South Bruce Area Microseismic Monitoring Project, Annual Event Summary Report, November 2021 - December 2022

APM-REP-01332-0381 January 2023

Nanometrics

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South Bruce Area Microseismic Monitoring Project

Annual Event Summary Report

(November 2021 - December 2022)

Prepared for

NUCLEAR WASTE MANAGEMENT ORGANIZATION

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Nanometrics Document Number: NMX-NWMO–SB-AESR-2022

Revision: R1.2

NWMO Document #: APM-REP-01332-0381

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Revision Summary

Rev	Date	Authors	Comments
R1.0	2022-11-30	Jamie Conway, Krista Kaski, Alberto Vivas, Eugen Besoiu	Initial issue
R1.1	2023-01-15	Krista Kaski,Nate Hermawan, Alberto Vivas, Eugen Besoiu	Requested edits, added December 2022 data
R1.2	2023-01-24	Krista Kaski	Updated instances of NRCan to CHIS

ATTENTION: PLEASE READ CAREFULLY.

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Table of Contents

Abbreviations

AOI: Area of interest for the Microseismic Monitoring Program to detect and quantify microseismicity approximately 50 km around the South Bruce site.

APM: Adaptive Phased Management

CF: Characteristic function for trigger detection algorithm

CHIS: Canadian Hazards Information Service

IRIS: Incorporated Research Institutions for Seismology

Mc: Magnitude of completeness for the monitoring network

ML: Local magnitude scale

MSL: Mean sea level datum

NWMO: Nuclear Waste Management Organization

Program: Microseismic monitoring program for the South Bruce area

SNR: Signal to noise ratio

STA/LTA: Short-time average through long-time average trigger detection algorithm

Vp: Seismic propagation velocity of P-waves

Vs: Seismic propagation velocity of S-waves

WGS84: World Geodetic System (1984)

1. Introduction

The Nuclear Waste Management Organization ("NWMO") is responsible for implementing Adaptive Phased Management ("APM"), Canada's plan for the long-term management of used nuclear fuel. The ultimate objective of APM is the centralized containment and isolation of used nuclear fuel in a deep geological repository located at a safe site in an informed and willing host community. NWMO is committed to implementing the project in a manner that protects human health, safety, security and the environment, while fostering the long-term well-being of the community and region in which it is implemented.

The Microseismic Monitoring Program ("Program") in the South Bruce area is part of Phase 2 Geoscientific Preliminary Field Investigations of the NWMO's APM Site Selection phase. The objective of the Program is to install a network of five seismic stations (broadband seismometers) and provide continuous monitoring and reporting of earthquake activity for an Area of Interest ("AOI") around the potential repository area (i.e., South Bruce site) located in the southern Ontario (Figure 1). The Program seeks to develop the ability to detect and quantify microseismicity within a predefined region approximately 50 km around the South Bruce site (Figure 2).

Nanometrics was contracted by NWMO for the implementation of the Program. Work activities that have been included in the Program are:

- Design of seismic monitoring network,
- Initial field assessments of station locations,
- Installation and maintenance of stations,
- Data acquisition, archiving and processing, and
- Annual cataloging of data and seismic events detected in the AOI.

This report is prepared by Nanometrics. It includes an annual summary of the Program for activities performed in 2022 regarding network operations, seismic data processing and event detection. An overview of work done for the derivation of a velocity model as well as the assessment of event location accuracy and network magnitude of completeness are also presented in this report.

