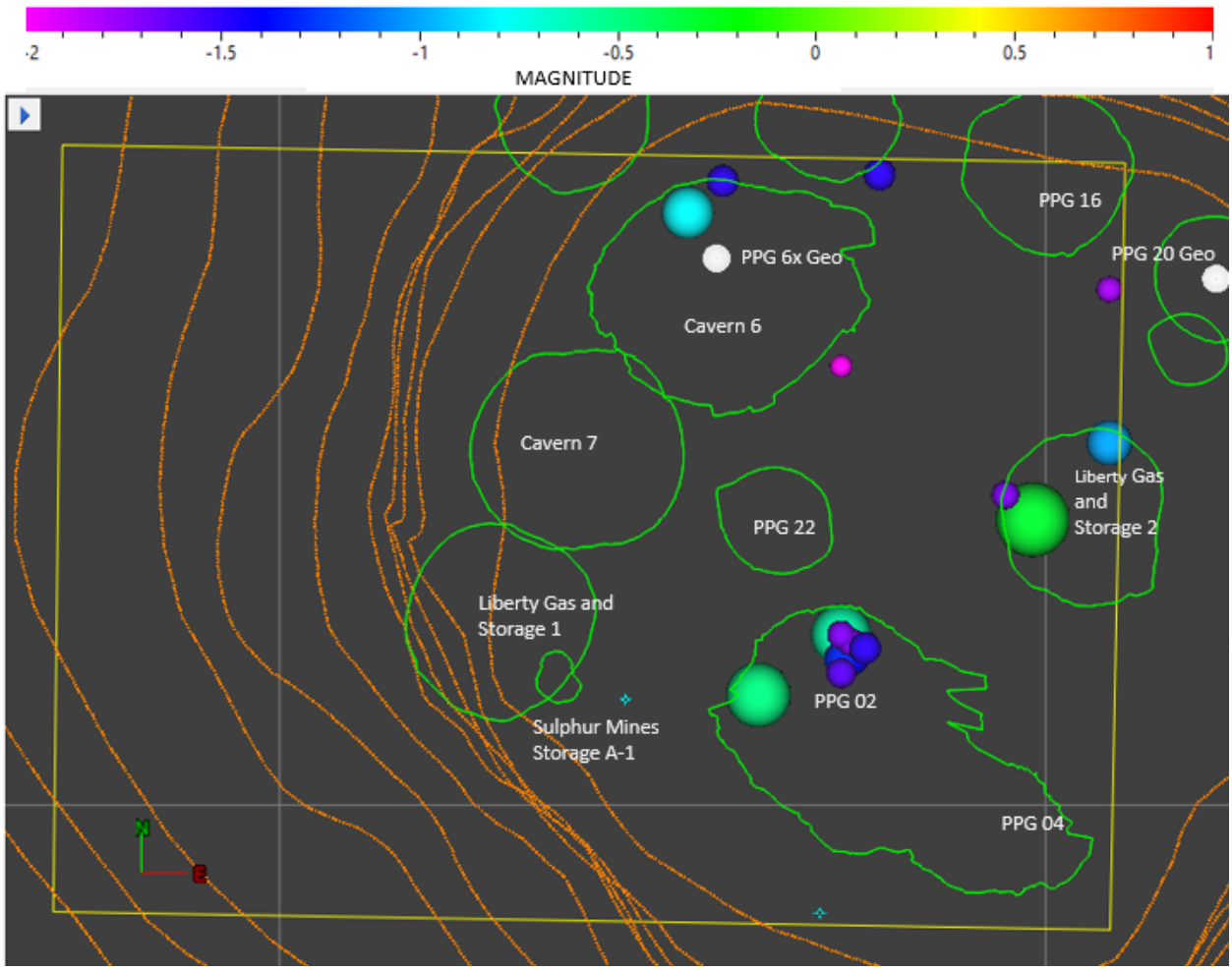

Figure 6. Map view of microseismic activity in December 2024 shown by colored dots in the proposed AOI (yellow box). The events are sized and colored by magnitude. The salt contours are shown by orange lines, cavern outlines by green lines. Grid is 2000 feet. The geophone wells are labeled.

