Advanced Multicomponent Seismic Software

Analysis of seismic data recorded in August 2026 by network C8 (stations SV1S-SV5S) at Aquistore test site

Report AQ-2026-08-IM

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1. Station performance

Station performance for August 2026 is summarized in Figure 1, and their state-of-health parameters are shown in Figure 2. Power-supply voltages looked generally good and station operation was practically uninterrupted.

In Figure 2, note the erratic behaviours of sensor “mass position” for station SV1S. This behaviour is likely related to numerous spikes present in this station’s data (next sections of this report). These observations suggest that the sensor cable connector have become faulty.

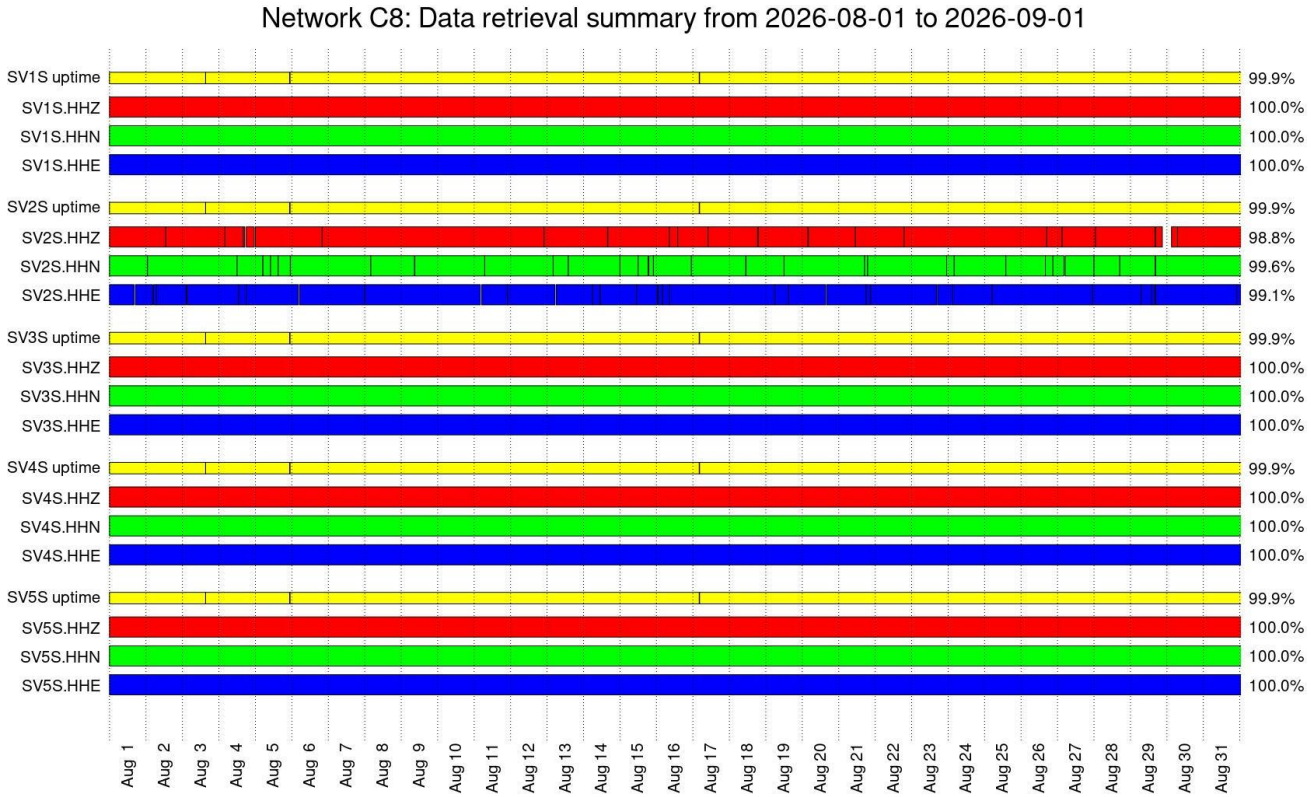


Figure 1. Retrieved data intervals for all channels (red, green, and blue bars) and uptimes (yellow). Total percentages of measured uptime and data retrieval are shown on the right.

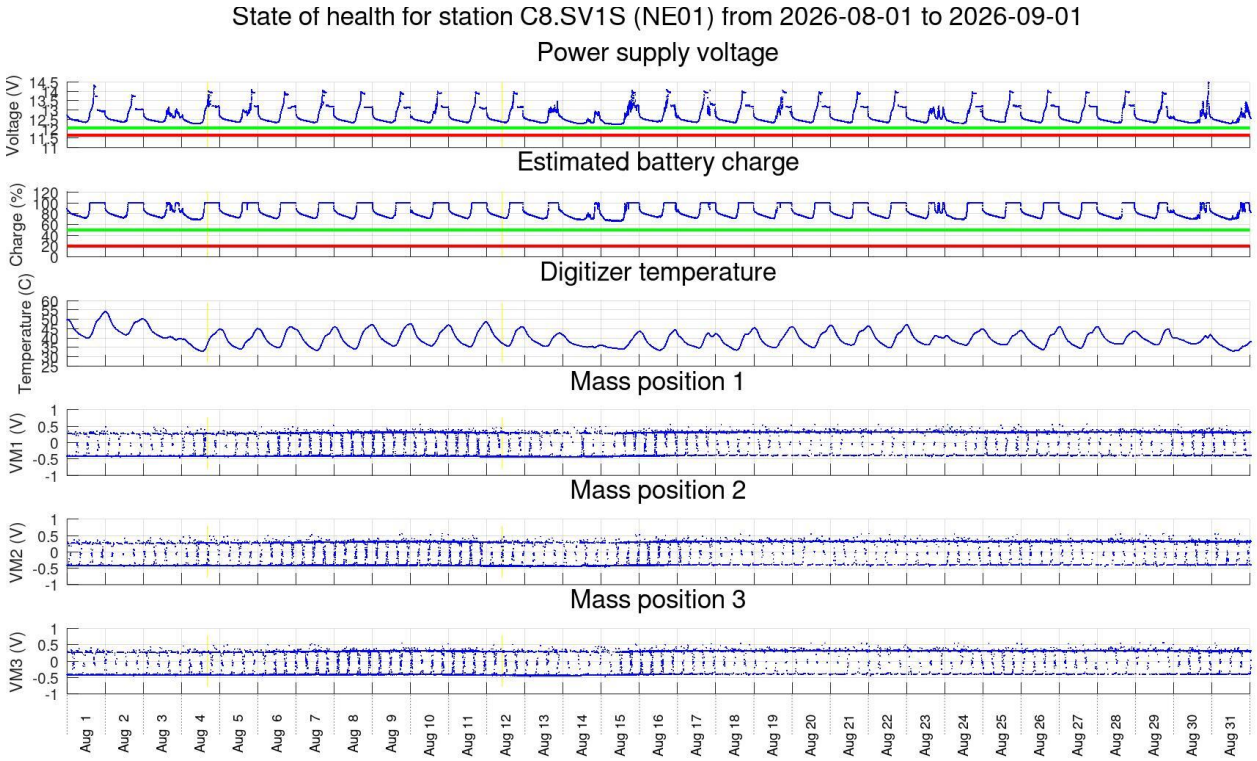


Figure 2. State of health parameters for each station (SV1S here). Image headings: power supply voltage, estimated battery charge levels, temperature on board, voltages measuring mass positions.

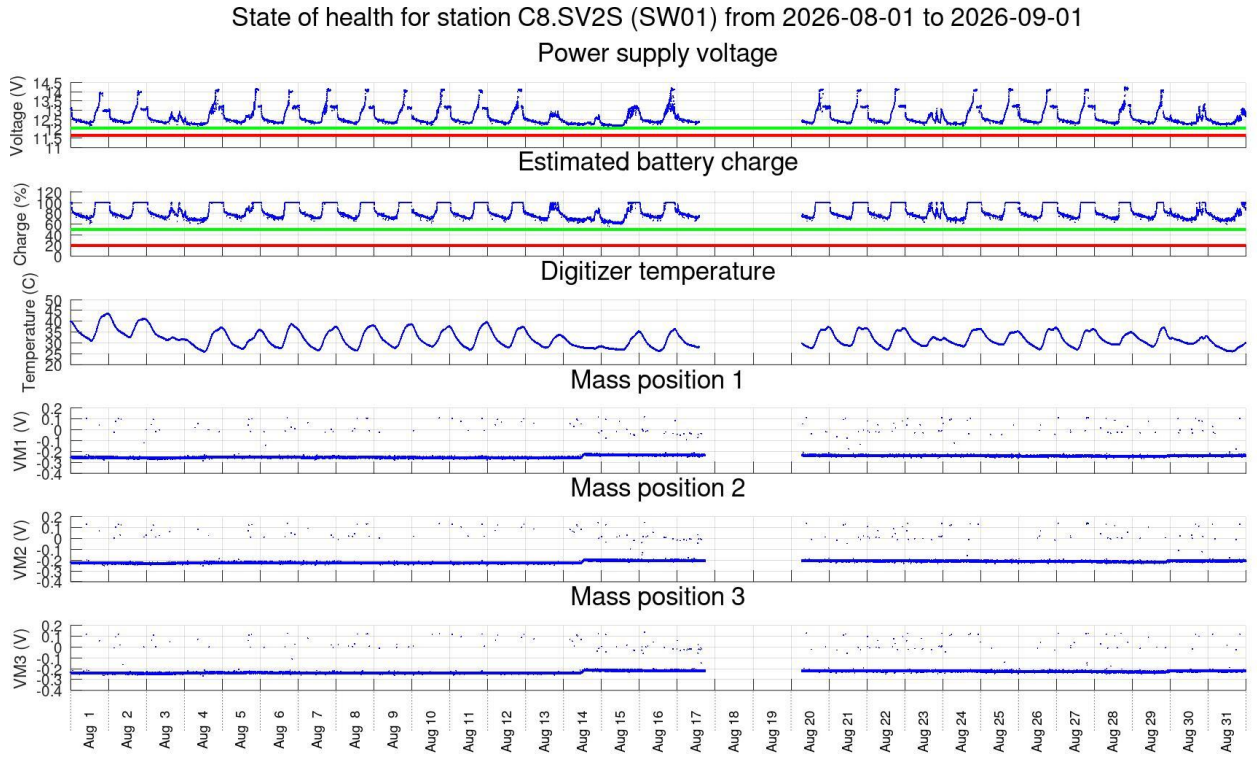


Figure 2, continued, station SV2S. SOH data between August 17 and 20 were missed in manual downloading.

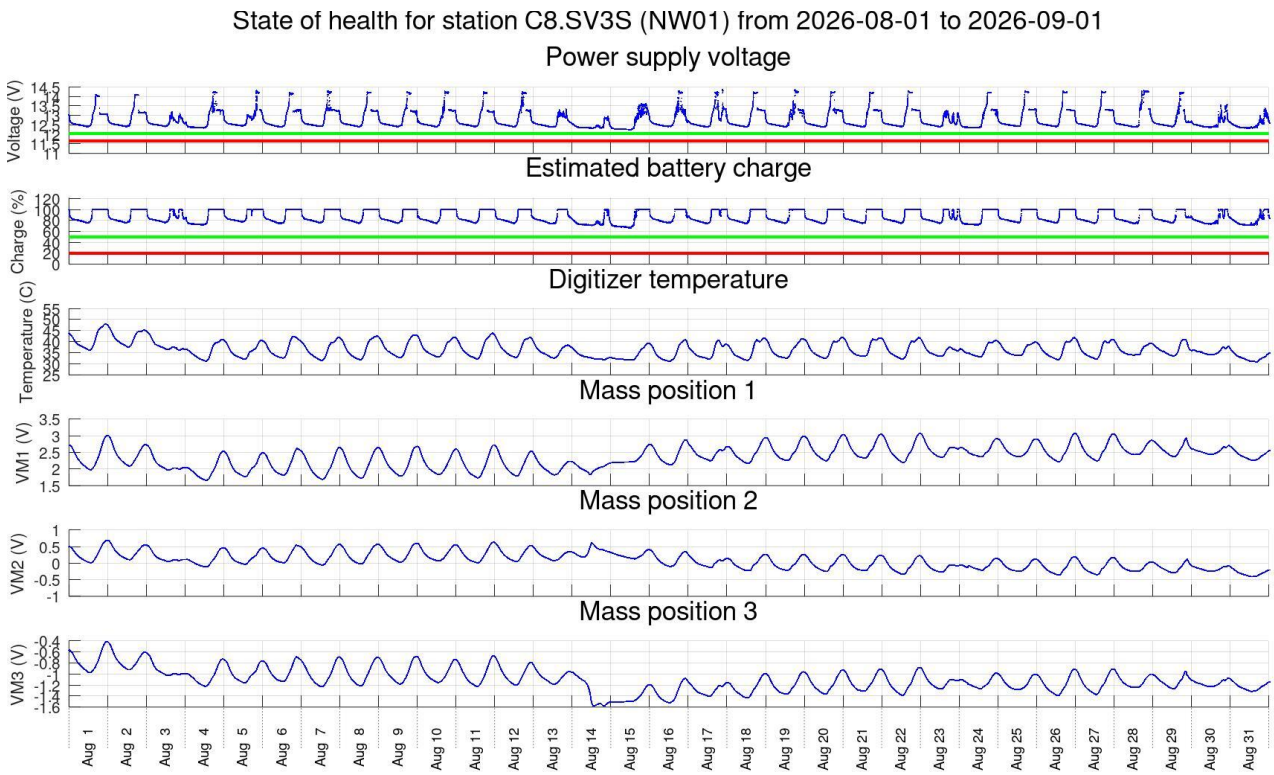


Figure 2, continued, station SV3S.

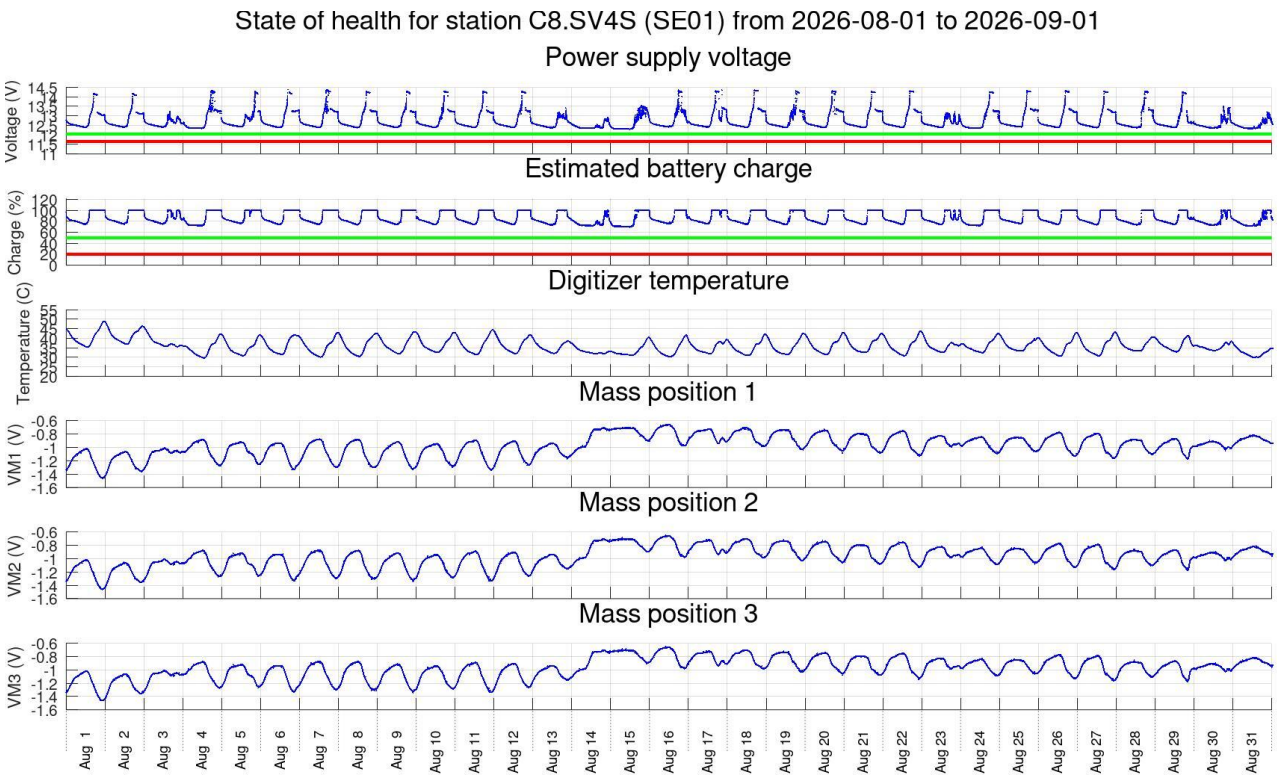


Figure 2, continued, station SV4S.