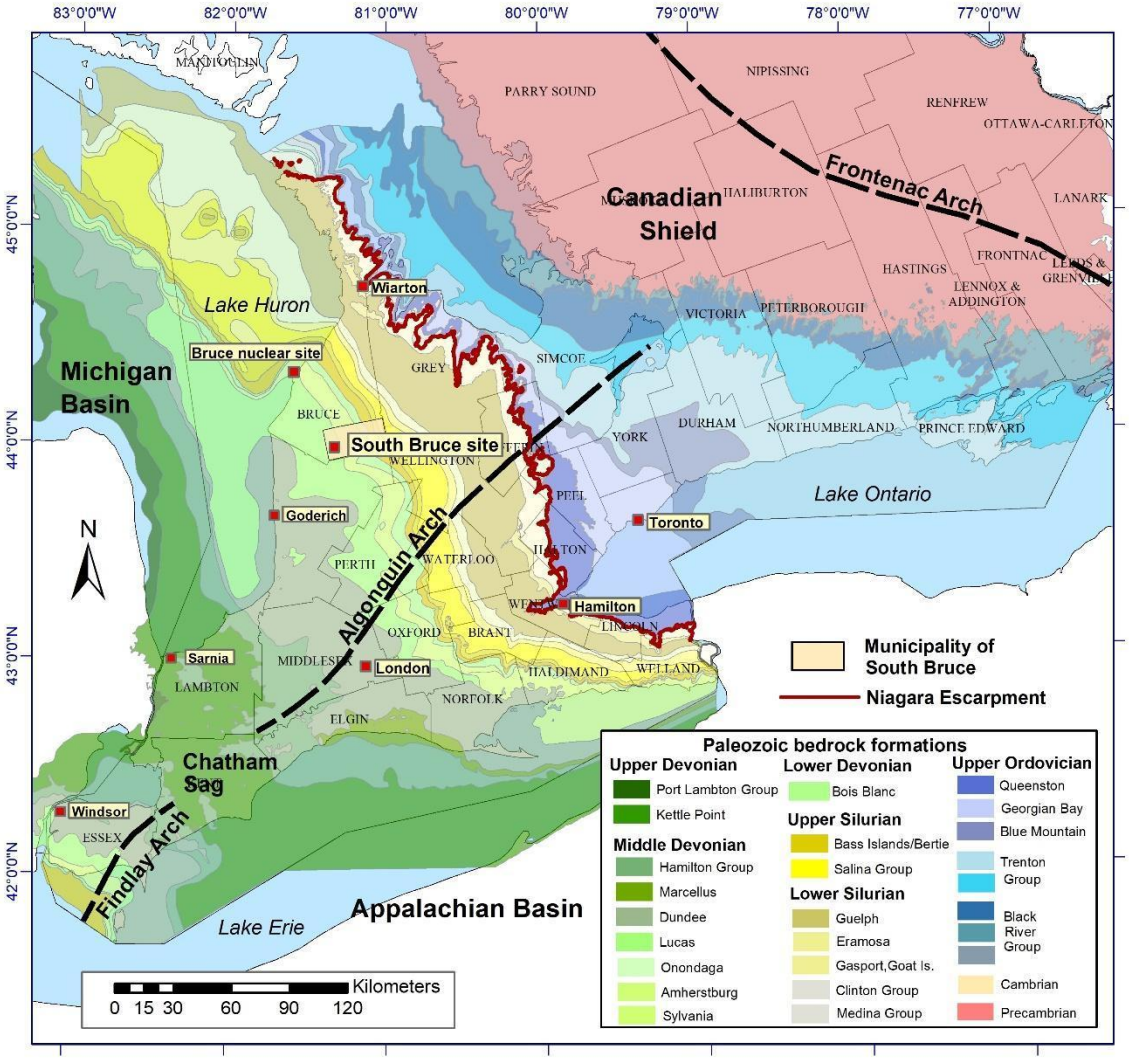

Figure 1. Bedrock geology of southern Ontario, derived from Somers (2017), Carter et al (2019, 2021) and Carter (2023).

2. Network Operations

A summary of operational activities, including the installation and maintenance of the monitoring network as well as the statistics on the station state of health and data completeness are presented in this section.

2.1. Seismic Monitoring Network

NWMO South Bruce seismic monitoring network consists of five stations (broadband seismometers), all located inside the AOI. All five of these stations stream data in real-time. The station locations are shown in Figure 2.

There are seven additional stations from public seismic monitoring networks in the area:

- WU.ACTO, WU.BASO, WU.BMRO, WU.BRCO, WU.BWLO, and WU.ELFO from the Southern Ontario Seismic Network, and
- N4.I49A from the Central and Eastern US Network

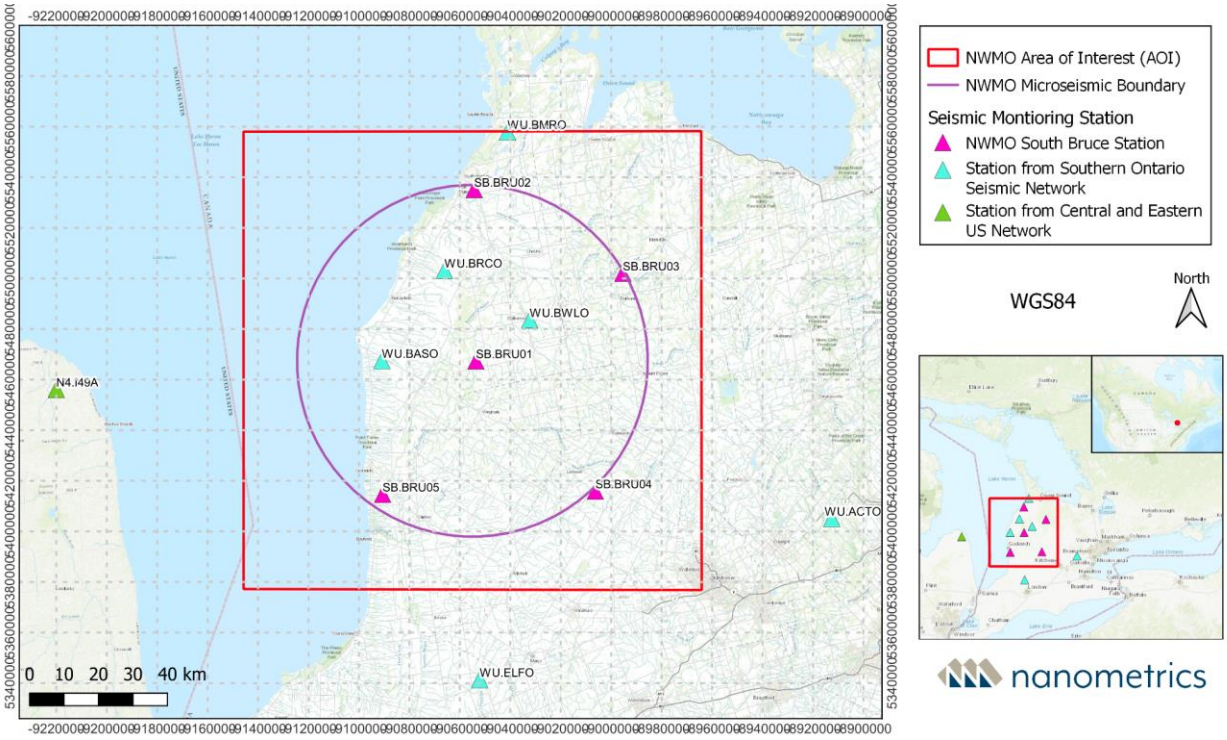

Figure 2. Locations of NWMO South Bruce stations within the AOI. Public stations from national seismic networks incorporated into the Program are also shown. Microseismic Boundary represents the 50 km area around the South Bruce site for microseismic monitoring. NWMO Area of Interest (AOI) represents the area defined by NWMO for detection, manual review and reporting of seismic activity.