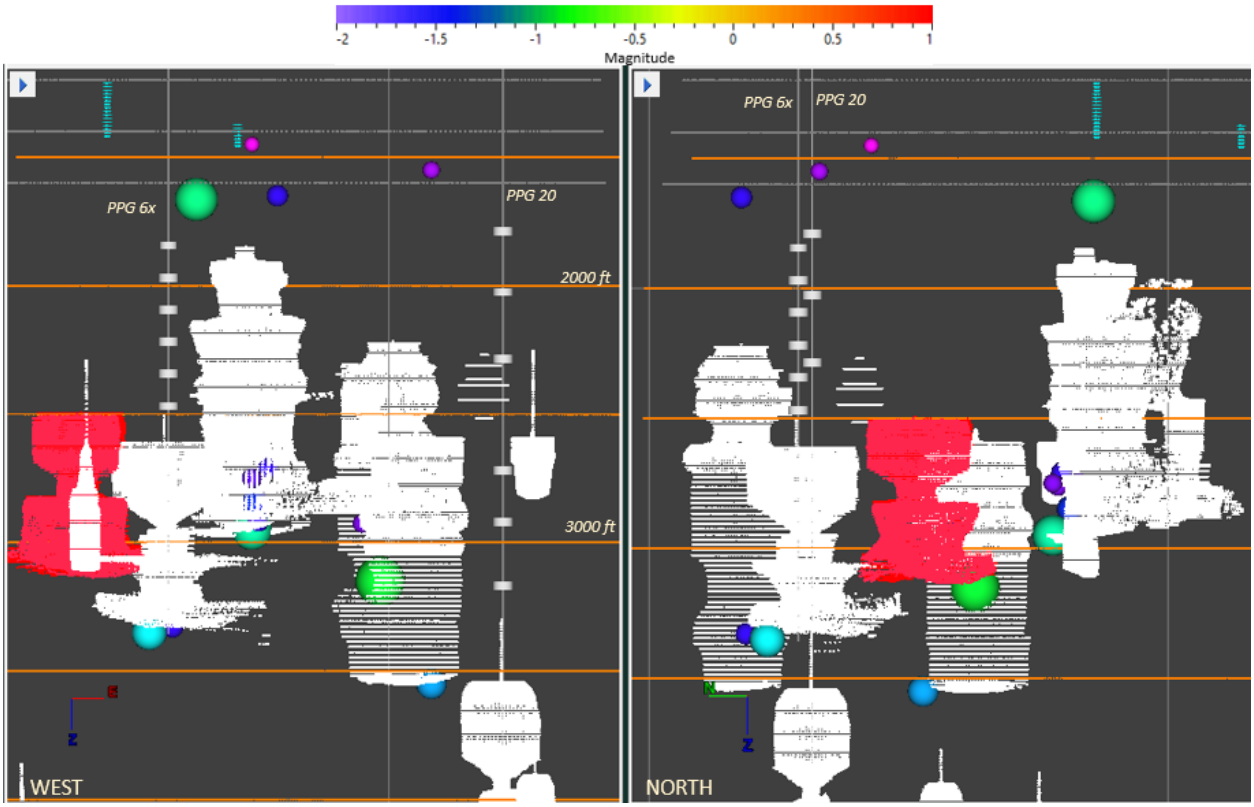

Figure 7. Vertical cross sections with the December 2024 microseismic events located in the proposed AOI with cavern sonars. Left cross section is oriented west–east (looking from the south) and the left figure is north-south (looking from west). Microseismic events are shown by colored dots, sized and colored by magnitude. Grid is 2000 feet. Salt boundary is shown in (orange), cap rock in gray. Cavern sonars are indicated by white dots, cavern 7 sonar is shown in red. The borehole geophone locations are indicated by hash marks, PPG 20 and PPG 6x wells are labeled.

LGS 02 and PPG 02 activity in December 2024. Figure 8 is an oblique depth view of the microseismic activity located near LGS 02 and PPG 02. A summary of this microseismic activity is below:

- PPG 02: All but one of the 8 events near PPG 02 cavern occurred on December 1 from 22:17 to 22:19 CST, as mentioned above. The remaining PPG 02 event, a magnitude -0.6, the largest of the PPG 02 activity in December, occurred on December 21 at 9:43 CST (Figure 8).

- LGS 02: Three events near the LGS 02 cavern occurred in December. The largest of the three events was a magnitude -0.3 on December 3 at 20:51 CST, located on the western side of the cavern at 3150 ft depth (Figure 8). The event was co-recorded on the surface array, which reported a magnitude -0.24.
    - The December 3 event at LGS 02 is the largest event recorded at Sulphur Mines in December and one of the largest magnitude events recorded using the borehole arrays since the start of the recording in April, a June 2024 event located near Cavern 6 has the same borehole magnitude and a larger surface array magnitude.

Refer to the event catalog in the Appendix Table 4 for details on time, depth and magnitude details.