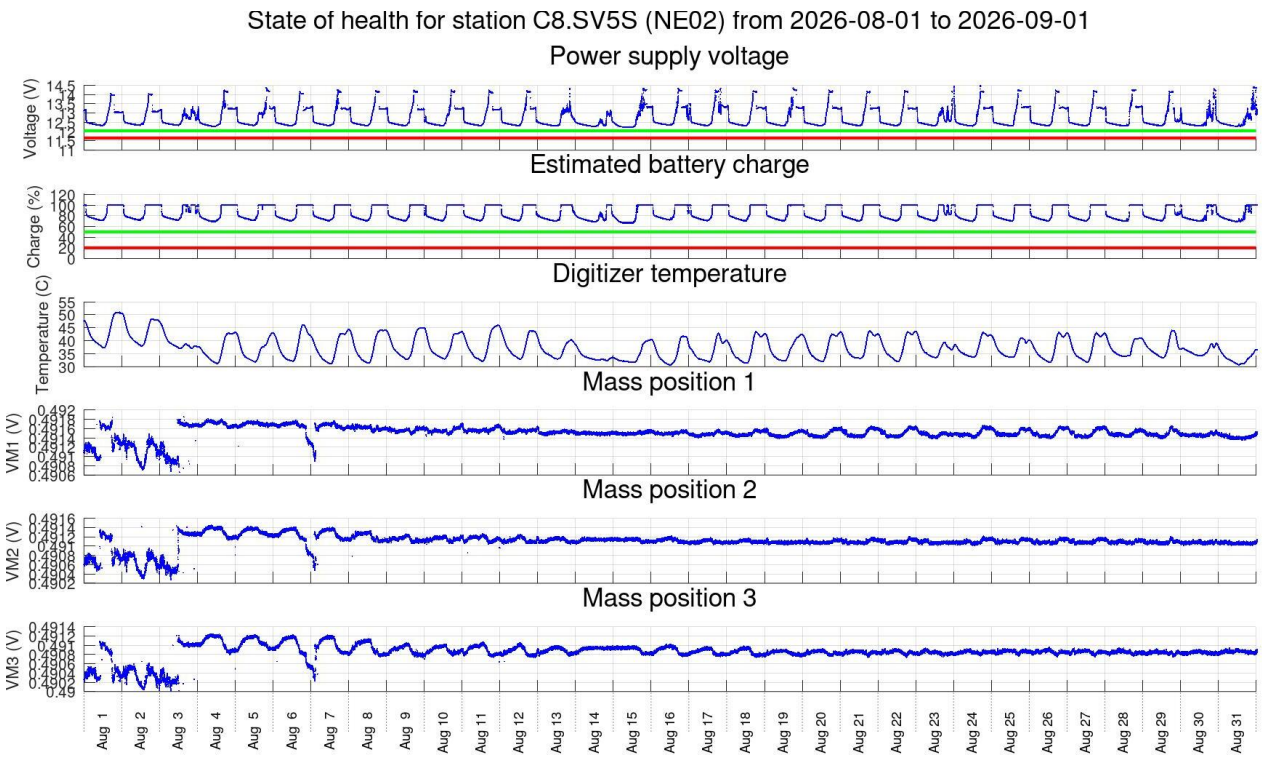


Figure 2, continued, station SV5S.

Data recovery

Data recovery from all stations was near 100% (Figures 1 and 2).

2. Data quality

Figure 3 shows two measures of data quality evaluated for each channel:

1) Numbers of spikes and tears (sharp changes of DC level) within 1-hour time intervals;
2) 1-hour interval root-mean square (RMS) average amplitudes in each channel.

Records from station SV1S continued to be strongly contaminated with spikes noted in the preceding report. Also as in preceding reports, stations SV3S and SV4S also show occasional intervals of spikes in the records.

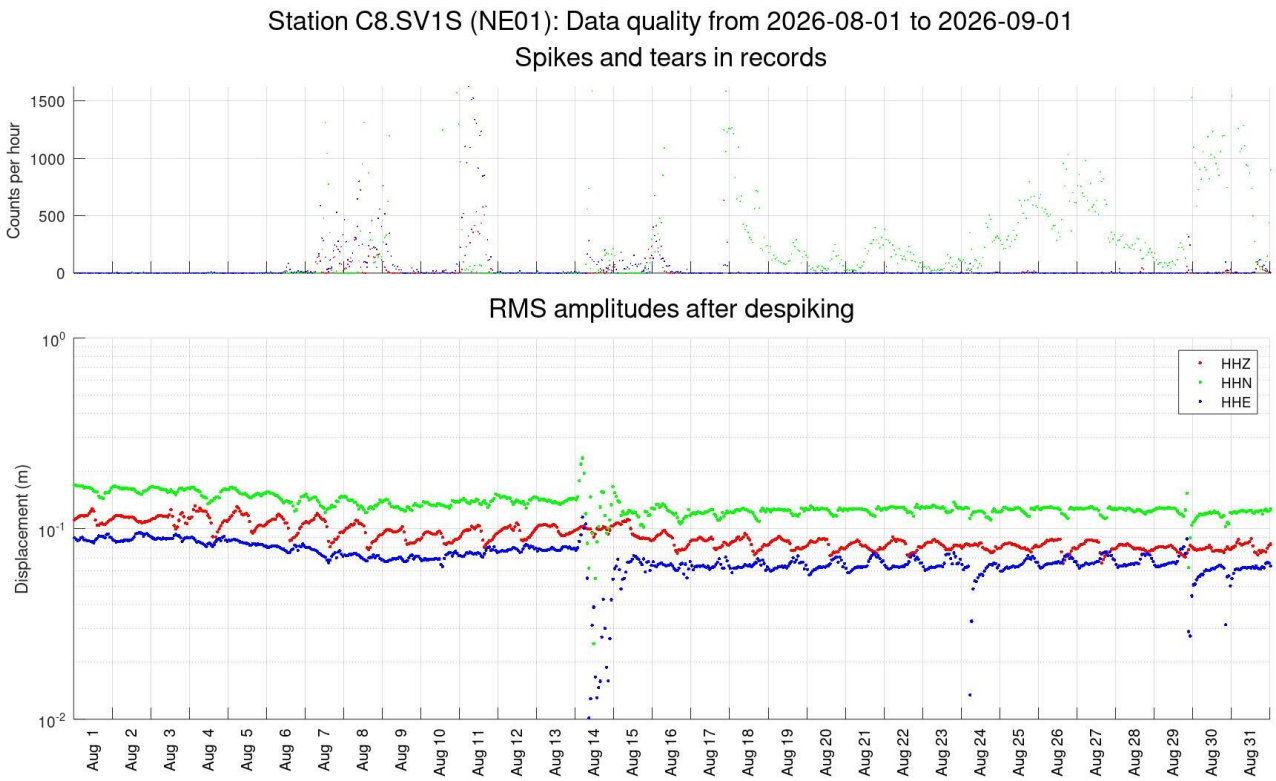


Figure 3. Measures of data quality in hour-long intervals. Station names and time intervals are indicated in plot headings (SV1S in this plot). Red, green, and blue colours correspond to channels HHZ, HHN, and HHE, respectively (as in Figure 1).

Top panels: Numbers of spikes and tears per hour auto-detected in data records.

Bottom panels: RMS ground displacements (meters).

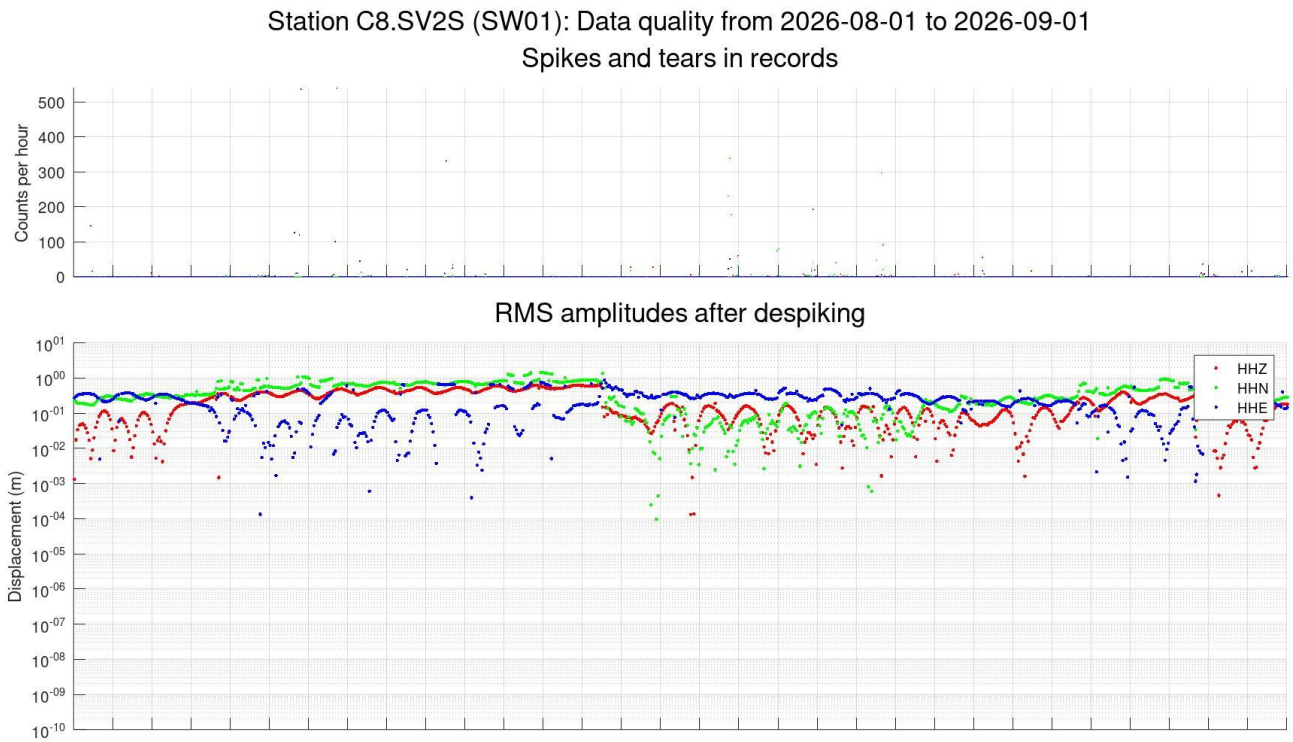


Figure 3, continued. Station SV2S.

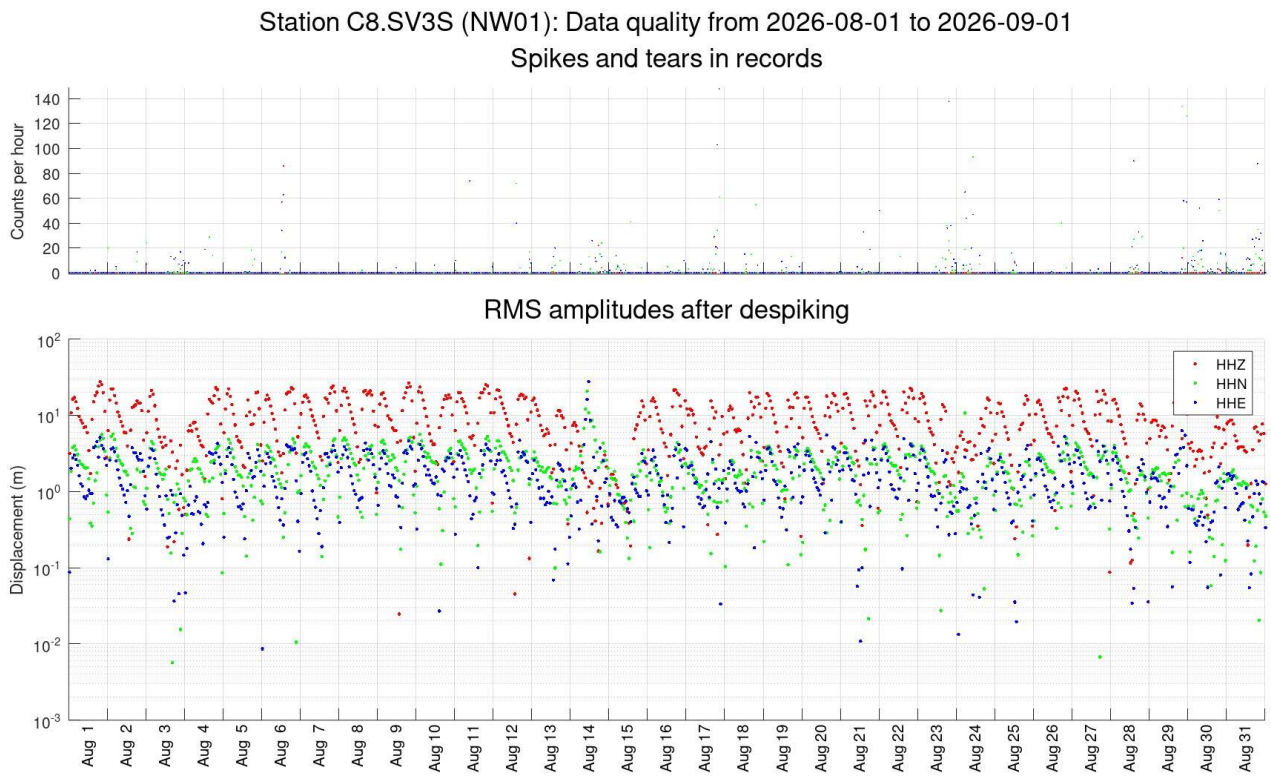


Figure 3, continued. Station SV3S. Note the large numbers of spikes, also seen in some waveform records below in this report.

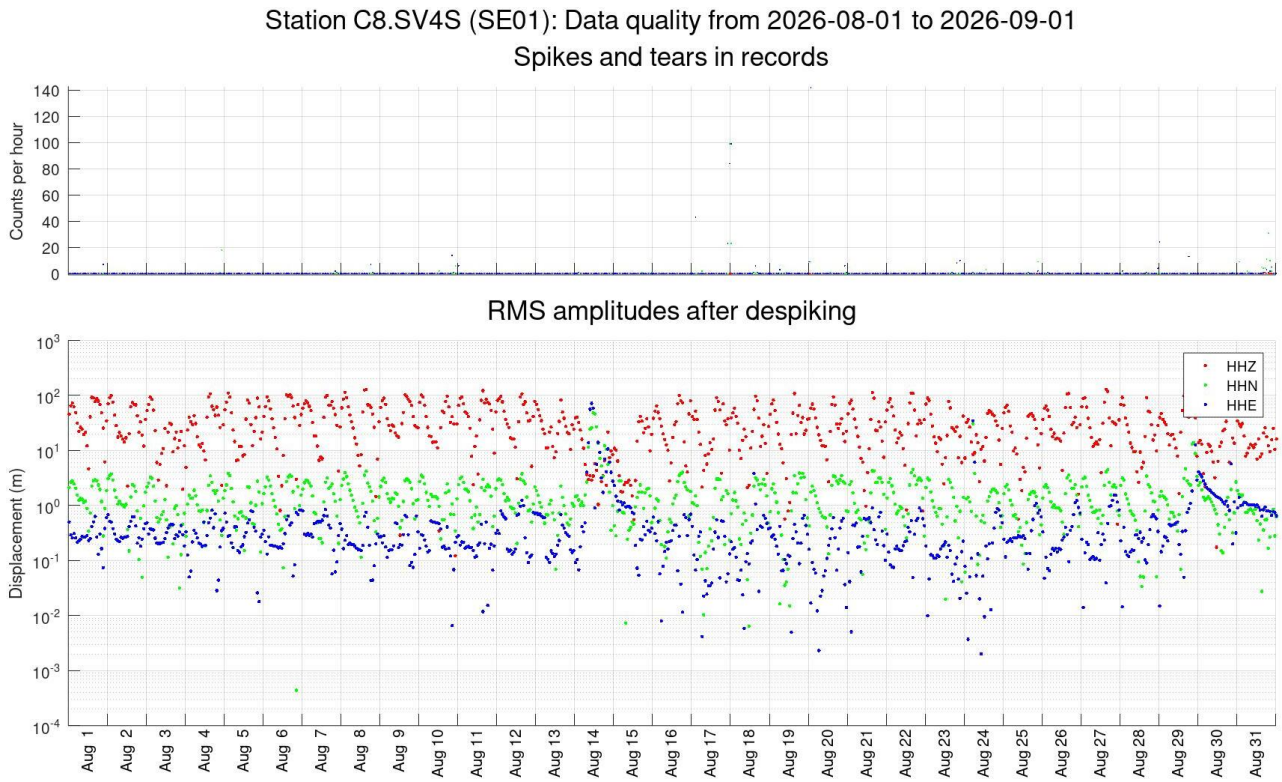


Figure 3, continued. Station SV4S. Also note significant numbers of intermittent spikes.