These seven public stations are also included in the Program. Their waveform data are streamed from the Incorporated Research Institutions for Seismology ("IRIS") and included in the data processing for event detection.

2.2. Operational Statistics and Maintenance Records

The first South Bruce NWMO station (SB.BRU01) was installed close to one of the drilled boreholes, near the center of the network, on July 30th, 2021. The site surveys and the installation for the remaining four stations were completed in November 2021. Table 1 shows the installation dates for South Bruce NWMO stations.

Table 1. Installation dates of NWMO stations

Station	Installation Date
SB.BRU01	2021-07-30
SB.BRU03	2021-11-07
SB.BRU02	2021-11-08
SB.BRU04	2021-11-08
SB.BRU05	2021-11-09

Table 2 shows a summary of station maintenance activities performed in 2022. Detailed station maintenance records were delivered to NWMO as they occurred and reference can be made to those documents for detailed descriptions. NWMO has taken the ownership of maintenance visits to replace GPS antennas as needed.

Table 2. NWMO station maintenance details

Date	Station	Notes
2021-11-12	SB.BRU01	GPS antenna has been replaced
2022-05-17	SB.BRU01	The data recorder (Centaur) was replaced for a loaner data recorder. The digitizer removed from the station Serial number 8467 was shipped to Kanata for verification where the GPS engine was replaced under warranty, the same was installed back at the station with the

		South Bruce NWMO personnel help. The station has been recording and transmitting data with ~100% data availability
2022-05-17	SB.BRU02 SB.BRU03 SB.BRU04	Preventive maintenance was performed to replace the GPS antennas at the stations.

2.3. Station State of Health Summary

Nanometrics actively monitors the state of health for streaming stations. If cellular connection to a station is lost temporarily (i.e., no data transmission), the station will continue recording data, as long as it maintains battery life. When the connection is restored, data transfer continues and the incomplete data is automatically filled, typically allowing for the continuation of 100% data collection. Stations were installed in rural areas and are working on batteries with the help of solar panels. Table 3 shows the station data availability (in percent) from November 1st, 2021 to December 31st, 2022, on a monthly basis. Tables provided in Appendix A show data availability on a daily basis. The South Bruce stations have not experienced any data lost since the installation.

Table 3. Station data availability (in percent) from November 2021 up to and including December 2022.

Station	November 2021	December 2021	January 2022	February 2022	March 2022	April 2022	May 2022
SB.BRU01	100	100	100	100	99.9	100	99.9
SB.BRU02	76.7	100	100	100	100	100	100
SB.BRU03	79.2	100	100	100	100	100	100
SB.BRU04	76.6	100	100	100	100	100	100
SB.BRU05	73.3	100	100	100	100	100	100
	June 2022	**July 2022**	**August 2022**	**September 2022**	**October 2022**	**November 2022**	**December 2022**
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

3. Seismic Data Processing

An overview of seismic data processing workflow for the detection and characterization of seismic events is presented in this section.

3.1. Automatic Event Detection

Seismic monitoring stations continuously record ground vibrations generated by anthropogenic activities (e.g., mining/quarry blasts - discussed in Section 6) and natural phenomena, including earthquakes. The NWMO South Bruce stations are equipped with highly sensitive seismometers that can detect vibrations well-below human perception. The recorded data are streamed to the Nanometrics Cloud Data Center in near real-time, for data processing.

The continuous waveform data acquired from each station is processed through a short-time-average through long-time-average ("STA/LTA") trigger detection algorithm. The algorithm predicts a characteristic function ("CF") of the signal based on continuously-moving short-time and long-time windows and declares a trigger when the CF exceeds a pre-set threshold. The automatic processing system declares an event when a minimum of four time-correlated seismic phase arrivals are picked at a minimum of four stations.

3.2. Manual Review

Not every automatic event detection would necessarily be associated with an earthquake. Event waveforms are reviewed by experienced analysts on a next day basis, in order to confirm if they are seismic activities or are non-seismic events due to anthropogenic activity. False positives (incorrect classification of random noise) is removed. For confirmed events, the review process also involves adjustment of automatic picks for phase arrivals and peak amplitudes, if deemed necessary, in order to ensure the quality of event solution (origin time, hypocenter location and magnitude). Following the manual adjustment of phase and amplitude picks, events are re-processed to determine the final event solutions.

Earthquake hypocenter locations are determined based on an 3D velocity model derived from velocity data provided by NWMO (reader is referred to Section 5 for details about velocity models).

Events that fall outside of the AOI after manual review are not included in the Program.

Event magnitudes are determined in terms of Richter local magnitude ("ML") based on a model proposed by Hutton and Boore (1987). Seismic events detected within the AOI are posted to Nanometrics Athena seismicity web portal for NWMO to review.