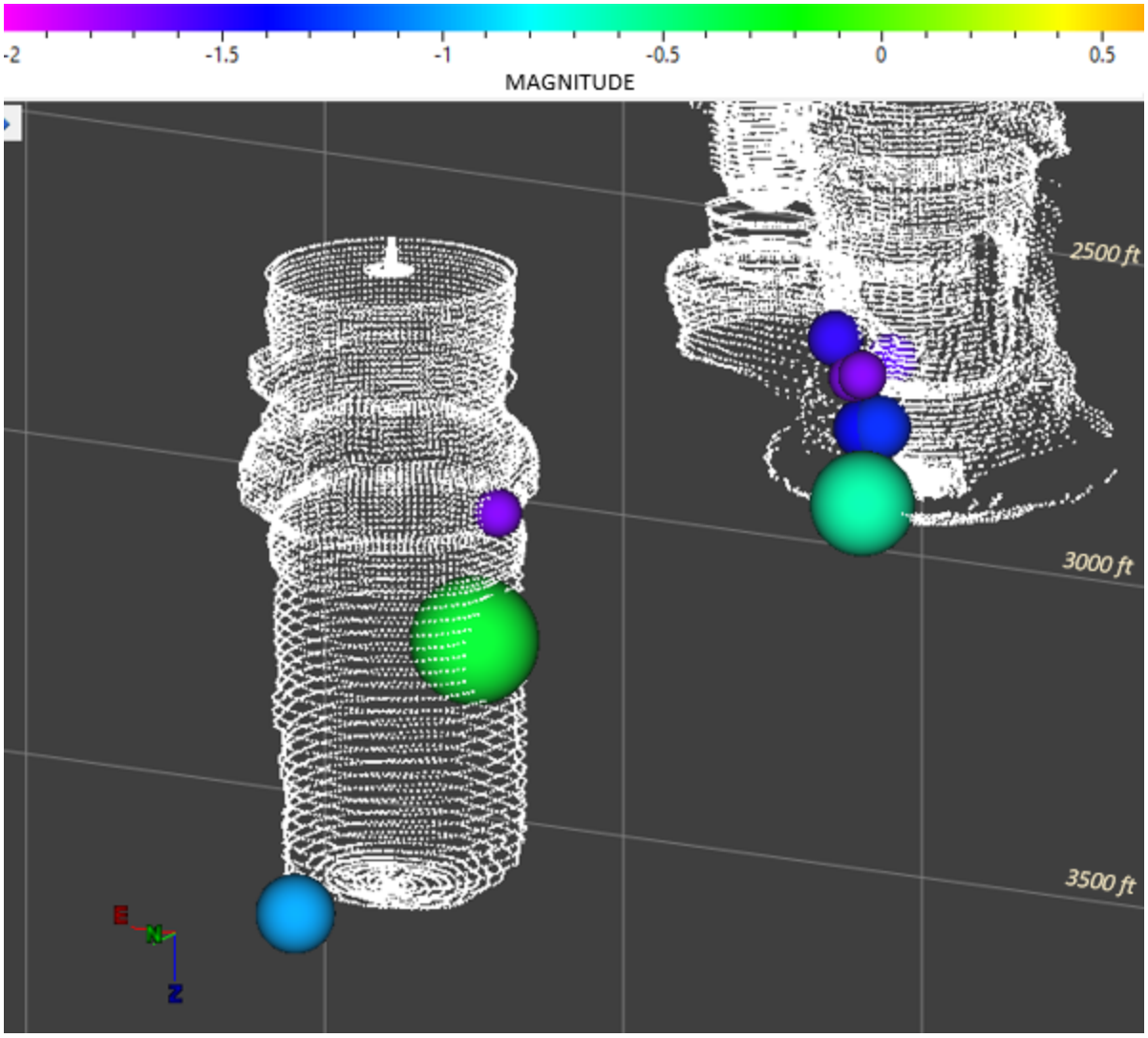

Figure 8. Oblique view (looking from the NW) of the December microseismicity (colored spheres) located near the caverns LGS 02 (3 events) and PPG 02 (8 events). The cavern sonars are shown by white dots. The events are sized and colored by magnitude.

a. Cumulative Seismicity since start of the borehole arrays

The cumulative seismicity located since April 22 to the end of 2024 in salt and cap rock is shown in Figures 9 and 10. In general, the cumulative seismicity is scattered throughout the Sulphur Mines dome and flanks. Events in the cap rock are generally ed over the salt dome with some clustering to the SSW. The events >4700 feet depth are mostly off the northern and southern flanks of the dome, with some clustering in the southern flank.