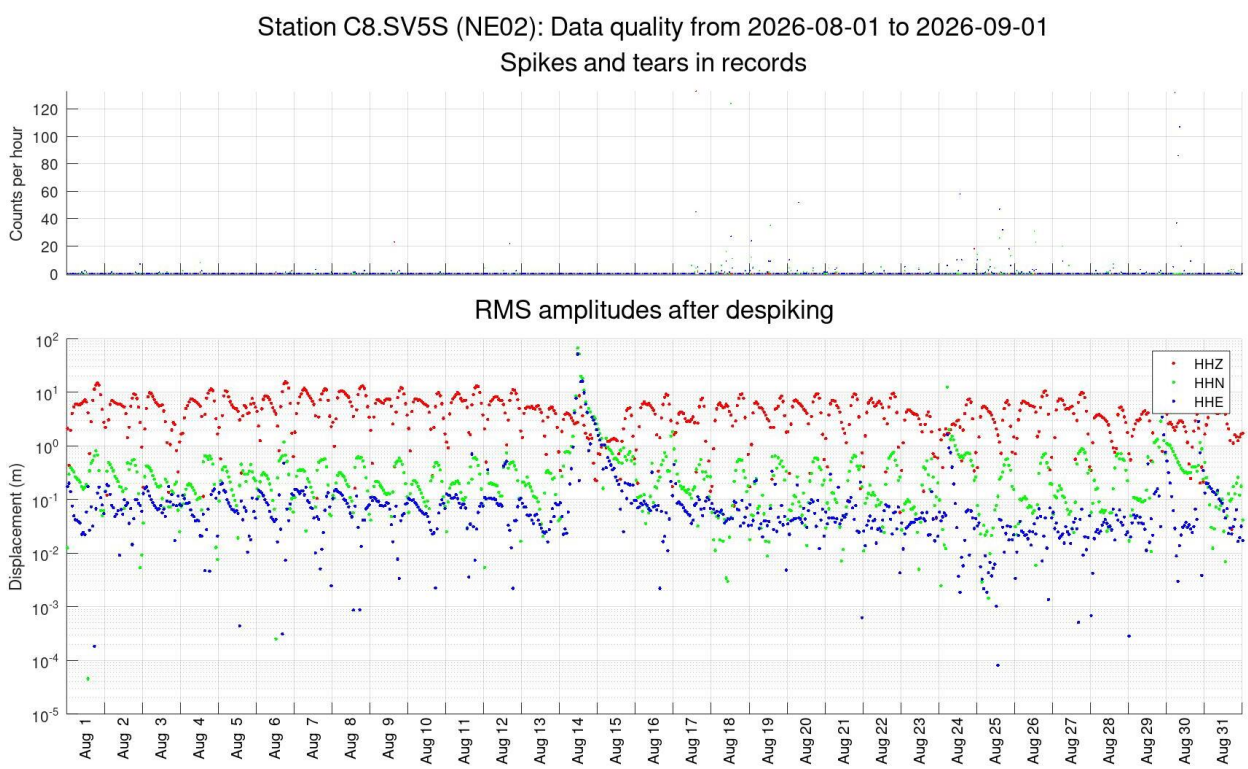


Figure 3, continued. Station SV5S.

3. Processing procedure and parameters

Processing procedure and parameters were the same as in previous reports.

4. Seismic event detection

The classification of seismic events used in these reports and numbers of events detected in August 2026 are shown in Table 2.

Table 2. Classification of seismic events and numbers of detections at Aquistore broadband seismic array

Event class code	Class name	Identification criteria	Number of detections in this report
1	Teleseismic	Hypocentral distance D > 1000 km, presence in catalogues	20
2	Regional	100 < D < 1000 km, presence in catalogues	0
3	Local	Approx. 4 < D < 100 km	----------
3a	Possible mine blasts	Characteristic waveforms, amplitudes, back-azimuths east of Aquistore, D about 12-15 km	5
3b	Mining-related	Low frequencies, extended repeated wavetrains low arrival velocities related to surface waves	2 (selected from numerous occurrences)
4	Proximity (close local)	D < 3-4 km, deviation of array moveouts from plane-wave patterns, high frequency	----------
4a	Surface sources near array	Large travel-time moveouts, variable back-azimuths	3 (selected samples)
4b	Target zone	Source at recognizable nonzero depth, small travel-time moveouts, high frequency	0

Automatic detections

The procedure of multichannel automatic detections is being revised and not shown in the present report.

Event bulletins

Earthquake data bulletins for the period of this report were obtained from NEIC (USGS) and NRCan web services (Figure). Events larger than magnitude 2.5 were taken from USGS, and all available events were retrieved from NRCan. Events located at regional distances or with magnitudes above the selected $magnitude \propto distance^{1.5}$ threshold (dashed green line in Figure) were reviewed interactively (next section).

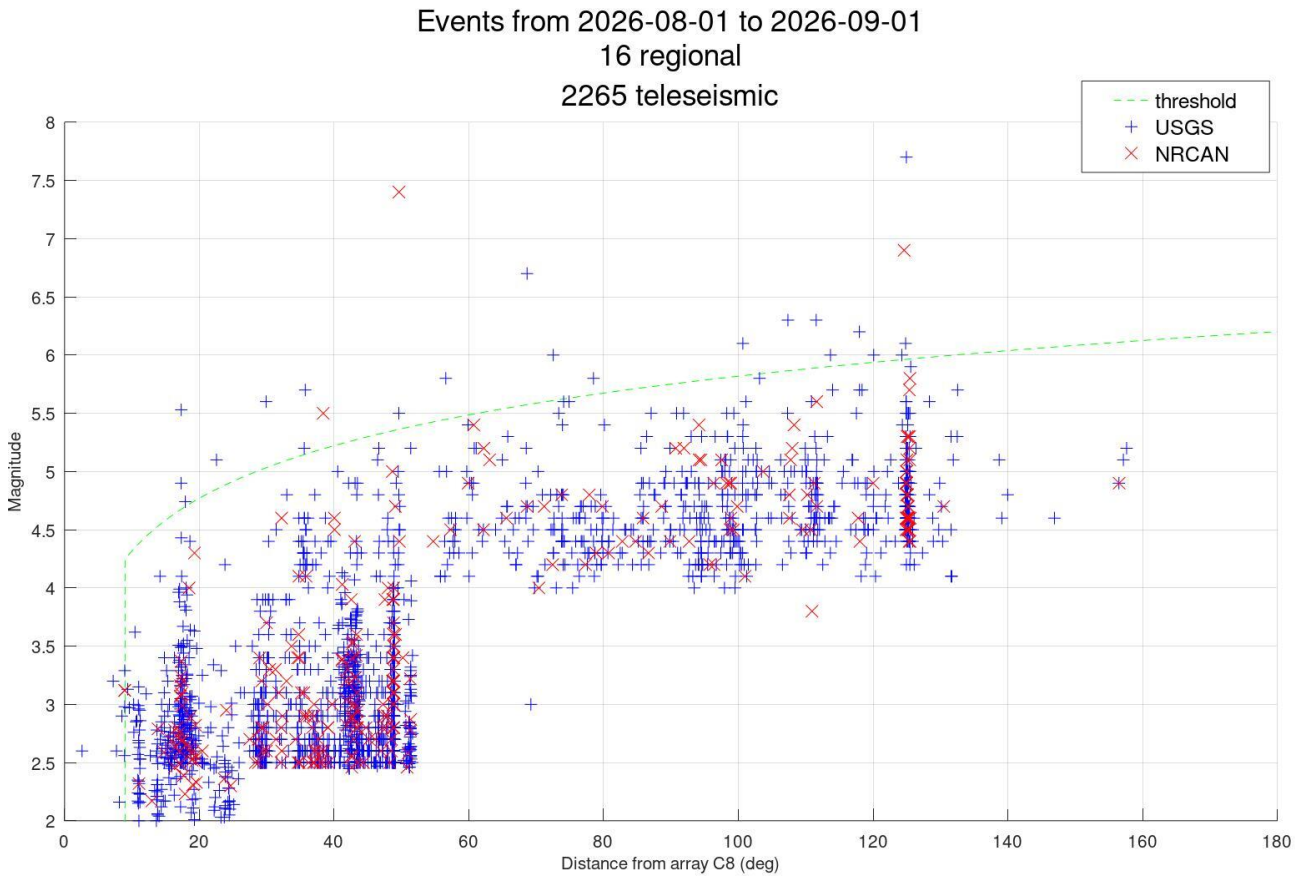


Figure 5. Magnitudes and distances from Aquistore for earthquake parameters downloaded from USGS and NRCan databases (legend). Dashed green line shows the detection threshold above which a manual review of events was performed.

Teleseismic events (class 1)

Above the threshold line in Figure 5, 20 teleseismic events (class 1 in Table 2) were identified in August 2026 (Figure 6). Most teleseismic events can be recognized by the onsets of S waves (red marks in Figure 6) and surface waves (low-frequency arrivals after the S waves). Some of the events also show strong P-wave (blue bars near time zero in Figure 6), and several events show strong and P/S or S/P mode conversions (between the P-wave and S-wave times).

In for most events in Figure 6, note that records from station SV1S are extremely noisy, particularly channels HHZ and HHN. The noise is caused by spikes occurring randomly but synchronously in both channels. This suggests that the noise may be due to malfunctioning sensor cable or connector.

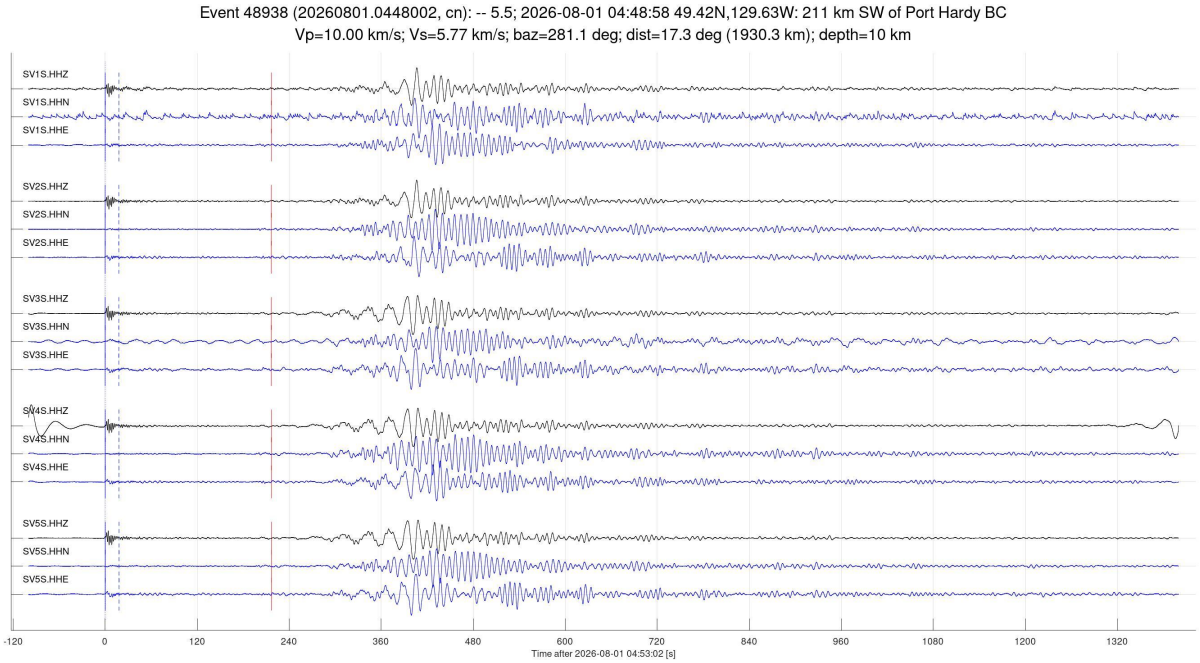
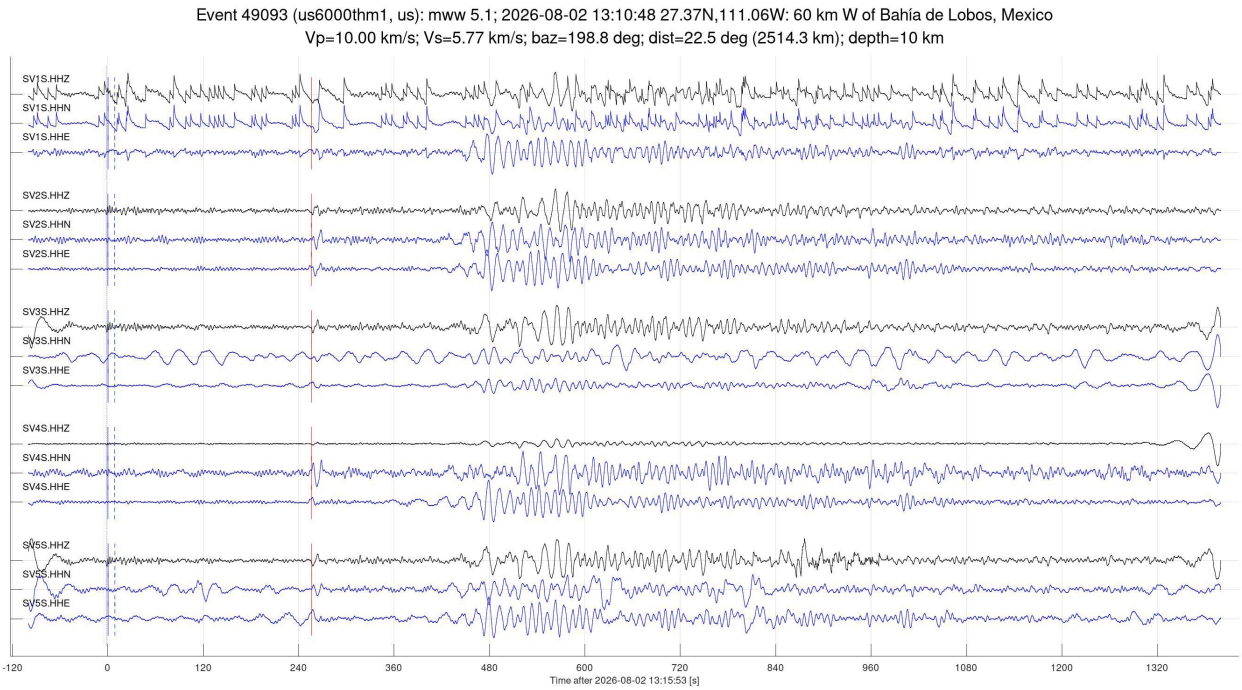


Figure 6. Teleseismic events detected at Aquistore in August 2026. Plot headings show catalogue IDs, magnitudes, times, distances in degrees, source coordinates and localities, back-azimuths ('baz='), distances ('dist=') and source depths. Vertical-component records are shown in black, and horizontal components in blue. Time zeros are located at the times of P-wave arrivals at the Aquistore array predicted in the reference model IASP91 and corrected interactively. Blue and red bars indicate the P-wave and S-wave picks, respectively. Ignore the (technical) cyan and dashed bars.