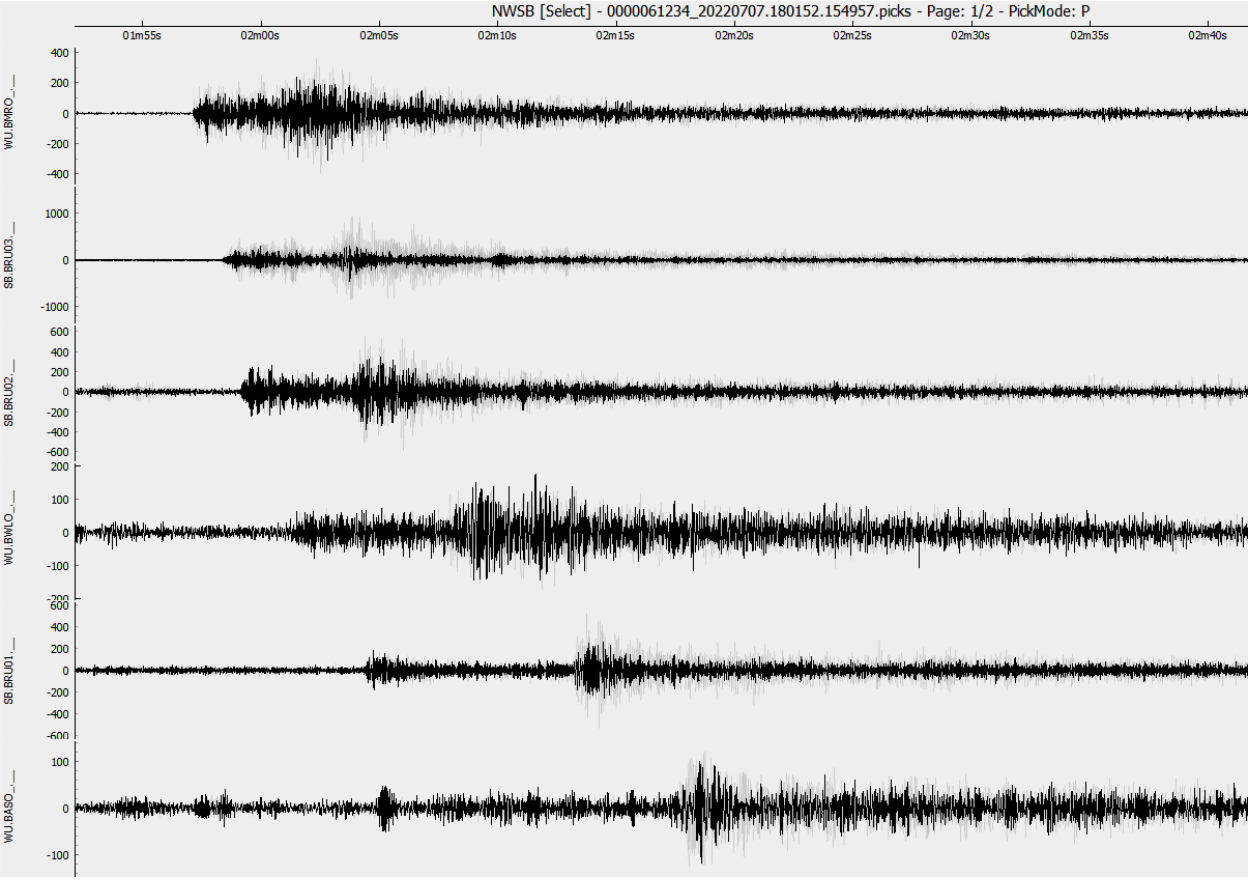

Figure 3. An event detected on July 7th, 2022 that was located inside the AOI - included in the Program.

4. Network Performance

A summary of the network performance based on automatic event detections is provided in this section.

Automatic event detection is not bounded by the AOI to ensure no events are missed due to automatic event location quality. This results in a large number of automatic event detections, with an average of ~6500 events per month. A total of 94,981 events were detected across the region from November 1st, 2021 to December 31st, 2022. Figure 4 shows the distribution of automatic event detections on a monthly basis.

The vast majority of these events were either false positives (detection of random noise) or events that landed outside of the NWMO South Bruce area of interest following manual processing. Several upticks in automatic event detections can be noted, such as in the month of December 2021. Common causes for such influxes of automatic detections are high wind patterns that cause increased vibrations at stations due to the shaking of trees and poles nearby. This can be noted in the months of December 2021, March 2022, and April 2022.