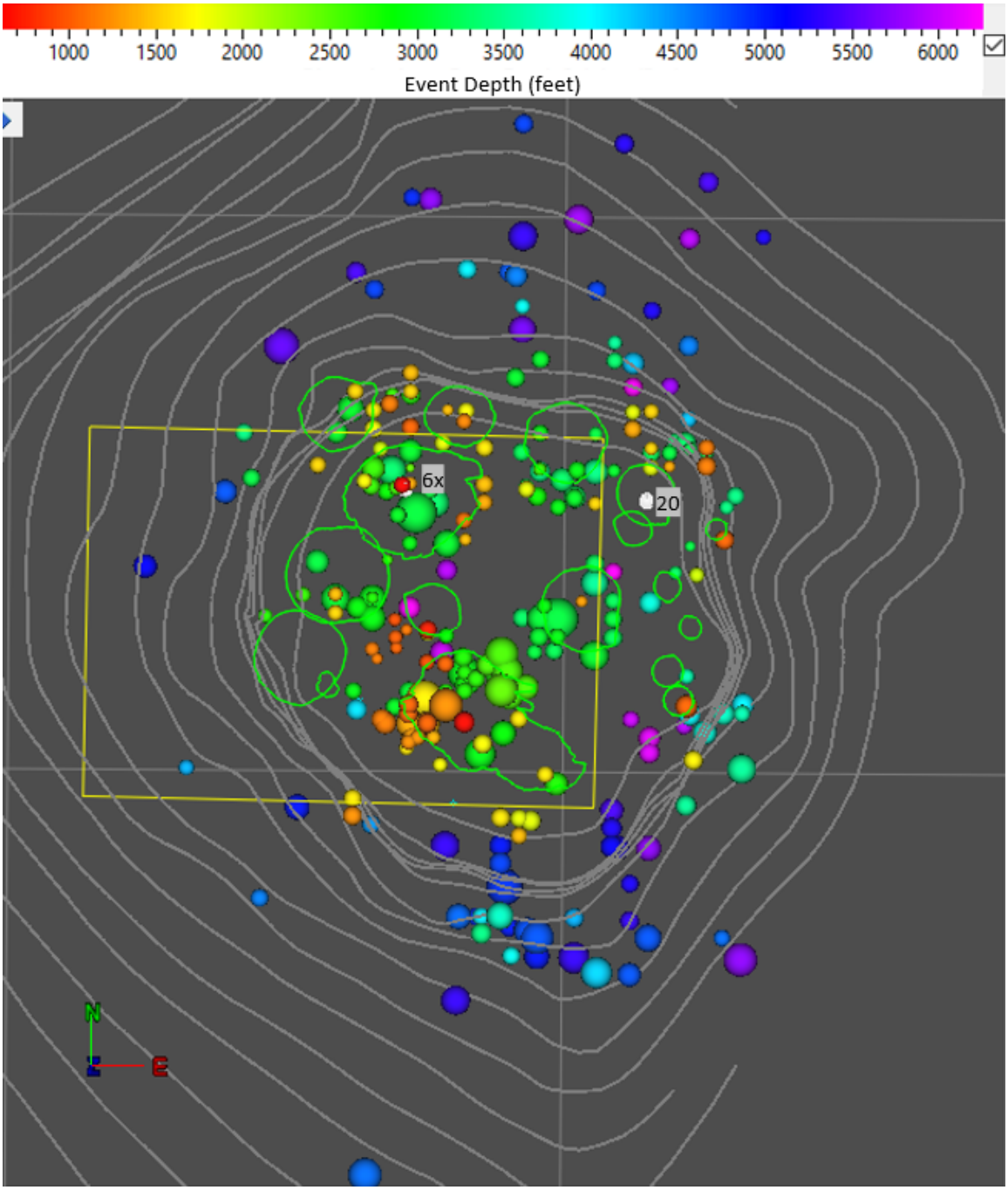

Figure 9. . Map view of the cumulative microseismicity recorded from April 22 to the end of 2024 using borehole seismic arrays (PPG 6-X and PPG 20 (labeled on map as 6x and 20)) Events are sized by magnitude and colored by depth. Grid is 3000 ft. The salt dome contours are shown by gray lines. The proposed AOI is indicated by yellow box. The green lines are cavern outlines projected to the surface.