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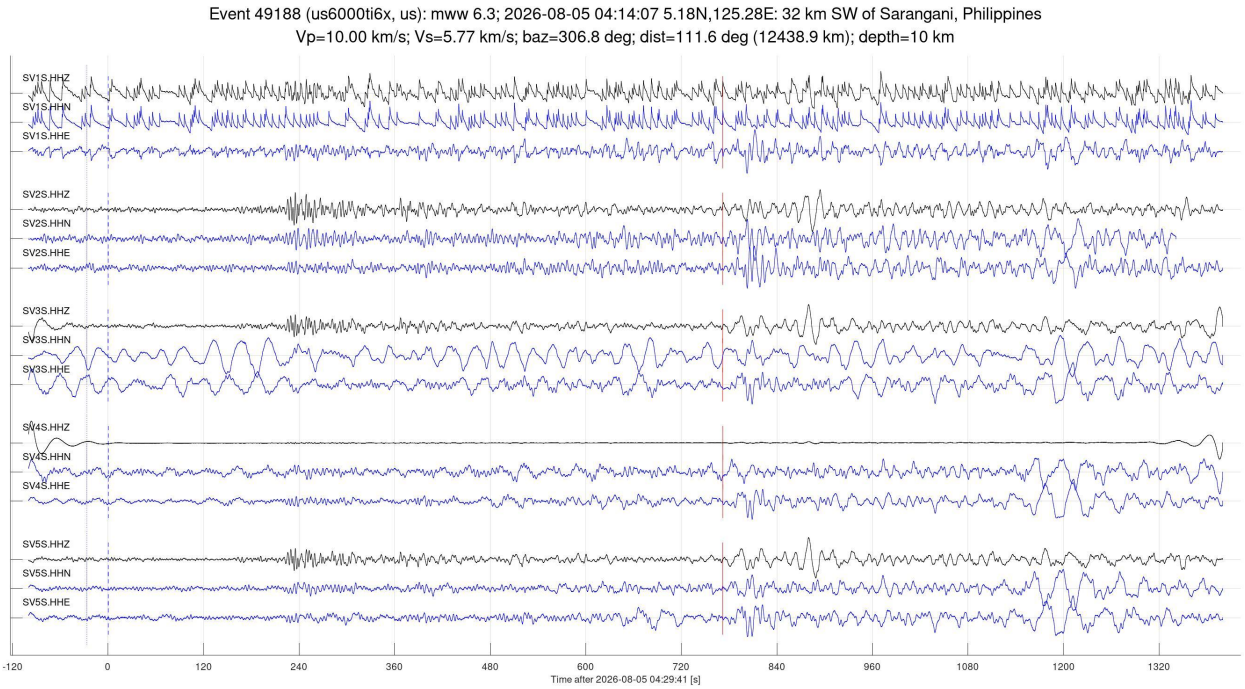

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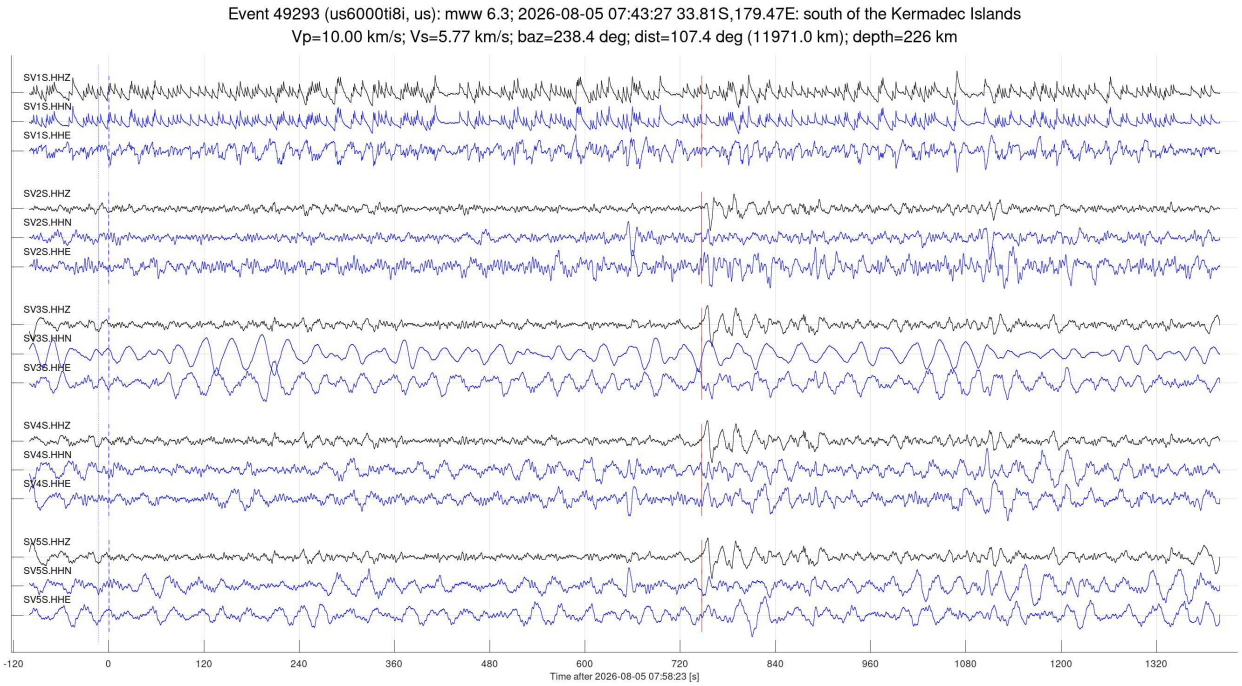

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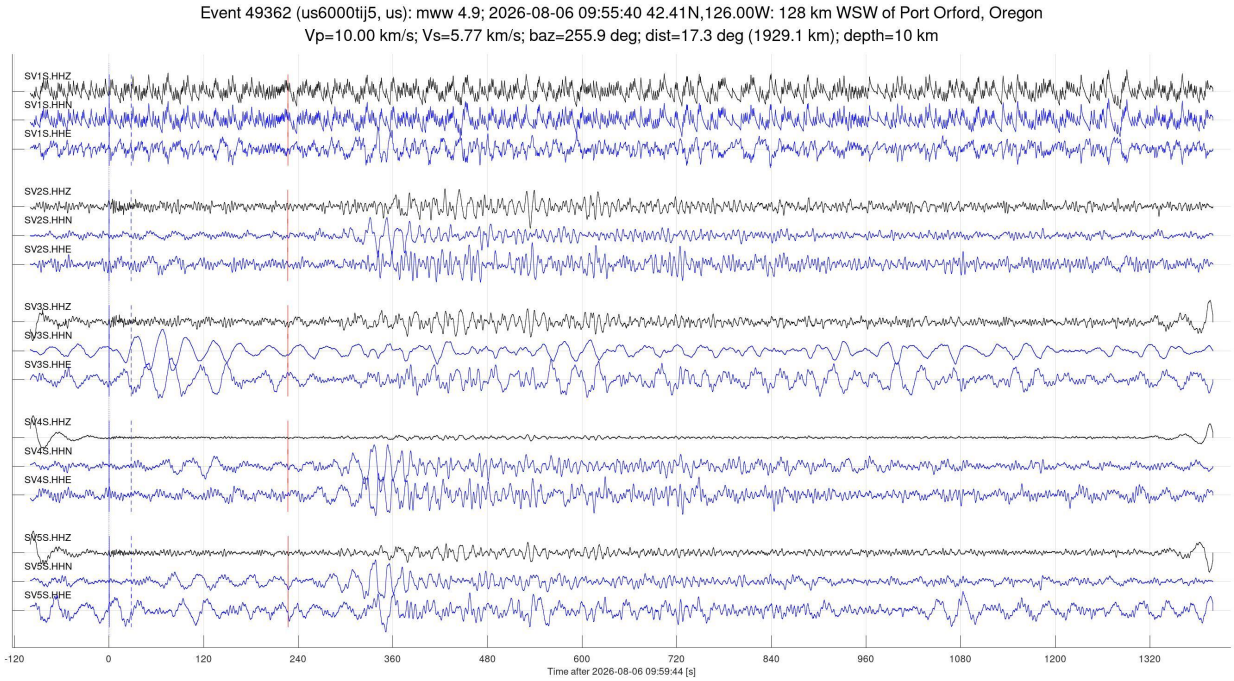

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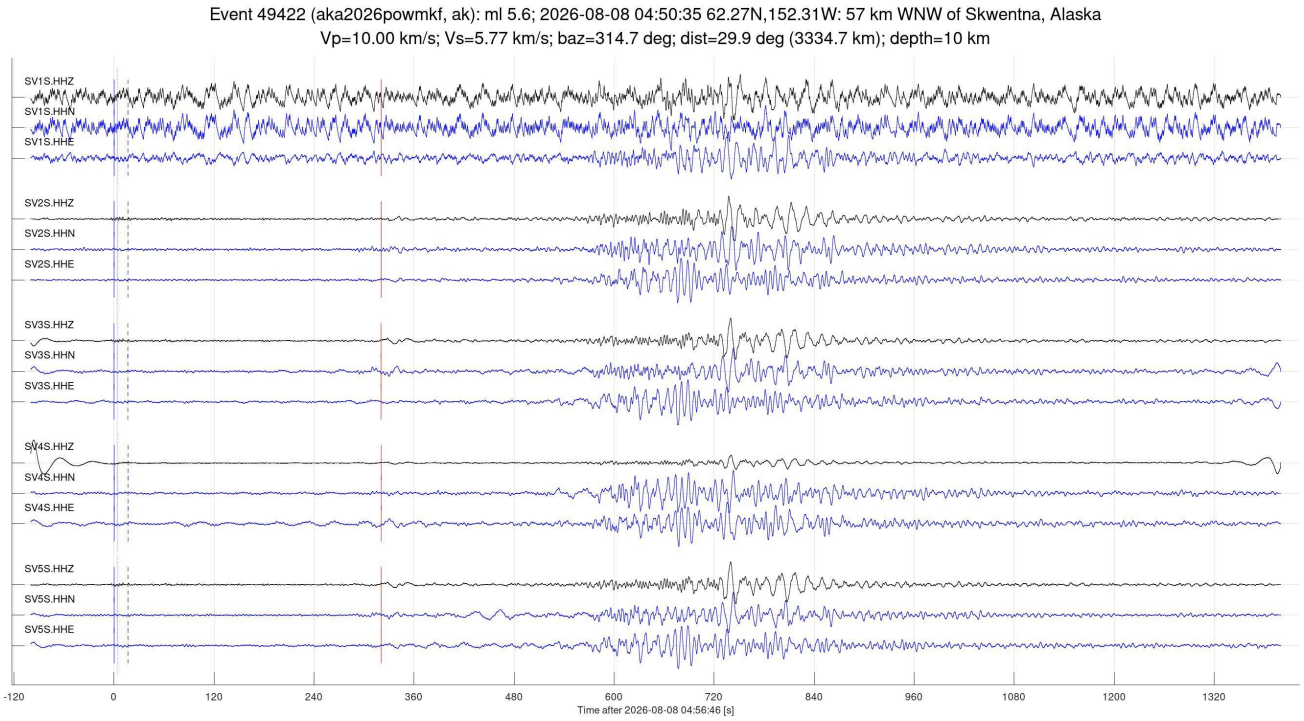

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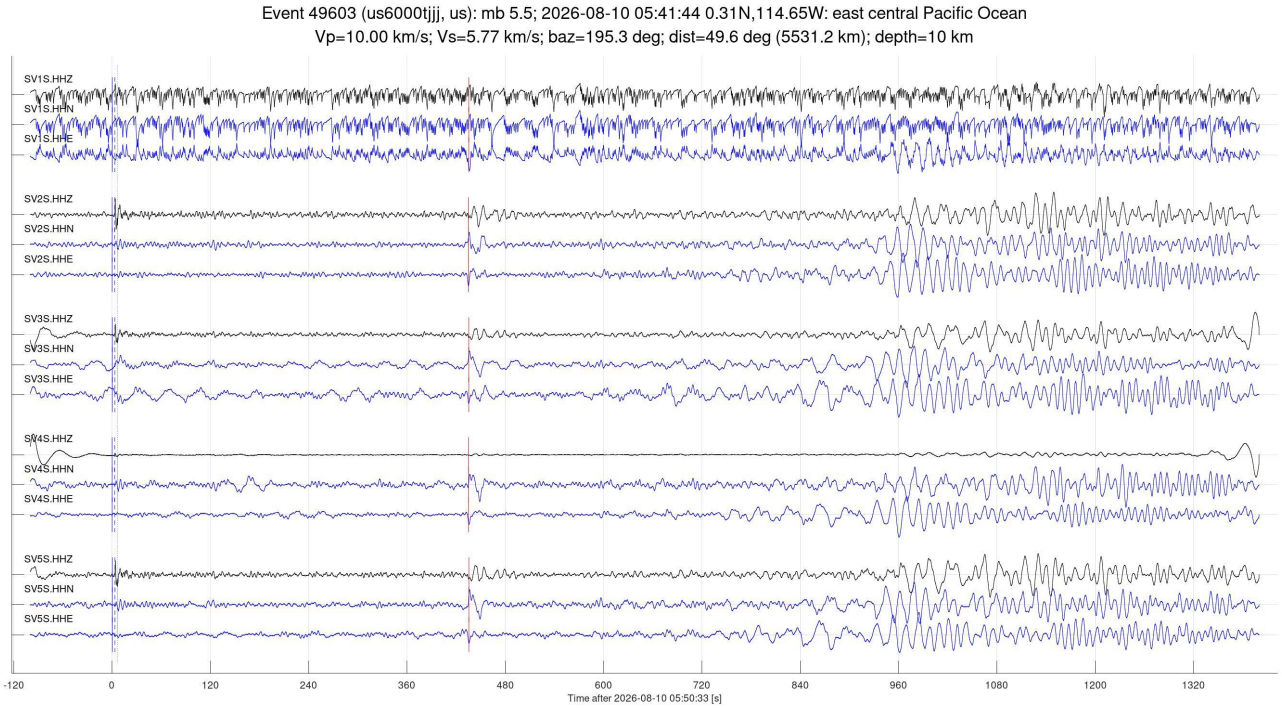

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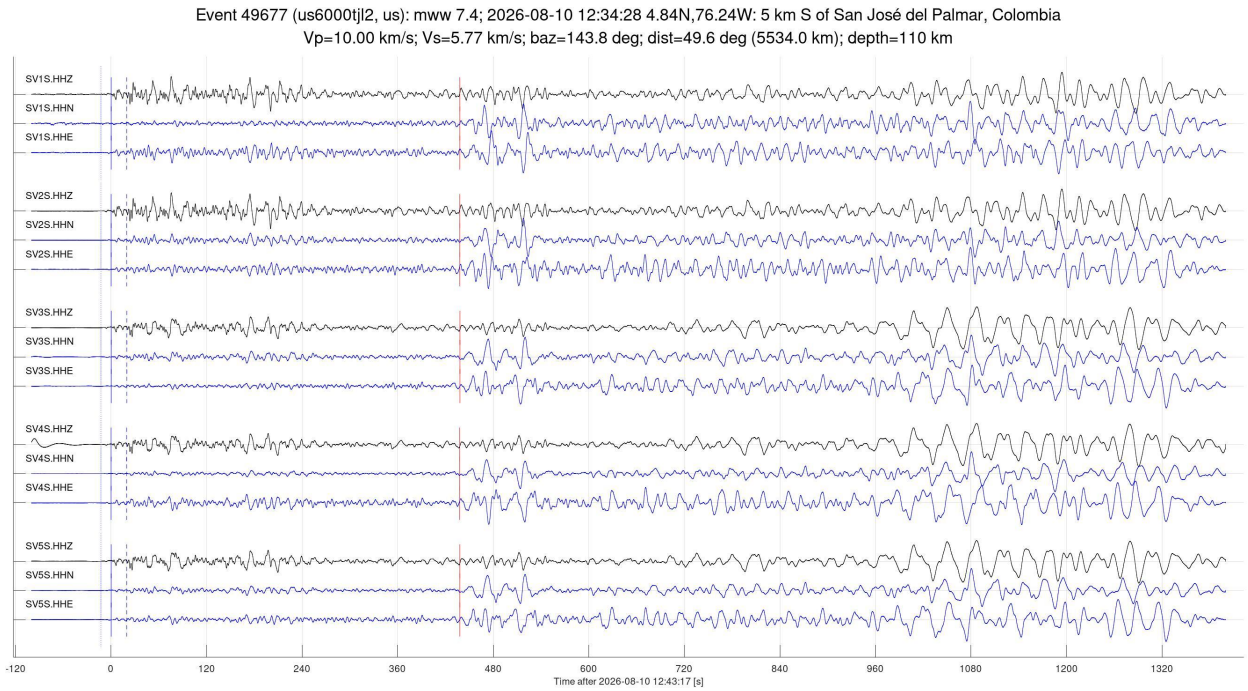