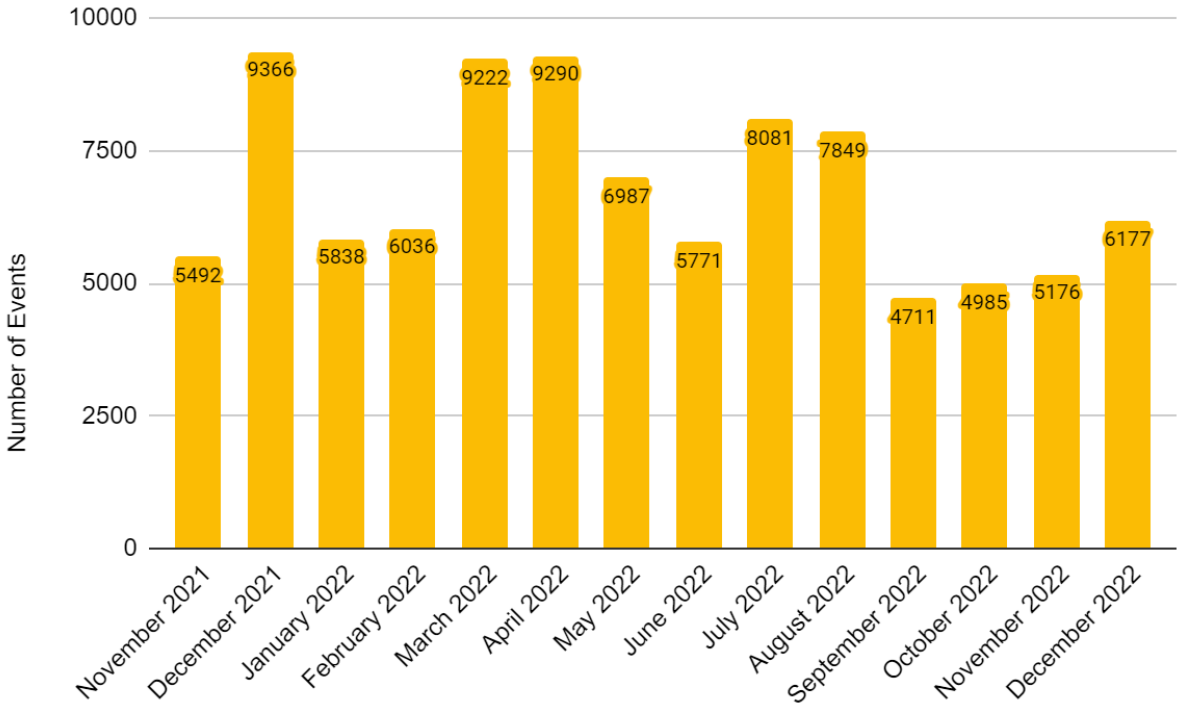

Figure 4. Rates of automatic event detections on a monthly basis

5. Seismic Velocity Model

A velocity model provides information on the seismic velocities present in the underlying geologic structure in an area (i.e. the speed with which seismic waves travel through the subsurface). Seismic velocity information allows for an estimation of distance between an event hypocenter and a recording station. Utilizing this information from several stations allows for the triangulation of earthquake hypocenters.

5.1. 3D Velocity Model

NWMO has supplied Nanometrics with sonic log and geological horizon data in order to develop a 3D velocity model for the South Bruce region.

Below are the steps used to create a 3D velocity model.

- Define 3D grid space and gather nearby velocity information
- Velocity information (sonic logs) is passed through a moving average in Z direction to filter sharp contrasts
- 2D velocity layers are generated by interpolating the available data
- Working with depth slices (layers) the velocity is smoothly interpolated across the grid space
    - Horizons are used to guide the sonic information
- Prior to interpolation,a cross-validation technique is applied to automatically remove poor data and limit sharp velocity contrasts within the model
- The final 3D volume is constructed by assembling the interpolated layers of the model
- Finally, a 3D smoothing algorithm is applied to further reduce sharp velocity contrasts which is required to improve event location stability within Nanometrics grid-search algorithm

Figure 5 shows the area covered by the velocity model relative to the AOI.

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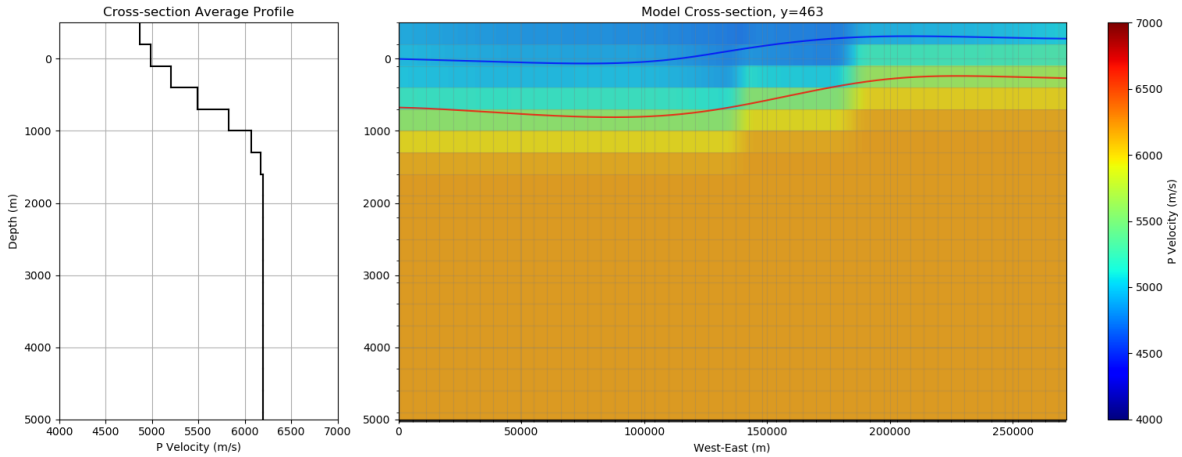
Figure 5. Velocity model extent displayed as orange box and cross-section highlighted by black dashed line. Red square shows the AOI and the pink circle represents the microseismic boundary.

Figure 6 shows Vp and Vs cross sections of the 3D velocity model along AA' line on figure 5.