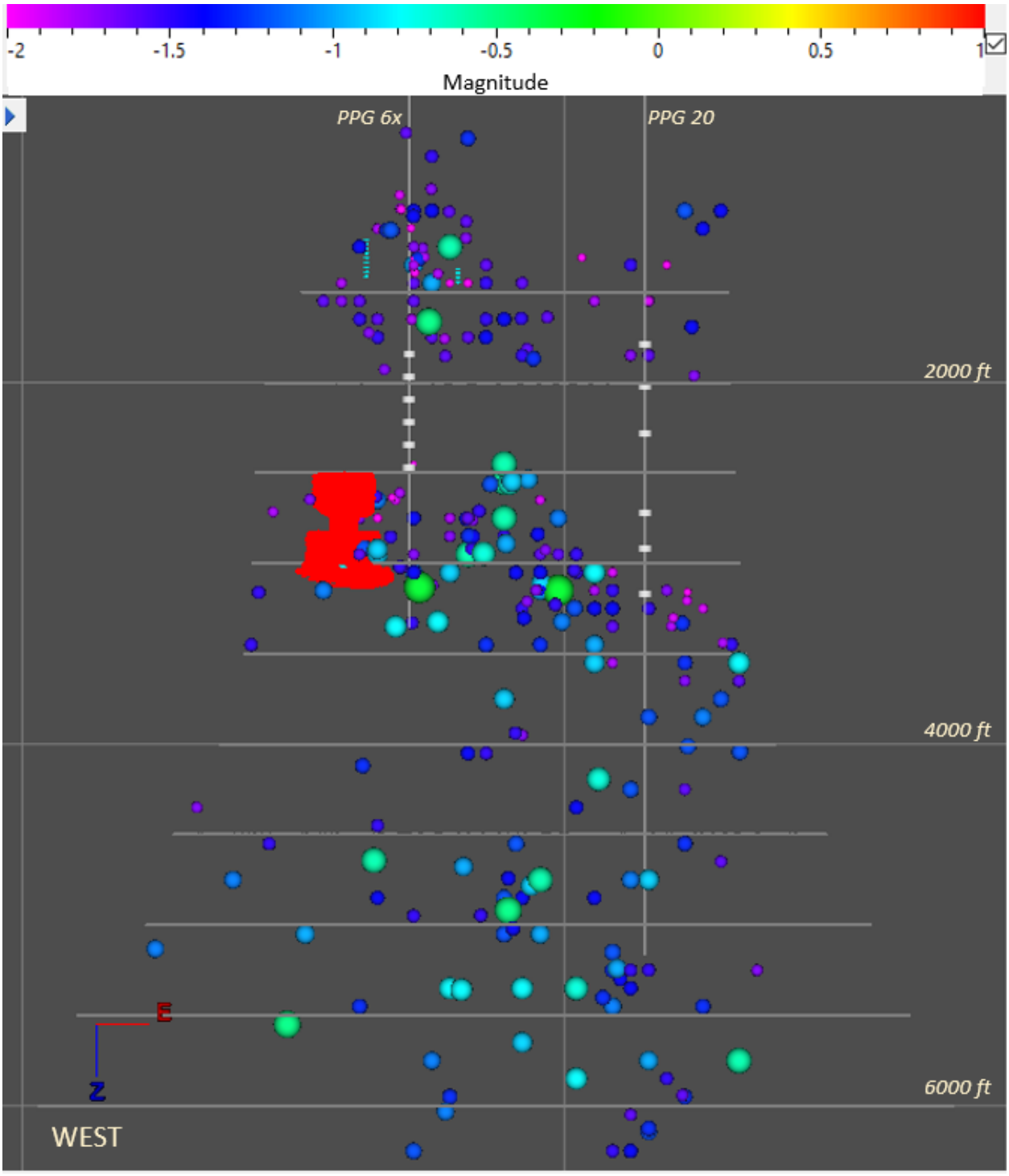

Figure 10. West-East side view (looking from the south) of the cumulative microseismicity recorded from April 22 to the end of 2024 using borehole seismic arrays (labeled PPG 6x and PPG 20). The microseismic events are sized by magnitude and colored by magnitude. The Salt boundary is shown by gray dotted lines and the. Cavern 7 sonar is shown in red. Grid is 2000 ft.

Figure 11 shows the timeline of the 264 events (excluding perforation shots) located since the start of the borehole monitoring on April 22, 2024 to the end of the year. The median magnitude for all the activity to the end of 2024 is magnitude -1.5 (Figure 10 inset).

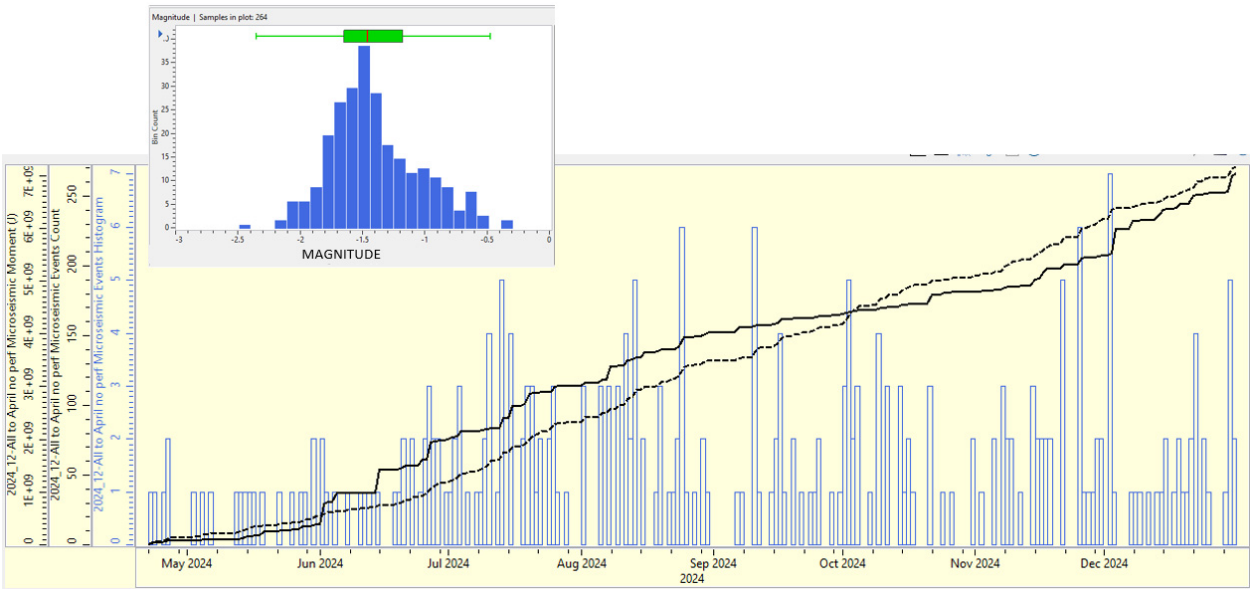

Figure 11. Time line of all microseismicity located at Sulphur Mines using the borehole arrays from April 22 to the end of 2024. The histogram is the number of events per day, the black solid line is the cumulative seismic moment and the black dotted line the cumulative number of events. The upper left histogram shows the magnitude distribution for the 264 events located at Sulphur Mines from April 22 to the end of 2024, (excluding the perforation shots).

In the AOI area, December 2024 marked the second largest cumulative energy located in the AOI since recording started in mid-April, however the number of seismic events in the AOI decreased in December compared to November's high of 28 events (Figure 12).