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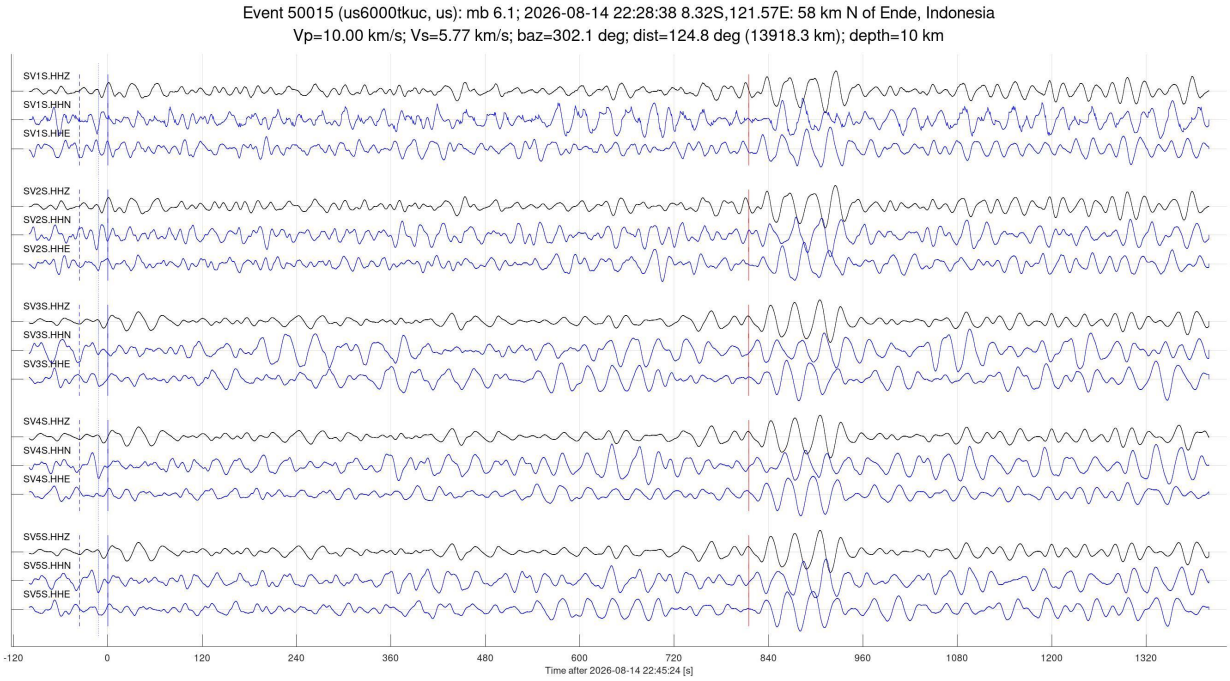
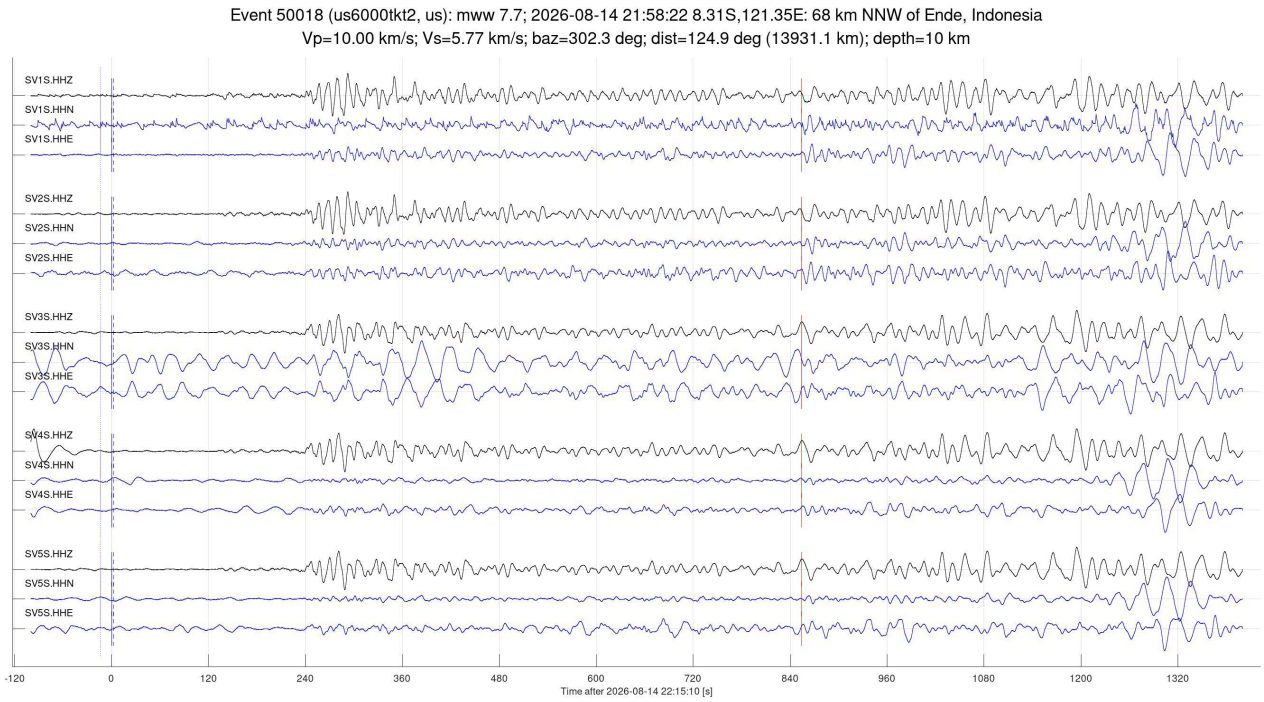


Figure 6, continued. Note that for such low-frequency events, S-wave and surface wave records are difficult to differentiate from local seismic noise near the site.



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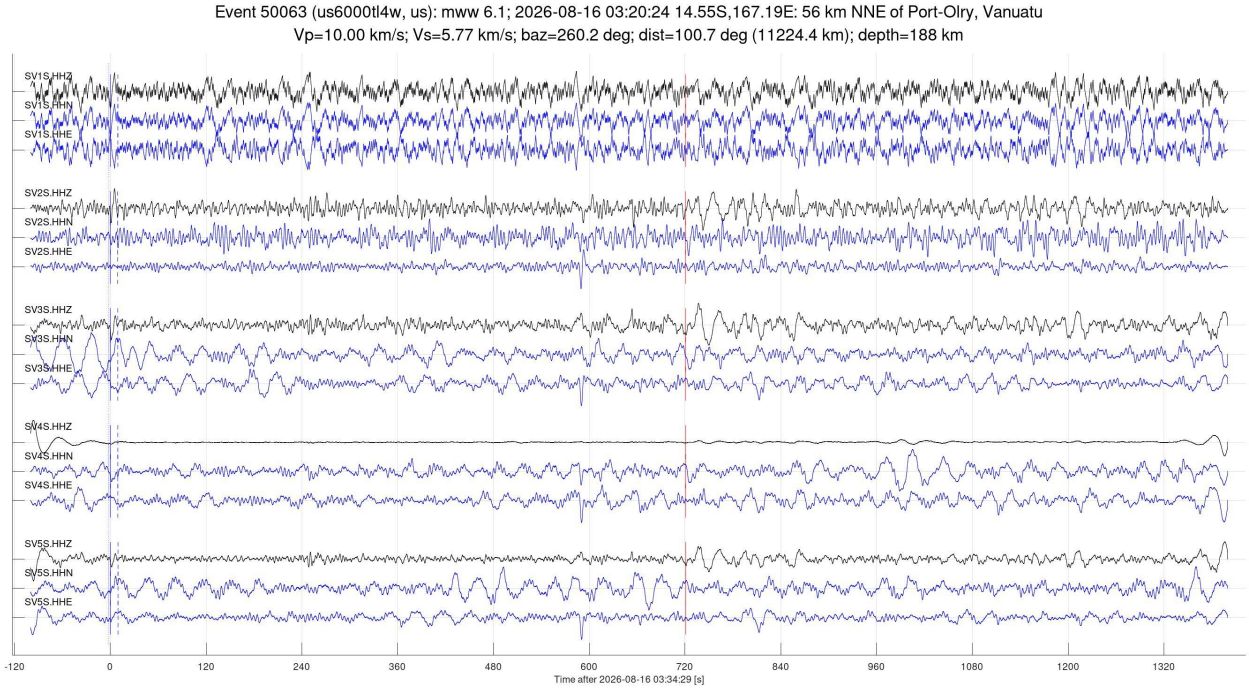

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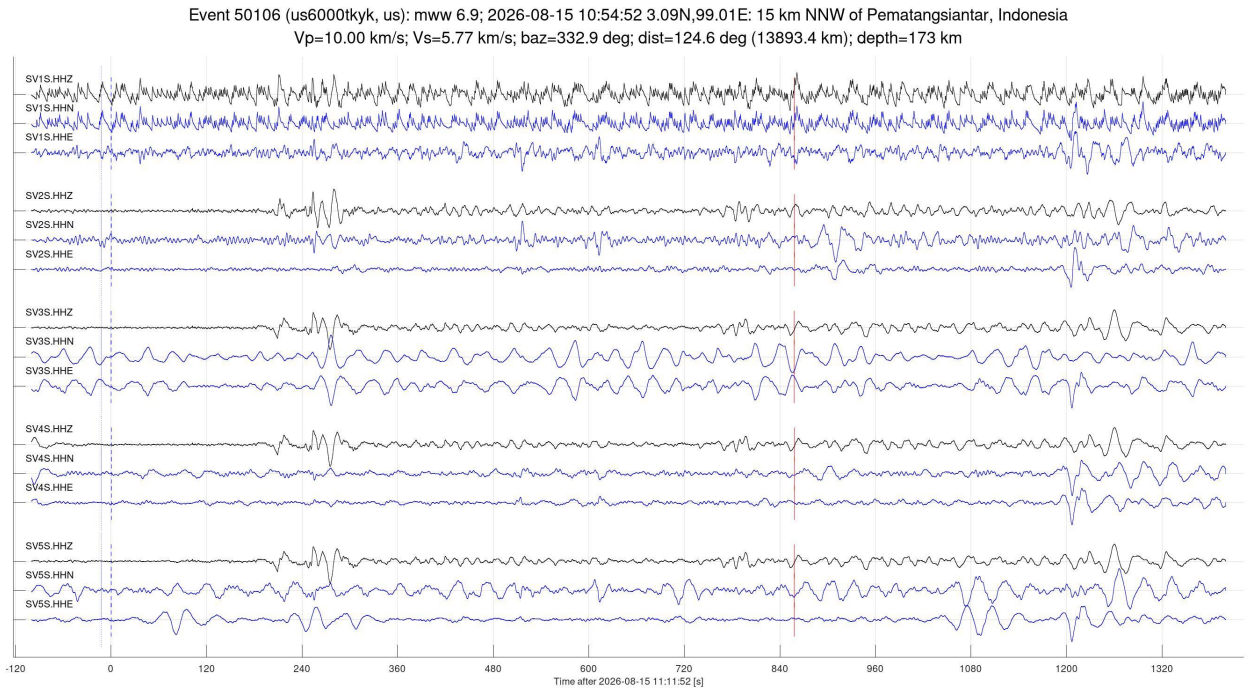

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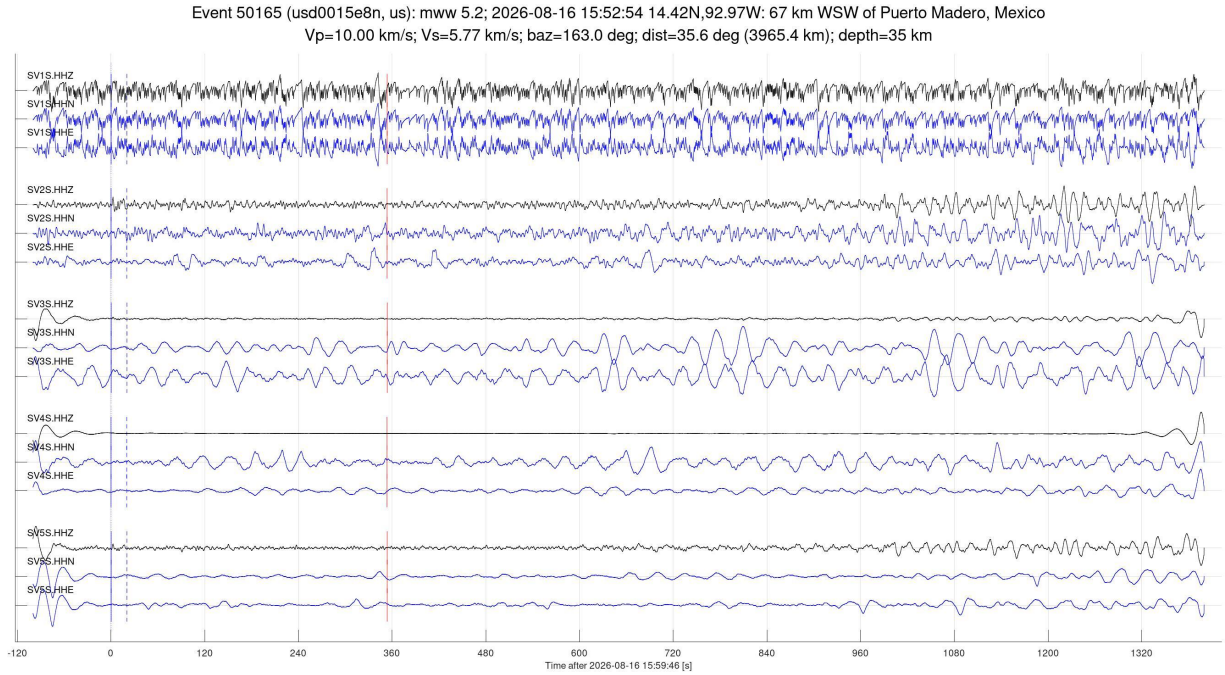

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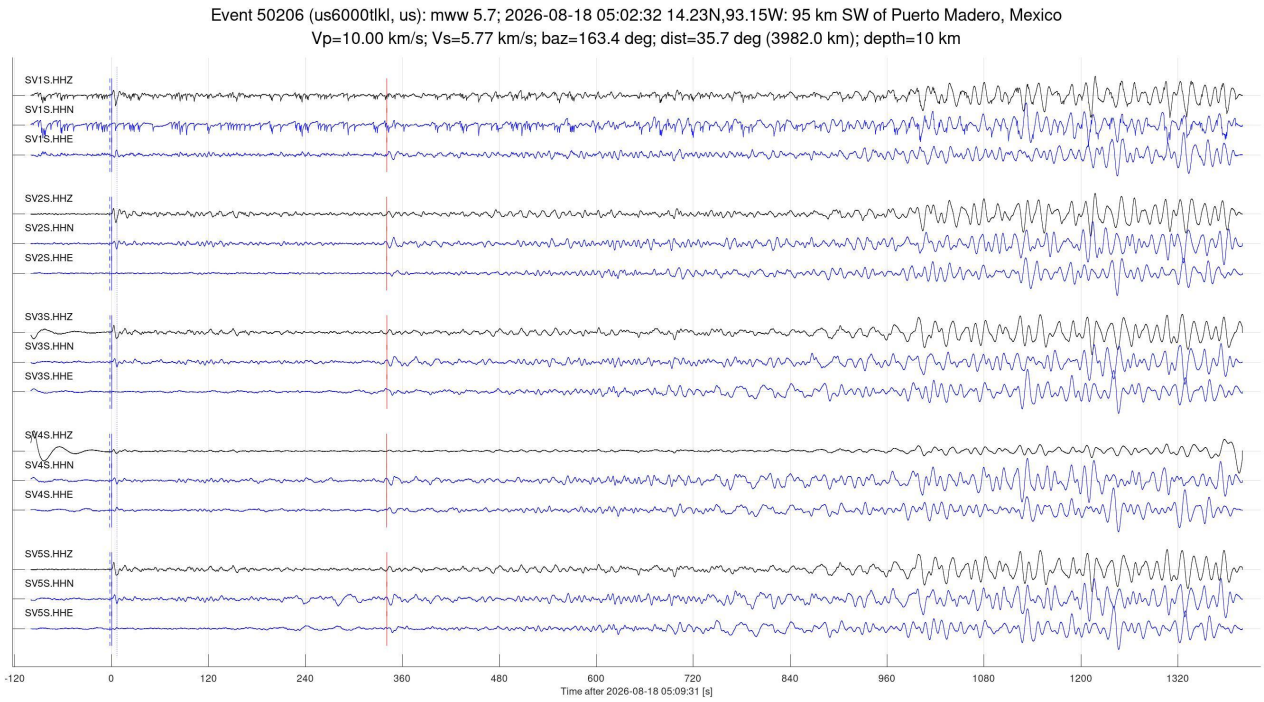