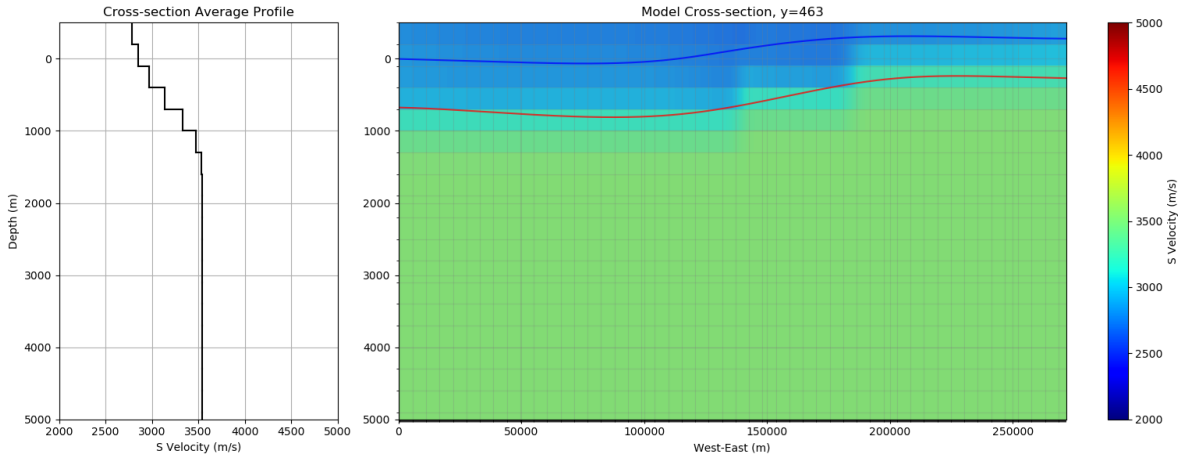


Figure 6. Top: Vp cross-section and **Bottom:** Vs cross-section of the 3D velocity model. The left panels display a cross-section average profile, the right panels display cross-section velocity. The velocity model is extended to 20 km depth.

The 3D velocity model is tested against seismic events detected within the AOI. Based on this preliminary assessment, Nanometrics has started a daily manual review of automatic events and the 3D velocity model provided herein is in use for locating manual events. This model will require further assessment and refinement upon detecting approximately 100 events. The event locations will be re-calculated based on the 3D velocity model when it is finalized.

6. Event Activity within the AOI

This section provides a summary of events observed within the AOI from November 1st, 2021 to December 31st, 2022.

A total of 13 events were observed within the AOI. 1 seismic event was observed with a local magnitude of 0.84M, and 12 quarry blast events were observed with a magnitude range of 1.02Ml to 1.89Ml. The largest event occurred on June 24th, 2022. Figure 7 shows the location of the events observed within the AOI relative to the monitoring network and Table 4 provides a list of these events and their key attributes. The only seismic event to date has a depth of 6.75 km, noted blast events in the area range in depth from -0.492 km to 1.32 km relative to mean sea level. The event depths were calculated based on a preliminary 3D velocity model. Depth estimates of blast events are approximate due to their distal location

relative to the seismic array, and the preliminary nature of the velocity model. Waveforms obtained from these events are included in Appendix B.

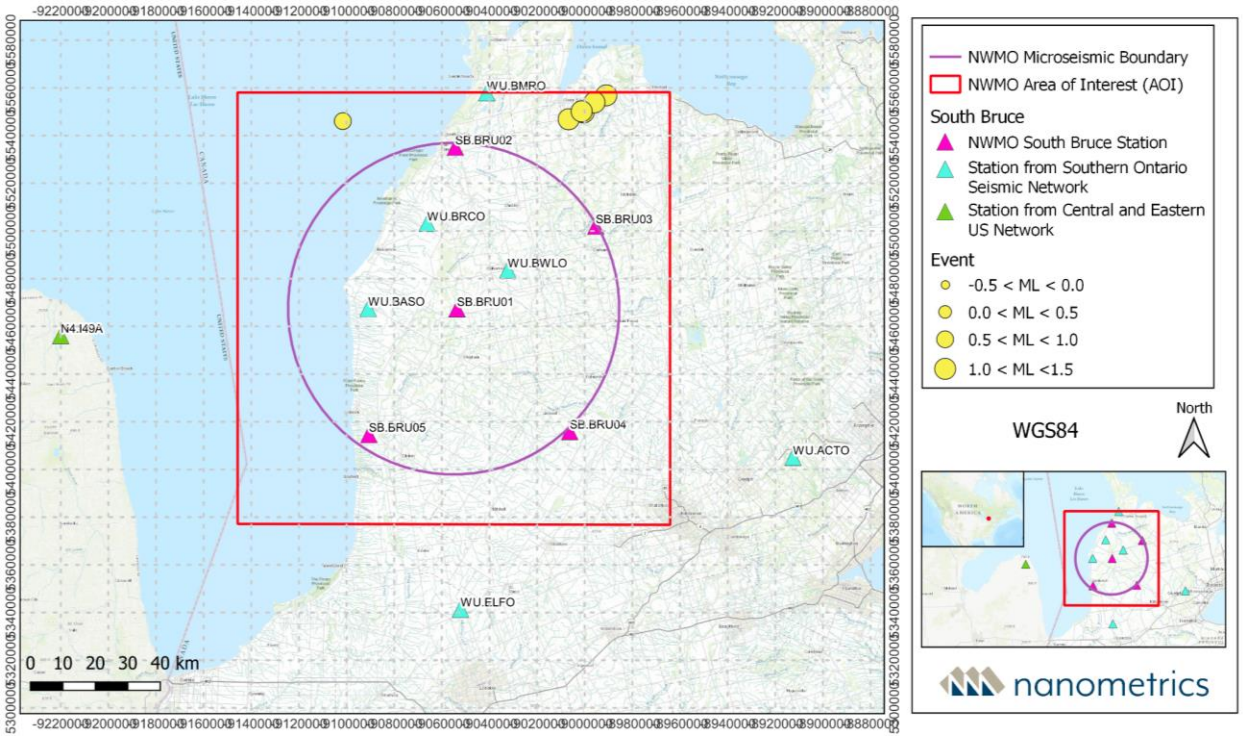


Figure 7. Events observed within the AOI from November 1st, 2021 to December 31st, 2022. The cluster of events to the North East of the AOI is associated with a quarry blast.