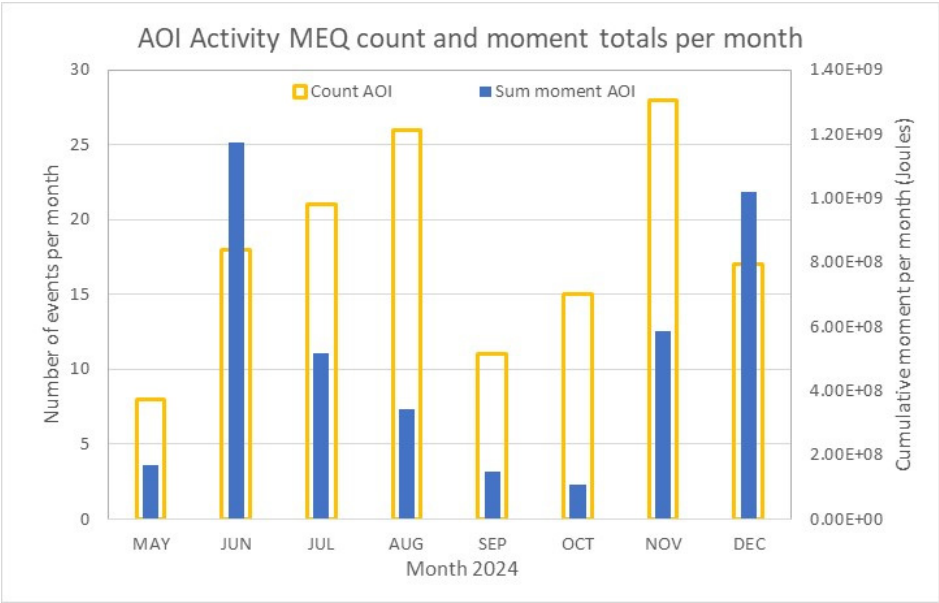

Figure 12. Graph of AOI microseismic activity by month. Yellow boxes indicate the count of MEQ per month (left axis) located in the AOI, the blue filled boxes (right axis) shows the cumulative seismic moment by month.

2. Surface Broadband Seismic Array Summary

- Three microseismic event were reported in December on the surface array, which were co-recorded by the borehole seismic array.
- All the surface seismic stations are operational in December.

a) Broadband Trillium Compact Seismic Array

Nanometrics (https://nanometrics.ca/home) operates and processes data for the broadband array. The broadband station locations are show in Figure 13 and listed in Table 3.

The background noise on stations SUL03, SUL05, SUL06, and SUL07 is the generally the lowest on the array in December, while SUL02 and SUL04 are about 5-10 dB nosier. The surface seismic stations typically show higher noise during the day. Over the Christmas holiday, the entire array recorded lower background noise levels, with stations SUL02 and SUL07 were slightly nosier than the rest of the array. The seismic station background noise continues to be highly variable, likely due to berm and other construction and dome activities in the area. The berm construction will affect the background noise level on the surface array as it moves around the dome in the vicinity of the various seismic stations.

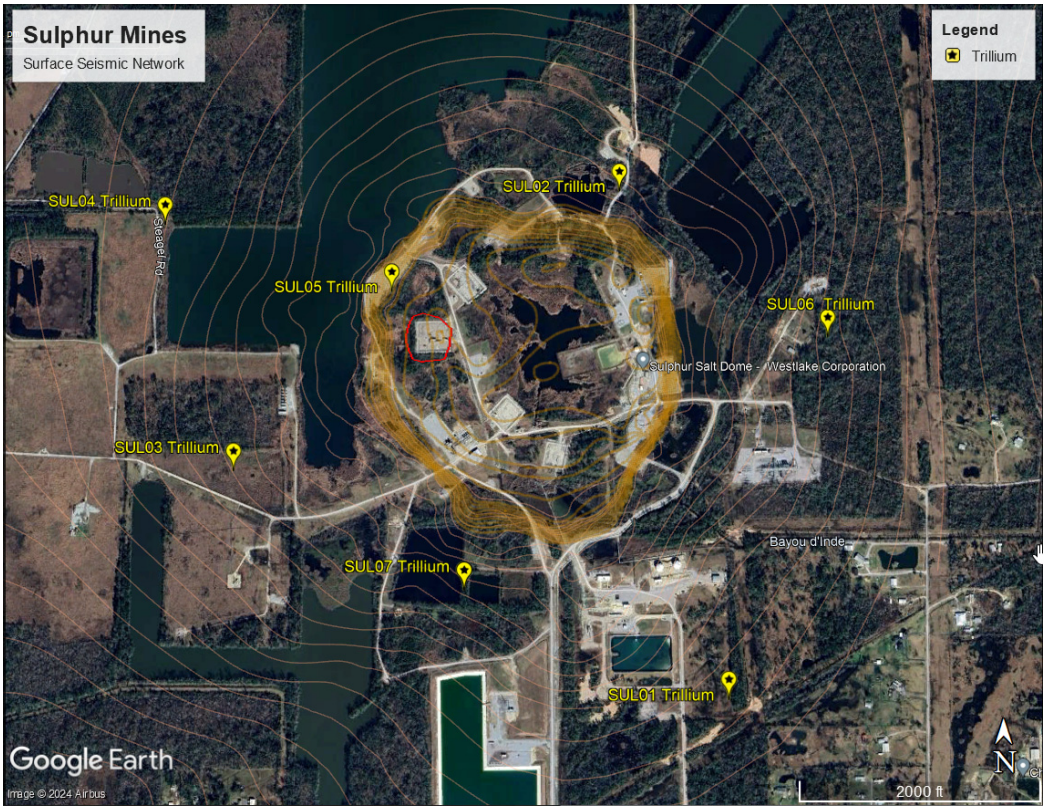

Figure 13. Google Earth map image showing the location of the six broadband seismic (Trillium Compact Sensors, yellow symbols and labels) stations near and at the Sulphur Mines Salt Dome. The contours are the salt and cap rock elevations, the red circle is the general outline of Cavern 7.

The three December surface array events were co-recorded on the borehole arrays. The two events located on the salt dome events have similar magnitudes (within magnitude 0.1) to their co-recorded

borehole array magnitude estimates. There is a very poor match in both location and magnitude for one co-recorded seismic event on December 22 at 14:39 CST. The surface array location is off-dome, south of station SUL03, with a -0.93 magnitude, while the borehole array location for this same event is in the northern dome cap rock and assigned a magnitude -1.5 (Figure 14).