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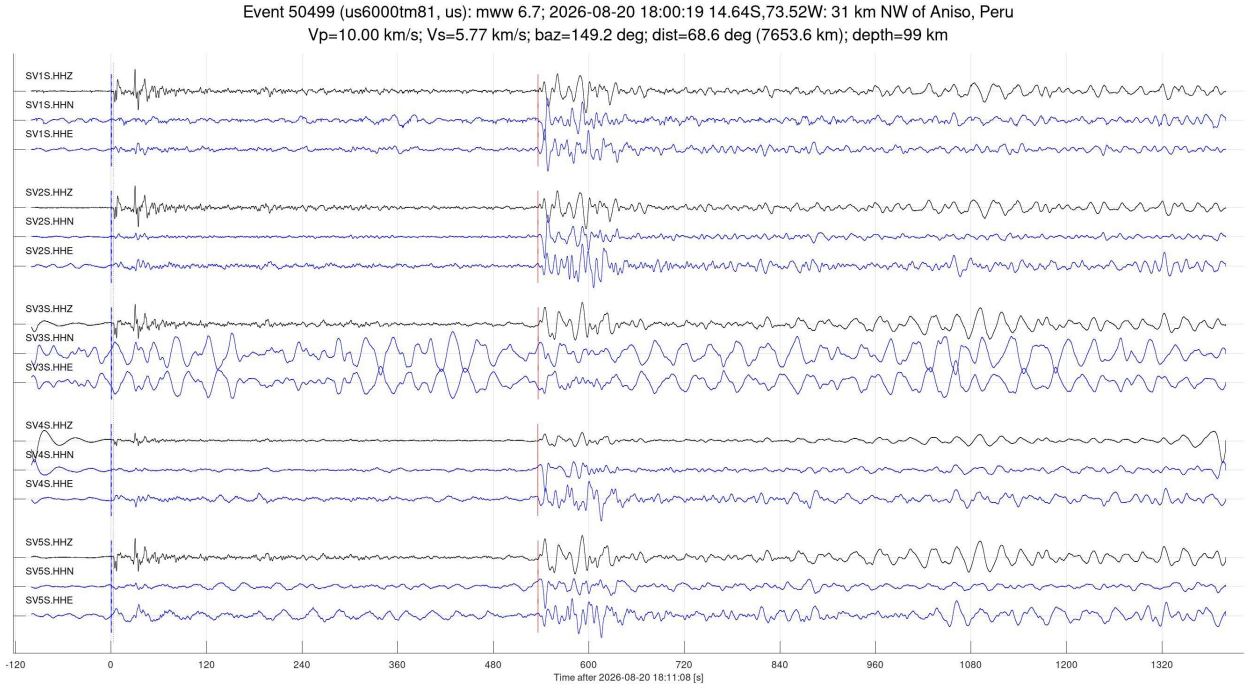

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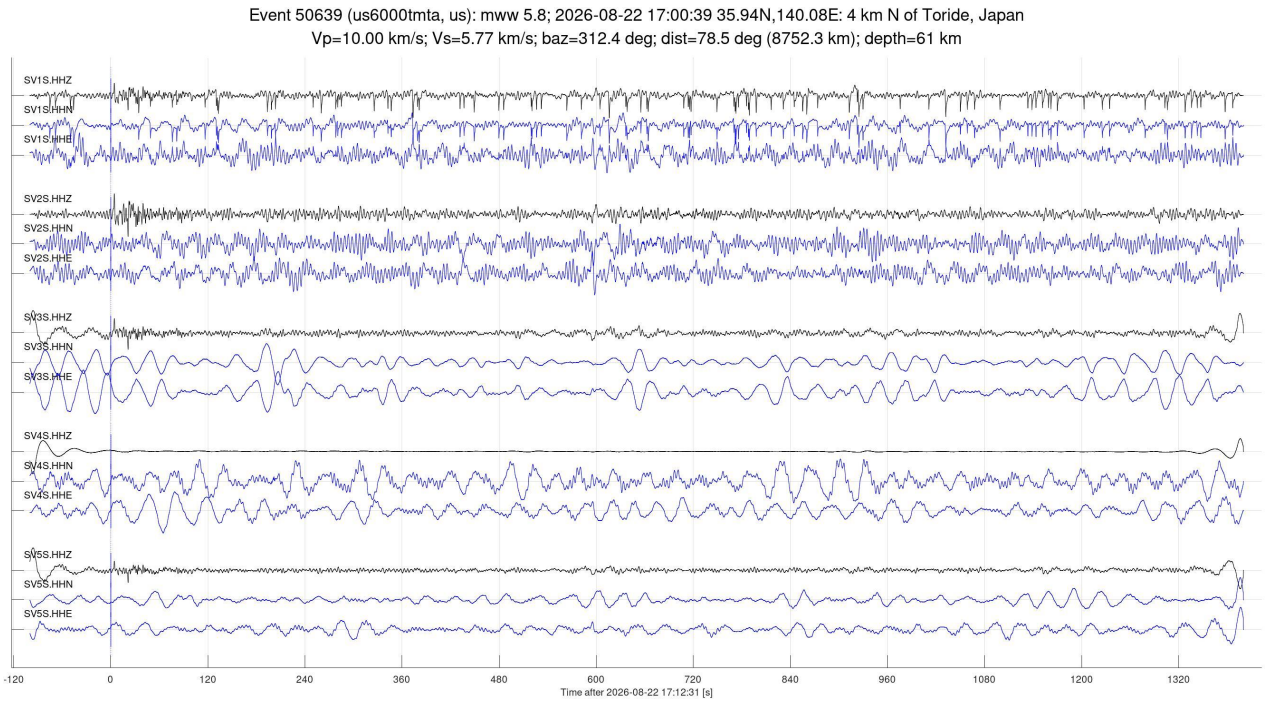

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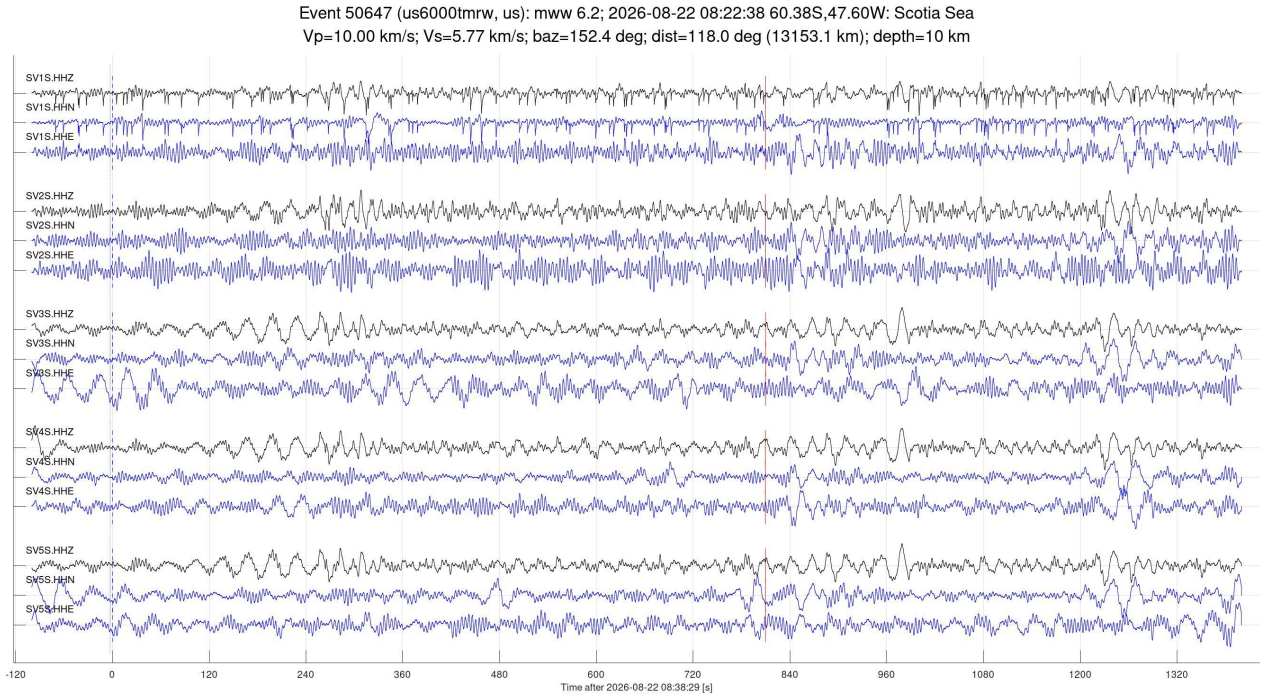

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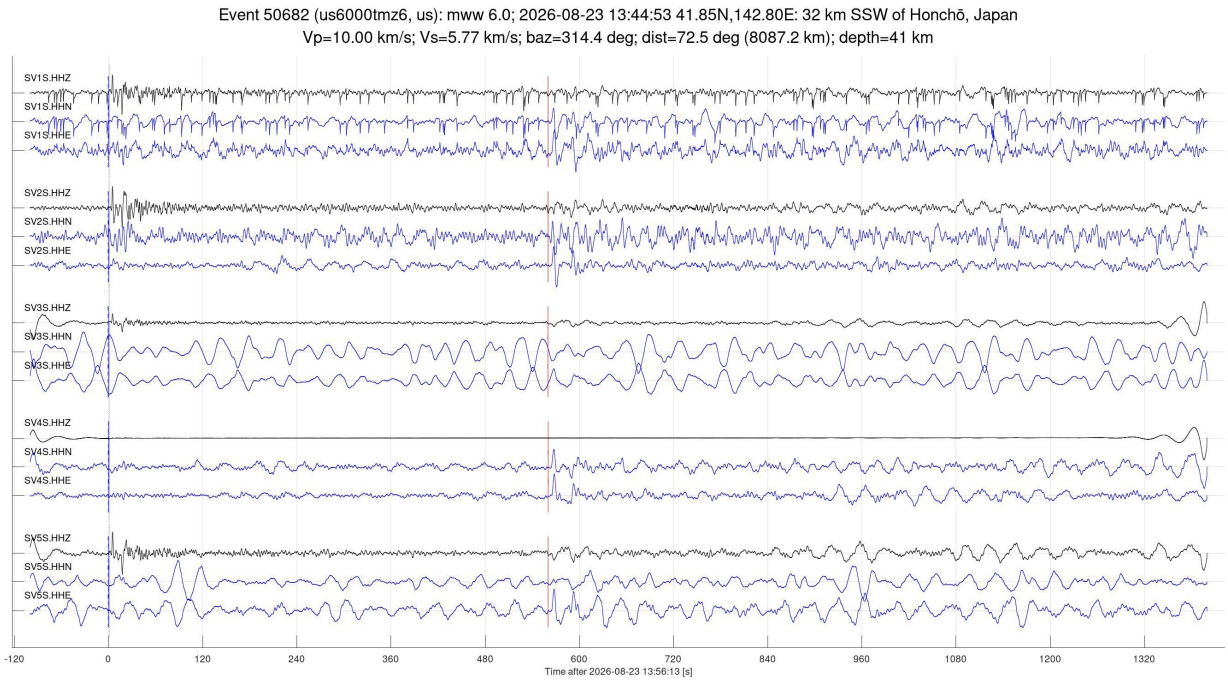

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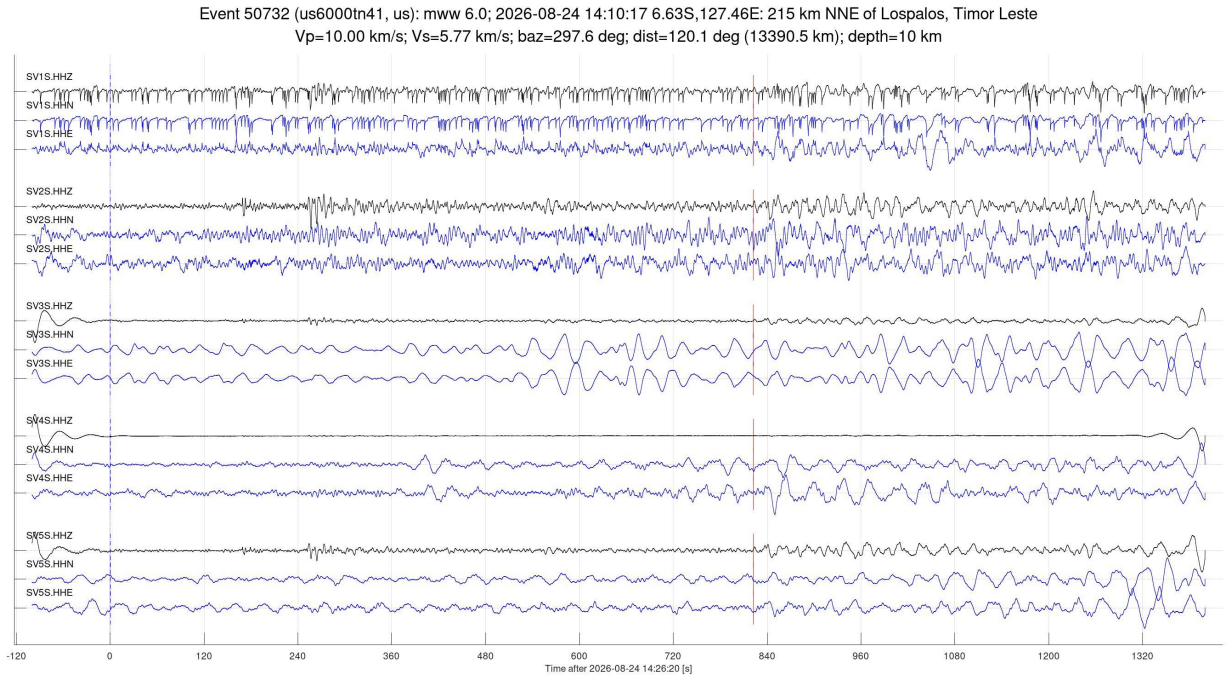

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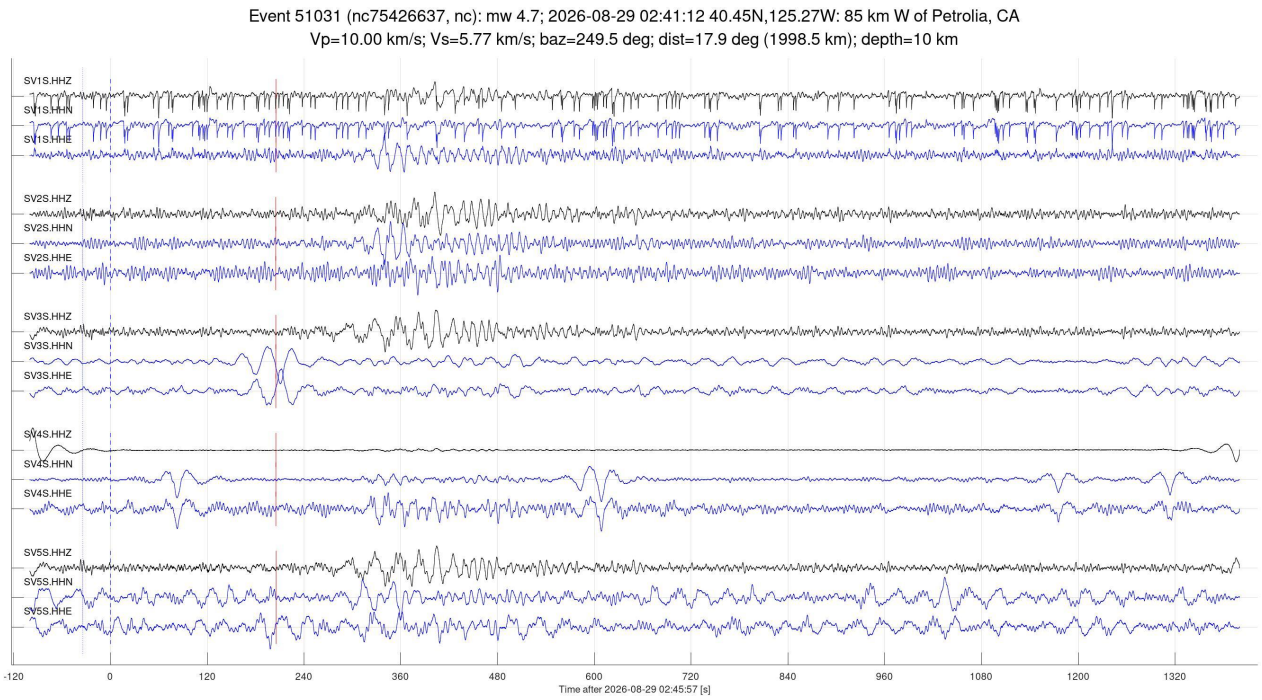

Figure 6, continued.

Regional events (class 2)

No regional seismic events (class 2 in Table 2) were identified in the reported period.

Local events (classes 3 and 4)

The following subsections summarize observations of event classes 3 and 4 in Table 2.

Possible mine blasts at the Estevan mine (class 3a)

Five events were identified as mine blasts in the area of Estevan coal mining (Figure 8). Similar to recent reports, these blasts appear to be located at distances around 25 km from the Aquistore array. Accurate location was not attempted.