Table 4. Events detected within the AOI from November 1st, 2021 to December 31st, 2022

Earthquake Origin Date and Time (UTC)	Latitude (WGS84)	Longitude (WGS84)	Depth (km)	Local Magnitude (ML)	Number of Stations with Phase Picks	Number of Phase Picks	Event Type
2022-11-23 17:35:51	44.55628	-80.8528	-0.4919	1.63	6	6	blast
2022-11-14 17:11:51	44.59416	-80.7863	1.2951	1.74	6	6	blast
2022-10-20 18:38:56	44.57006	-80.8348	-0.4838	1.6	6	6	blast
2022-09-29 17:30:57	44.54594	-80.8832	1.2951	1.9	5	5	blast
2022-08-25 16:47:22	44.5879	-80.7666	1.3274	0.98	5	5	blast

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2022-08-06 22:31:42	44.51865	-81.7605	6.749	0.84	5	7	
2022-07-07 18:01:52	44.54208	-80.8523	1.2951	1.34	6	6	blast
2022-06-24 16:38:18	44.56521	-80.8187	0.5431	1.65	6	6	blast
2022-06-07 18:07:15	44.56898	-80.8111	-0.4677	1.27	7	7	blast
2022-05-10 16:31:02	44.53195	-80.8919	1.2951	1.72	5	5	blast
2022-04-12 16:31:32	44.52365	-80.9086	-0.4919	1.42	6	6	blast
2022-03-01 18:02:13	44.54487	-80.8596	-0.2089	1.37	5	5	blast
2021-11-29 21:08:16	44.54337	-80.8626	0.0337	1.53	5	5	blast

Figure 8 shows the rate of seismic activity in each month.

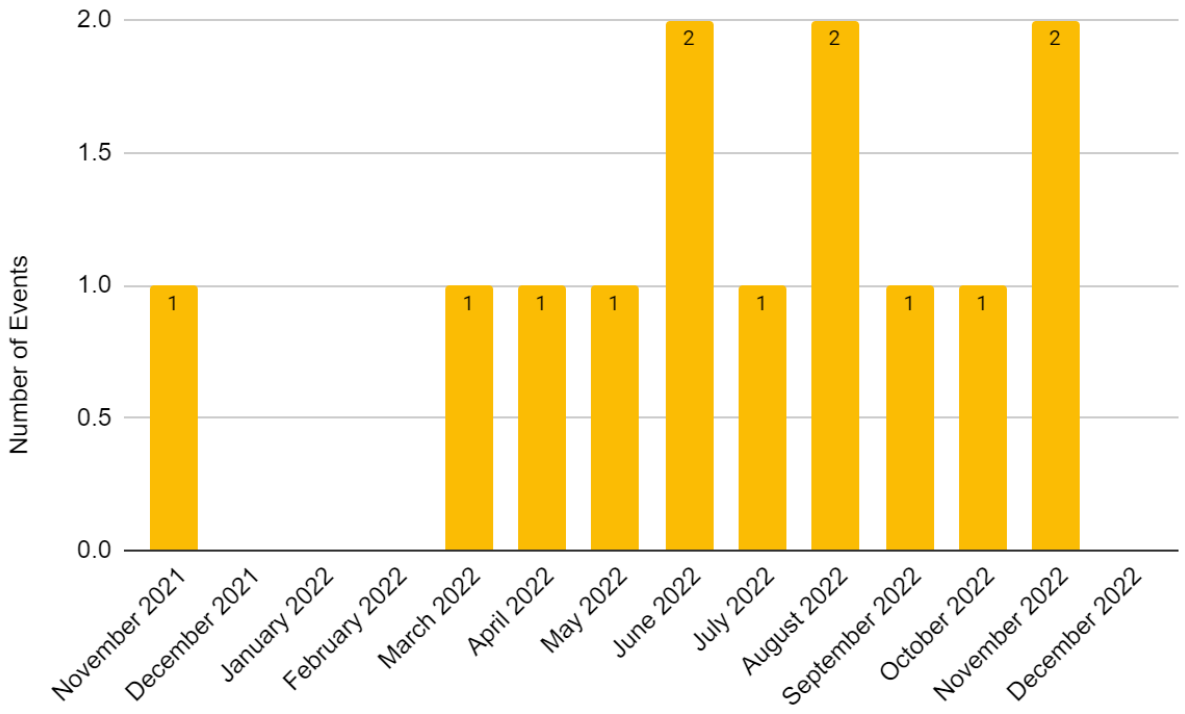

Figure 8. Number of events observed within the AOI on a monthly basis

7. Anthropogenic Activity

There are a few active quarries located within 150 km of the NWMO network (the maximum distance that an event from a nearby anthropogenic source can be detected). Blasting activities at these quarries are one of the major sources of events detected by the automatic processing system. In the manual review stage, non-seismic events, including mining/quarry blasts, are identified by experienced analysts by visual inspection of recorded waveforms in terms of presence and motion of seismic phases (P and S waves), Wood-Anderson simulated traces, and their correlated timing at multiple stations.