Nanometrics and Baker Hughes are working together to merge the borehole and surface arrays in January 2025. The surface seismic stations will be merged into the borehole processing data flow and be analyzed by Baker Hughes microseismic team. Future reporting will have event locations and magnitudes computed used the combined seismic array data to compute locations and magnitudes.

Figure 14. Image from Nanometrics Athena website of the microseismic events located using the surface seismic array in December 2024. The colored dots indicate the event locations colored by magnitude.

Appendix

Table 1. Proposed Microseismic Alert Level Criteria and Response for Sulphur Mines Dome.

Alert Status	Criteria	Response
Low (GREEN)	No events with magnitude ≥0.5 in AOI and/or Less than 30 MEQ per day in AOI with magnitudes ≥ -1	Once per week data processing, with previous monthly microseismic activity summary in the AOI is provided by the 15th of the following month to LDNR IMD.
Advisory (YELLOW)	Event with magnitude ≥0.5 and <1.0 in AOI and/or Count of MEQ per day ≥30 and <40 in AOI with magnitudes ≥ -1	Daily data processing M-F. Weekly reporting is provided LNDR IMD with activity summary from the previous week. Status remains active until seismic levels within the AOI reach "low"(green) level for 1 day.
Watch (ORANGE)	Event with magnitude ≥1 and <1.5 in AOI and/or Count of MEQ ≥40 and <50 with magnitudes ≥ -1 in AOI	Seven days per week data processing, 2x week reporting with activity for the previous days is provided via email and text message notifications to IMD. Status remains active until seismic levels within the AOI reach Advisory or Low criteria for 2 consecutive days.
Warning (RED)	Event with magnitude ≥1.5 in the AOI and/or Count of MEQ ≥50 with magnitudes ≥ -1 in the AOI	Seven days per week data processing, daily reporting with online meetings with stake holders as needed. The warning status level remains active until seismicity levels within the AOI reach a lower status level for 2 consecutive days.

Table 2. Borehole Sensor Locations

Wellbore	Sensor #	TVD SS	Northing ft	Easting ft
PPG 6x	Sonde 1	1844	1343141	583425
PPG 6x	Sonde 2	1969	1343141	583425
PPG 6x	Sonde 3	2094	1343141	583425
PPG 6x	Sonde 4	2219	1343141	583425
PPG 6x	Sonde 5	2344	1343141	583425
PPG 6x	Sonde 6	2469	1343141	583425
PPG 20	Sonde 1	1790	1344445	583372
PPG 20	Sonde 2	2025	1344445	583372
PPG 20	Sonde 3	2285	1344445	583372
PPG 20	Sonde 4	2720	1344445	583372
PPG 20	Sonde 5	2920	1344445	583372
PPG 20	Sonde 6	3170	1344445	583372

Table 3. Seismic Station locations and operational dates at Sulphur Mines Dome (to November 1, 2024). Temporary Station locations and start and end dates provided by Westlake. Trillium station locations provided by Nanometrics and Westlake (Trillium SUL 02-07).

Station	LAT WGS84	LON WGS84	Date start	Date end
Temp_1a	30.2575	-93.4123	1/30/2023	2/9/2023
Temp_1b	30.2534	-93.4135	2/9/2023	4/3/2023
Temp_2a	30.2570	-93.4097	1/30/2023	2/9/2023
Temp_2b	30.2555	-93.4132	2/9/2023	2/27/2023
Temp_2c	30.2547	-93.4138	2/27/2023	4/5/2023
Temp_3a	30.2533	-93.4091	1/30/2023	2/9/2023
Temp_3b	30.2563	-93.4146	2/9/2023	4/5/2023
Temp_4a	30.2486	-93.4123	1/30/2023	2/27/2023
Temp_4b	30.2507	-93.4121	2/27/2023	3/8/2023
Temp_4c	30.2506	-93.4100	3/8/2023	3/15/2023
Temp_4d	30.2503	-93.4119	3/15/2023	est 4/3/2023
Temp_5a	30.2502	-93.4156	1/30/2023	2/27/2023
Temp_5b	30.2507	-93.4153	2/27/2023	3/15/2023
Temp_5c	30.2504	-93.4140	3/15/2023	est 4/3/2023
Temp_6a	30.2532	-93.4166	1/30/2023	3/15/2023
Temp_6b	30.2529	-93.4161	3/15/2023	4/4/2023
Temp_7a	30.2547	-93.4161	1/30/2023	4/3/2023
Semi Perm S01	30.2453	-93.4073	4/4/2023	
Semi Perm S02	30.2571	-93.4098	4/6/2023	
Semi Perm S03	30.2536	-93.4091	4/6/2023	
Semi Perm S04	30.2470	-93.4213	4/5/2023	5/12/2023
Semi Perm S04_1	30.2506	-93.4204	5/12/2023	
Semi Perm S05	30.2564	-93.4224	4/5/2023	
Semi Perm S06	30.2532	-93.4167	4/5/2023	
Semi Perm S07	30.2547	-93.4162	4/5/2023	
SUL01 trillium	30.2452	-93.4071	9/20/2023	3/12/2024
	LAT NAD 83	**LON NAD 83**		
SUL02 trillium	30.2570	-93.4098	9/13/2023	
SUL03 trillium	30.2505	-93.4203	9/12/2023	
SUL04 trillium	30.2563	-93.4224	9/12/2023	
SUL05 trillium	30.2547	-93.4161	9/13/2023	
SUL06 trillium	30.2535	-93.4043	3/12/2024	
SUL07 trillium	30.2477	-93.4141	3/12/2024	

Table 4. December 2024 Borehole Array Microseismic Event Catalog.