In Figure 8, note the significantly noisier records from station SV1S. These plots show that the spike noise level is below the strong signals from mine blasts. However, it is still prohibitive for detecting weaker teleseismic arrivals and likely the potential events occurring within the target zone.

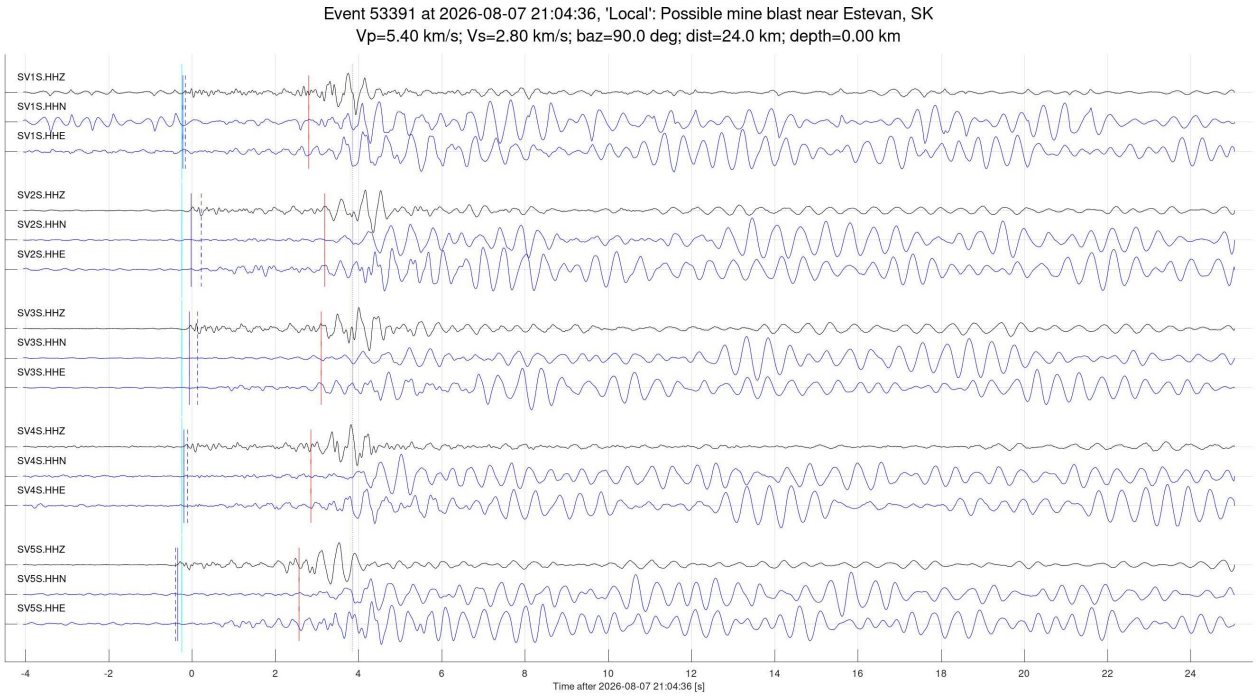

Figure 8. Seismic arrivals produced by mine blasts at the Estevan mine. Colours and labels are as in Figure 6.

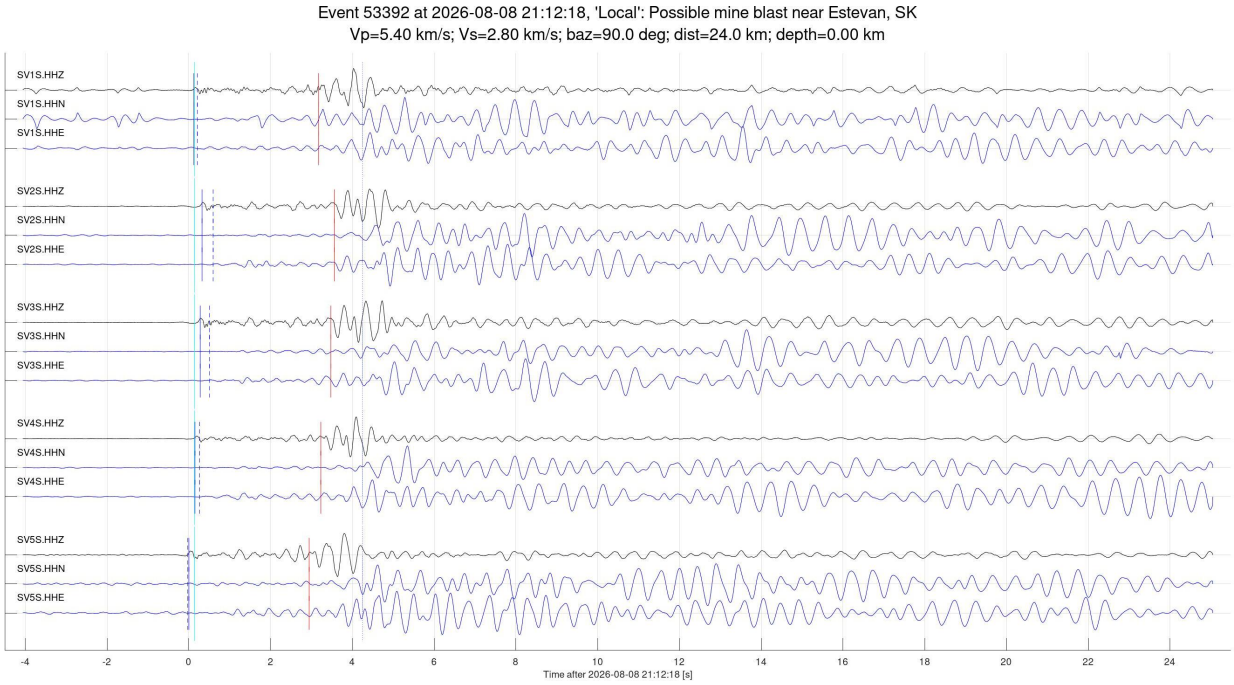

Figure 8, continued.

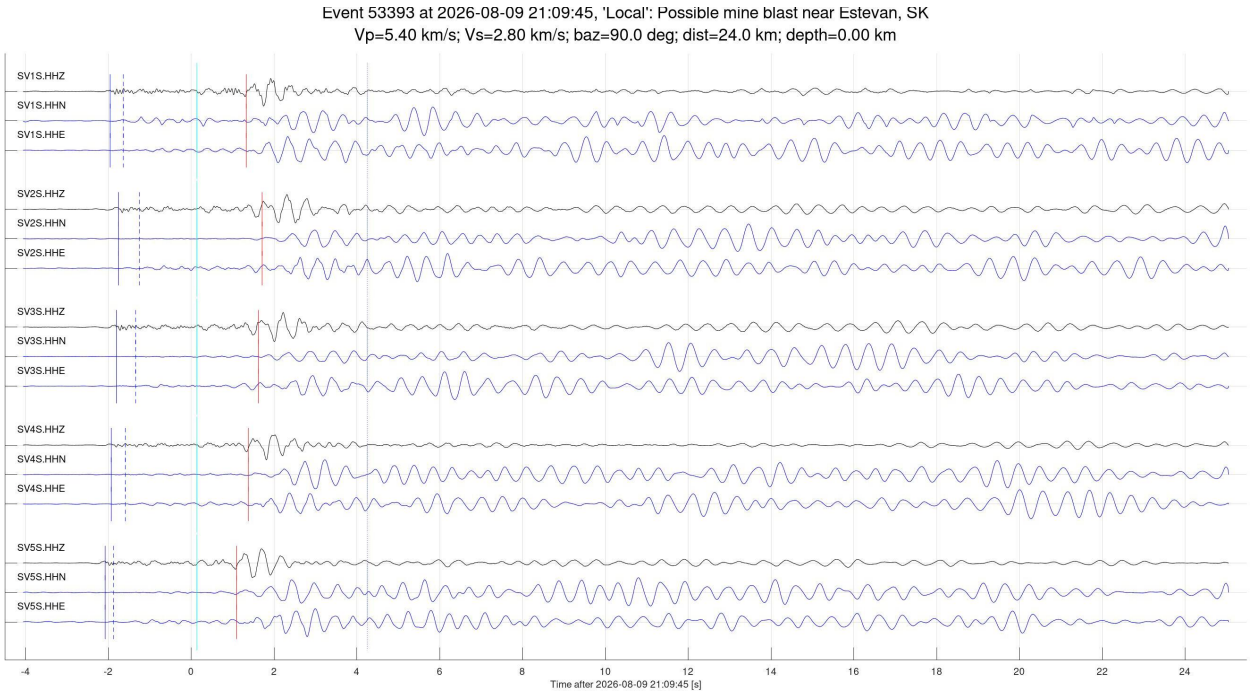

Figure 8, continued.

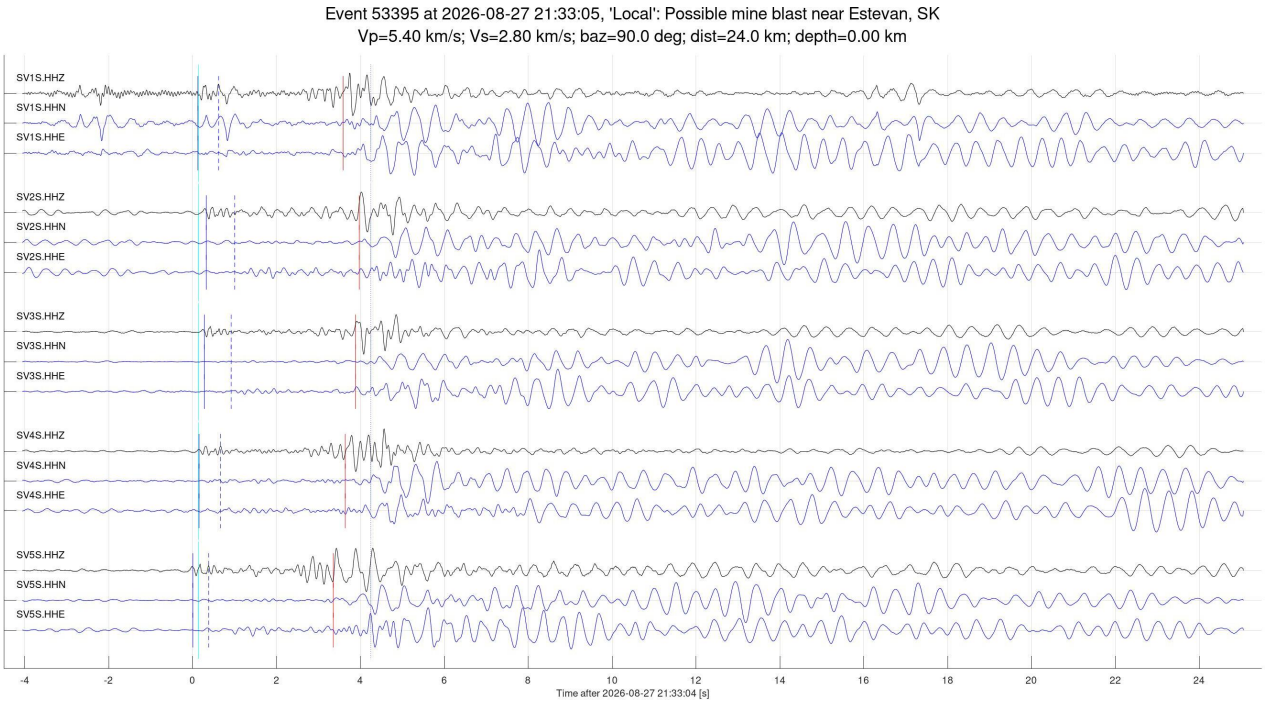

Figure 8, continued.

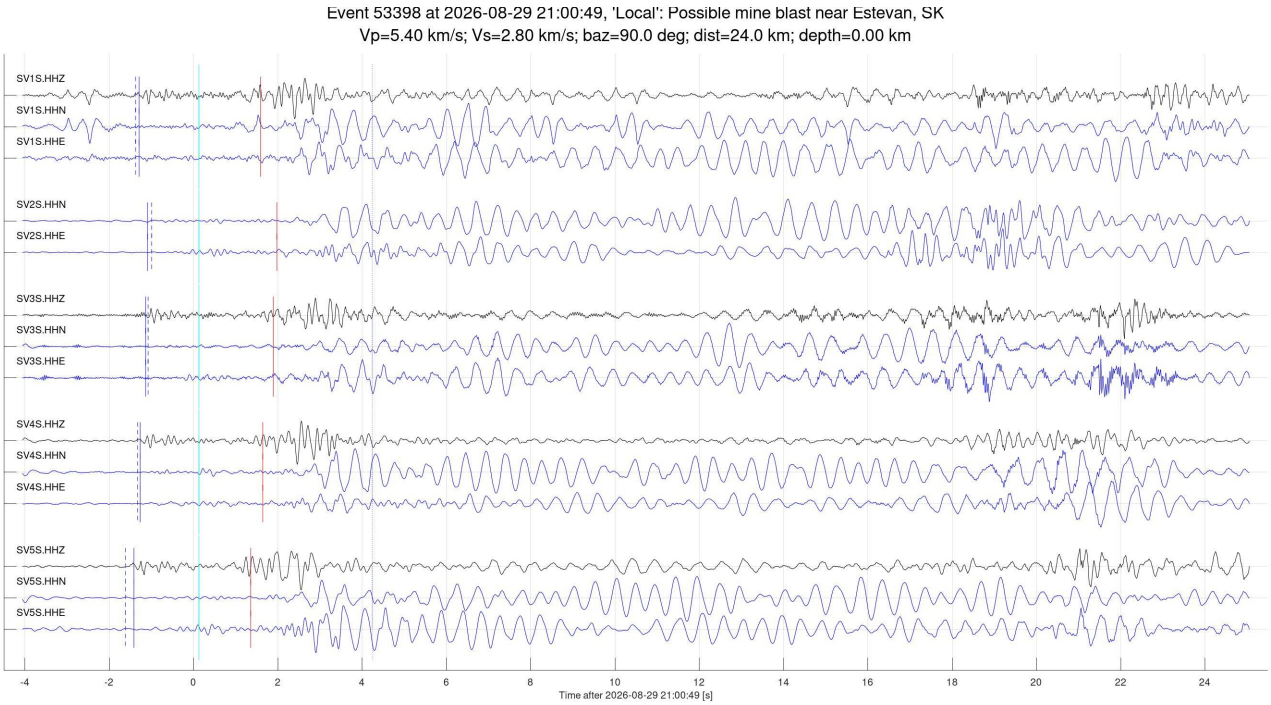

Figure 8, continued.

Events related to mining operations (class 3b)

Numerous mining- and industrial-operations related seismic events were observed in the area. Many such events may be produced by trains or surface waves from teleseismic and regional events. Figure 9 illustrates two such events.

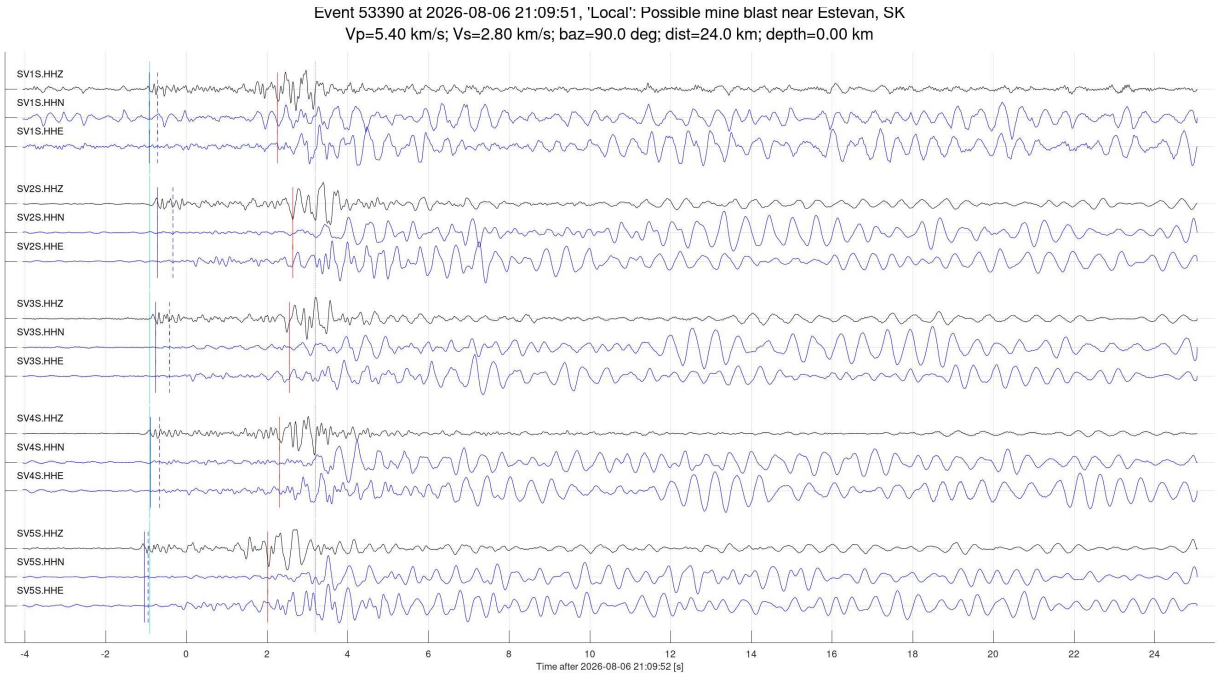

Figure 9. Sample events interpreted as due to mining activity in the area. Lines, colour bars and labels are as in the preceding figures.

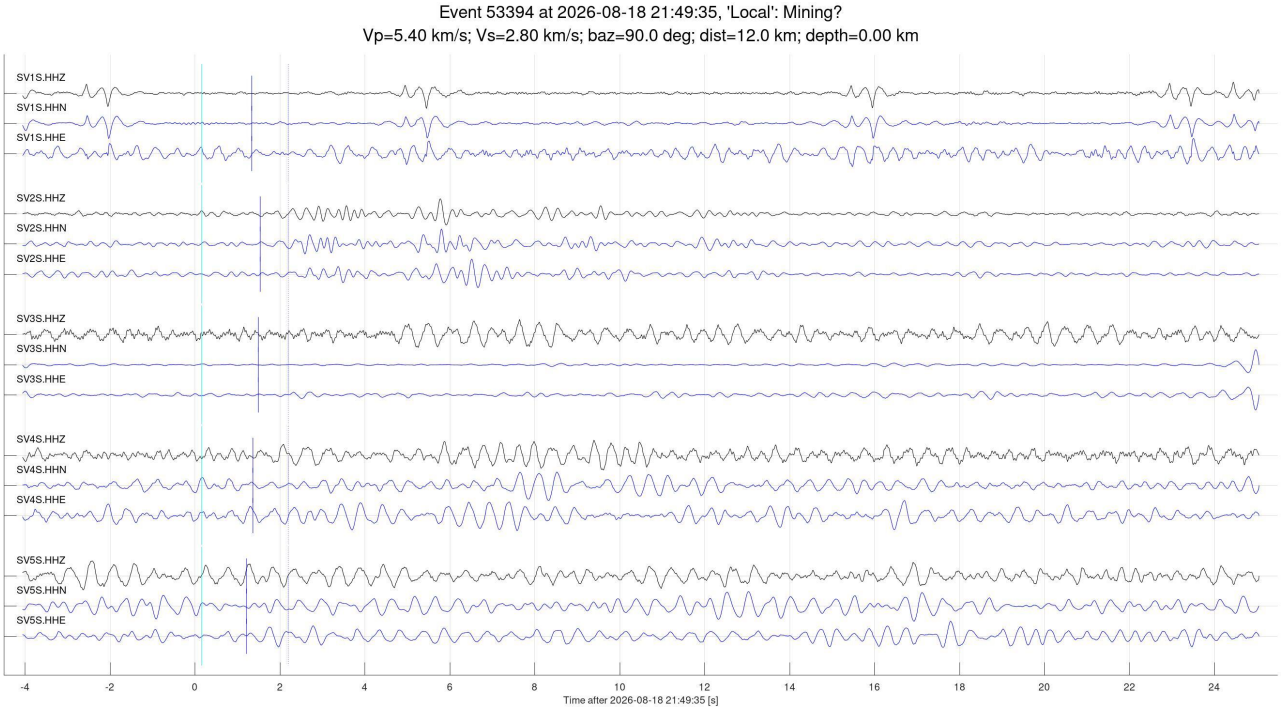

Figure 9, continued.

Events in array proximity (classes 4a and 4b)

Three seismic events were identified as possibly occurring in the proximity of the array (class 4a) (Figure 10). The waveforms (strong and compact strikes) appear typical of heavy machinery. Large time moveouts between stations suggest S waves traveling in a very low near-surface velocity of about 0.2 – 0.3 km/s. Clearly, these events originated close to the surface. These events appeared in clusters of which only selected occurrences are shown in Figure 10.

To illustrate one of these impulsive events more closely, Figure 11 shows a close-up view on event 53396 recorded at station SV3S. The waveforms look very similar to the seismograms produced by an impulsive surface source, such as mine blasts in Figure 8 but with much higher dominant frequency due to a closer location. From time separations between the P-, S-, and surface-wave arrivals, the source was likely located at 500-600 m south from station SV3S.

Records shown in Figure 10 also indicate a complex near-surface attenuation structure of the site. The surface-wave signals are of significantly higher frequency at station SV3S although stations SV2S and SV4S are located closer to the source. This difference can be explained by much lower near-surface wave attenuation near station SV3S. However, an alternative explanation of this difference may be in the use of a surface sensor Trillium 120P instead of the posthole Trillium Compact installed at all other stations. It may be that surface installations work better in this environment. This question needs to be investigated on similar impulsive sources or controlled sources conducted in the area.

No events which could be related to class 4b (impulsive, higher-frequency, and deeper) were found.

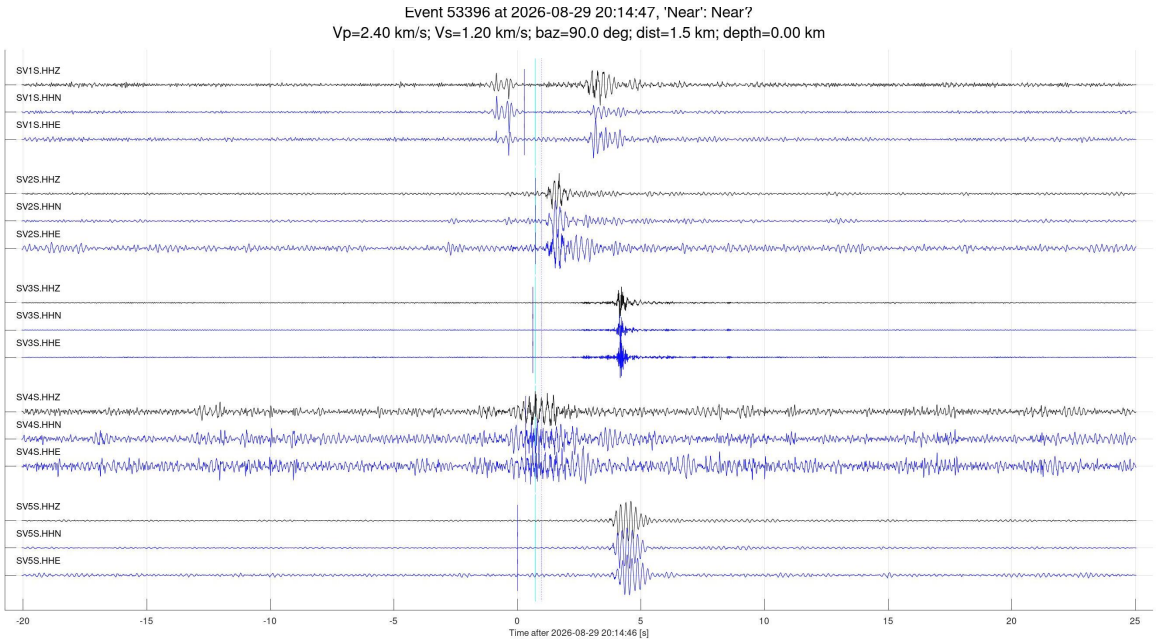

Figure 10. Possible event occurring near surface in the proximity of the array (class 4a in Table 2). Lines, colour bars and labels are as in the preceding figures. This event appears to be caused by heavy machinery operating near station SV3S.

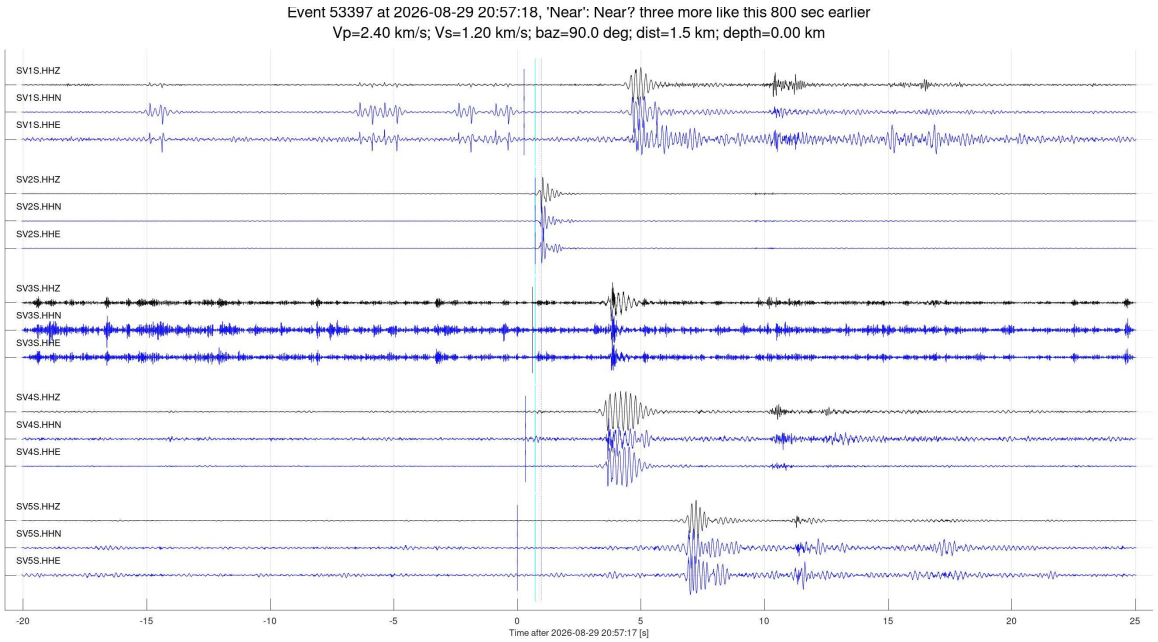

Figure 10, continued.

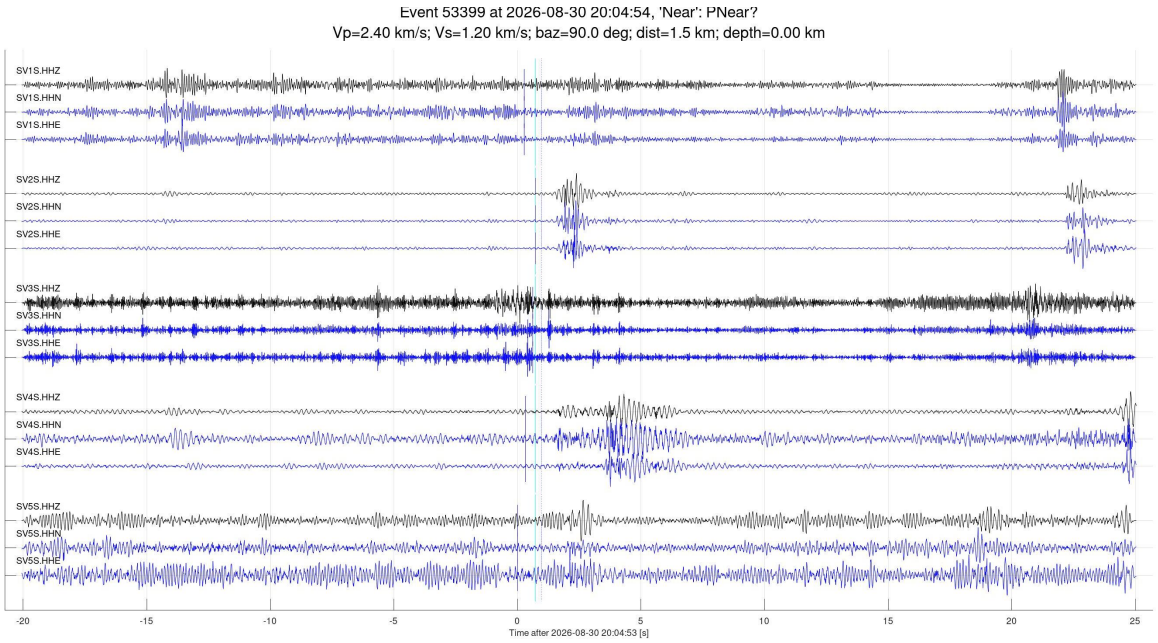

Figure 10, continued.

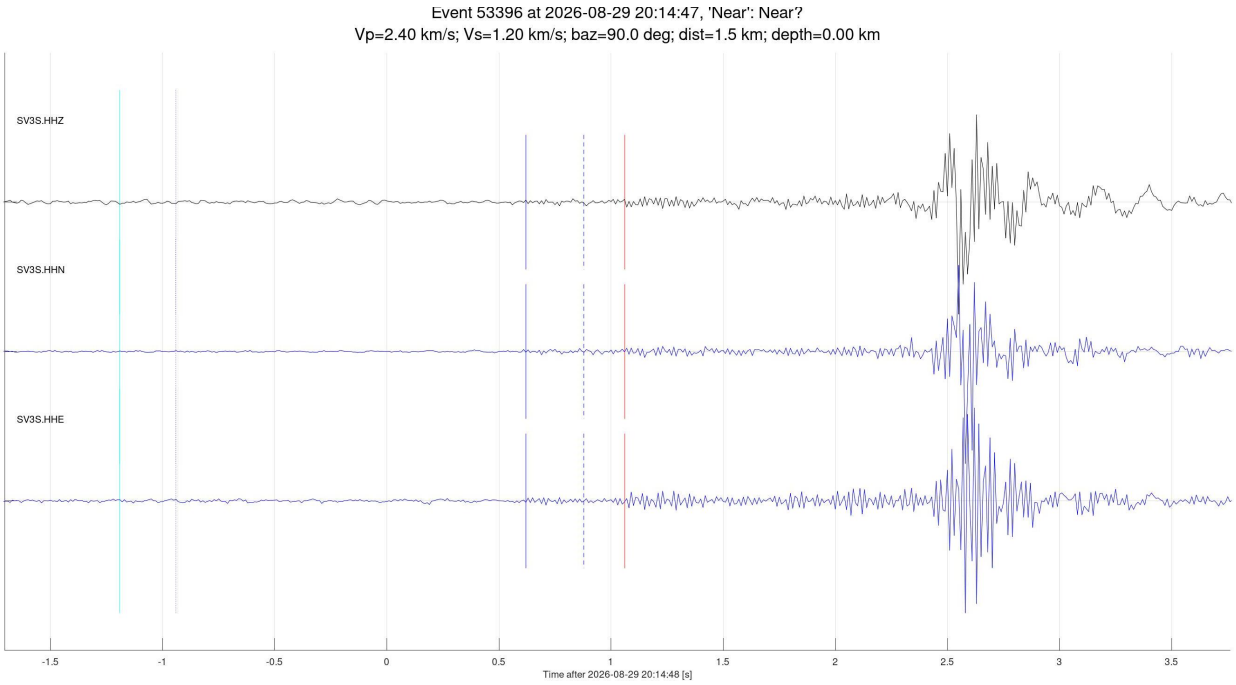

Figure 11. Detail of waveforms from event 53396 (Figure 10) at station SV3S. Note the P and S-wave arrivals (blue and red bars, respectively) and the strong surface wave following at about 1.5 s after the S wave.

5. SEGY files

Event time windows are provided in SEGY format in the attached zipped archive, separately for teleseismic and regional event detections. Subdirectory names and file naming convention and header formats are described in our reports for August and October 2024.

6. Conclusions and recommendations

Seismic array operation:

- Seismic data retrieval from all stations was nearly 100%.
- Records from station SV1S are strongly contaminated with persistent spikes. To correct this problem, replacement of the sensor cable is recommended.
- Intermittently, records from stations SV3S and SV4S also contain significant intervals of spikes.

Data and observations:

- 20 teleseismic events and five mine blasts were detected in August 2026.
- Numerous local events were observed, likely related to mining operations or freight trains. These events were not catalogued or analyzed in detail.
- Several impulsive events with near-surface sources related to industrial operations were identified in the vicinity of the array. These events need to be analyzed further to produce a velocity/attenuation model for the site and possibly make recommendations for improving the seismic deployment.
- No events occurring near the reservoir level were identified.