UTC time is used for monthly catalog time window.

Note: Cap rock, salt and cavern classification based on waveforms and Baker Hughes interpretation of event location.

						Location Uncertaines			
Local time CST (UTC -6 hours)	Easting (ft)	Northing (ft)	Depth (ft)	Mag (Mw)	Surface Array Mag (Mw)	ΔEasting (ft)	ΔNorthing (ft)	ΔDepth (ft)	Cavity
12/01/2024 22:17:36	1343466	582344	2750	-1.6		362	1544	1012	AOI_PPG_02
12/01/2024 22:17:42	1343470	582380	2848	-1.3		342	1541	823	AOI_PPG_02
12/01/2024 22:18:09	1343466	582444	2750	-1.7		373	1474	865	AOI_PPG_02
12/01/2024 22:18:46	1343487	582393	2922	-1.5		340	1509	740	AOI_PPG_02
12/01/2024 22:18:50	1343494	582384	2852	-1.4		345	1524	779	AOI_PPG_02
12/01/2024 22:18:56	1343491	582425	2762	-1.7		318	1476	730	AOI_PPG_02
12/01/2024 22:19:02	1343528	582409	2710	-1.5		326	1475	705	AOI_PPG_02
12/03/2024 20:51:19	1343966	582744	3150	-0.3	-0.24	626	1149	824	AOI_LGS_02
12/07/2024 01:21:21	1342946	579751	4643	-0.6		219	182	181	Off_Dome
12/08/2024 07:50:44	1343466	584644	4050	-1.4		855	2443	1194	Flank
12/09/2024 14:16:30	1344166	583344	1550	-1.8		219	696	441	AOI_Cap_Rock
12/11/2024 01:45:47	1343066	583944	2650	-1.9		346	1038	546	Flank
12/13/2024 04:15:13	1344066	580944	5350	-0.7		947	3483	1721	Flank
12/14/2024 17:48:04	1343066	583544	3350	-0.8		396	1325	594	AOI_PPG_06
12/14/2024 22:23:46	1343766	584444	3950	-1.7		591	2065	944	Flank
12/15/2024 16:39:00	1344366	580844	4750	-1.1		1270	3272	2459	Flank
12/17/2024 20:30:48	1343157	583626	3329	-1.5		559	1274	535	AOI_PPG_06
12/18/2024 04:57:32	1343666	581144	3750	-0.9		656	2872	1333	Flank
12/18/2024 09:18:20	1343732	584617	4551	-1.2		899	2304	1036	Flank
12/19/2024 12:05:30	1343466	583144	1450	-2.0		240	881	577	AOI_Cap_Rock
12/20/2024 02:21:33	1344766	583644	3250	-1.9		377	654	479	Flank
12/21/2024 09:43:48	1343466	582444	2950	-0.6		375	1469	685	AOI_PPG_02
12/21/2024 21:07:05	1345066	584844	5250	-1.7		1023	2981	1752	Flank
12/22/2024 08:58:09	1343166	584044	1450	-1.6		441	1308	602	Cap_Rock
12/22/2024 14:39:58	1343053	583871	1162	-1.5	-0.93	698	1249	555	Cap_Rock
12/22/2024 15:18:17	1343895	582808	2926	-1.7		336	1074	594	AOI_LGS_02
12/22/2024 20:37:10	1344566	584044	5850	-1.5		932	3171	1941	Flank
12/24/2024 08:59:16	1343166	585044	4950	-1.5		1051	2987	1512	Flank
12/24/2024 11:11:54	1344310	585346	5300	-1.4		975	3379	1736	Flank
12/25/2024 19:01:01	1343766	585444	4850	-1.4		1416	3467	2559	Flank
12/29/2024 13:06:45	1344666	584244	4550	-1.3		678	2027	1052	Flank
12/30/2024 10:51:15	1344966	582244	3650	-1.6		662	1436	1208	Flank
12/30/2024 10:51:43	1344766	582144	3850	-1.1		750	1668	1335	Flank
12/30/2024 10:51:49	1344683	582242	4012	-1.2		757	1675	1357	Flank
12/30/2024 10:52:00	1344971	582300	4042	-1.2		700	1536	1335	Flank
12/30/2024 11:13:49	1343250	582287	1664	-0.5	-0.58	387	1482	875	AOI Cap_Rock
12/30/2024 23:25:00	1344166	582944	3550	-1.0		410	1162	492	AOI_LGS_02
12/31/2024 09:45:11	1343566	583644	1650	-1.5		283	860	561	AOI_Cap_Rock

Table 5. **December 2024 Surface Array Microseismic Event Catalog.**

Local time CST (UTC -6 hours)	Easting (ft)	Northing (ft)	Depth (ft)	Mag (Mw)	Location Uncertaines ΔHorizontal (ft)	ΔDepth (ft)
12/03/2024 20:51:19	1343266	582757	1378	-0.24	615	919
12/22/2024 14:39:57	1340814	581105	755	-0.93	231	492
12/30/2024 11:13:49	1342825	582517	1837	-0.58	364	689