Events detected by the Canadian National Seismograph Network are reviewed and categorized by the Canadian Hazards Information Service ("CHIS") depending on their sources. The historical event catalog is accessible from the Earthquakes Canada website (https://chis.nrcan.gc.ca/index-en.php). Figure 9 shows seismic and anthropogenic events identified by CHIS in the region from November 1st, 2021 to December 31st, 2022 (the event list is provided in Appendix C). The events associated with blasting activities by CHIS are clustered around the Sydenham and Milton quarries in Canada.

Most of these events are quarry blasts. However, there are a few events that are labeled by CHIS as seismic events. The seismic events are also included in the event list in Appendix C.

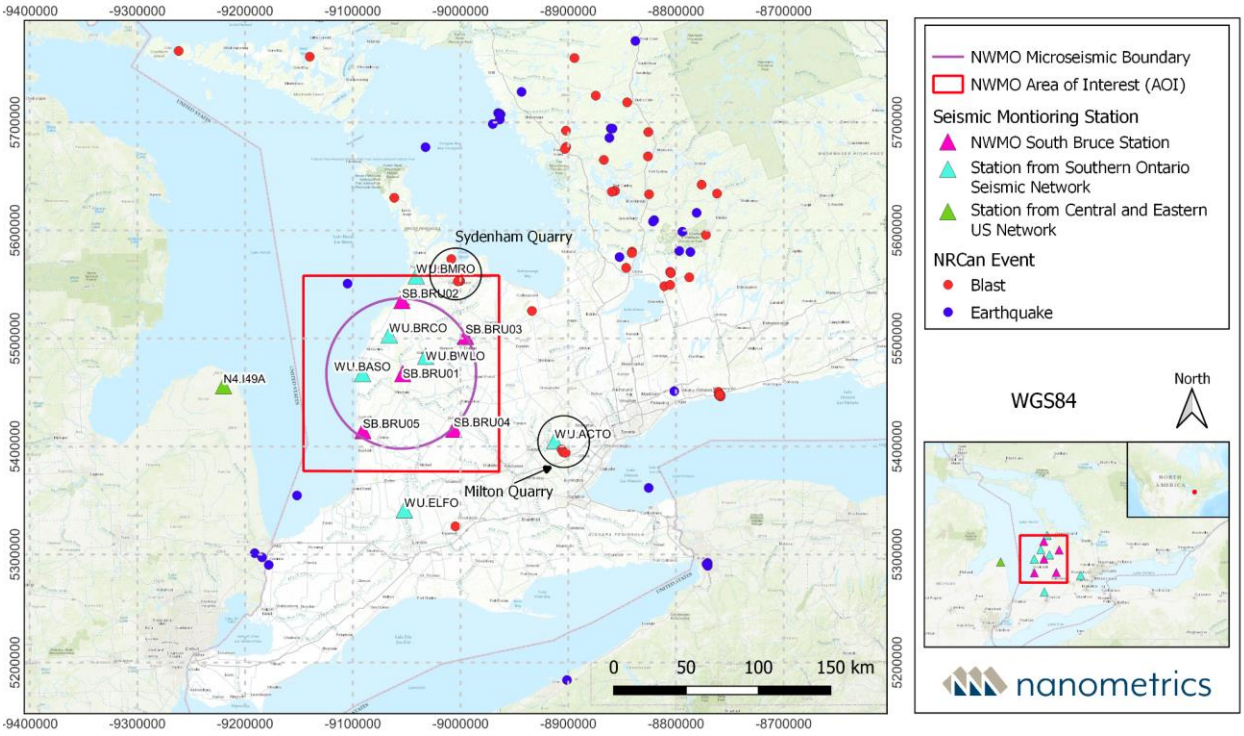

Figure 9. Seismic and quarry blast events observed in the region by CHIS.

8. Event Location Accuracy

In this section, the location accuracy of earthquakes within the AOI is investigated using synthetic events, in order to understand the effect of the velocity model complexity and the network density on the event location uncertainty. To this end, a number of distributed synthetic hypocenters with a specified depth and spacing are simulated. Travel time grids are generated for the velocity model using the Eikonal finite-difference method (Podvin et al., 1991). For each simulated event, synthetic P and S first arrivals with Gaussian- distributed timing errors are computed.

Simulated events are then located using a grid search algorithm to determine hypocentral probability density functions and maximum likelihood locations. The probability density function for each event accounts for P and S pick time uncertainties and an overall travel time uncertainty. Location uncertainty, σ, is calculated as the standard deviation of the hypocenter probability distribution for horizontal and vertical direction.

The 3D velocity model is used to model the location accuracy, considering all 12 stations (5 NWMO stations and 7 public stations). A timing error of 120 ms is assumed in this assessment. Figure 10 shows the modeled horizontal uncertainty of events detected by the monitoring network within the AOI. This is applicable for events which are well recorded by most stations. Overall, the vertical uncertainty is expected to be higher than the horizontal uncertainty due to its higher sensitivity to the station proximity.

Accuracy event hypocenter locations depends on two key factors:

i. Azimuthal coverage and number of stations at which the timing of phase arrivals are identified accurately, and
ii. The compatibility of the velocity model used for locating events

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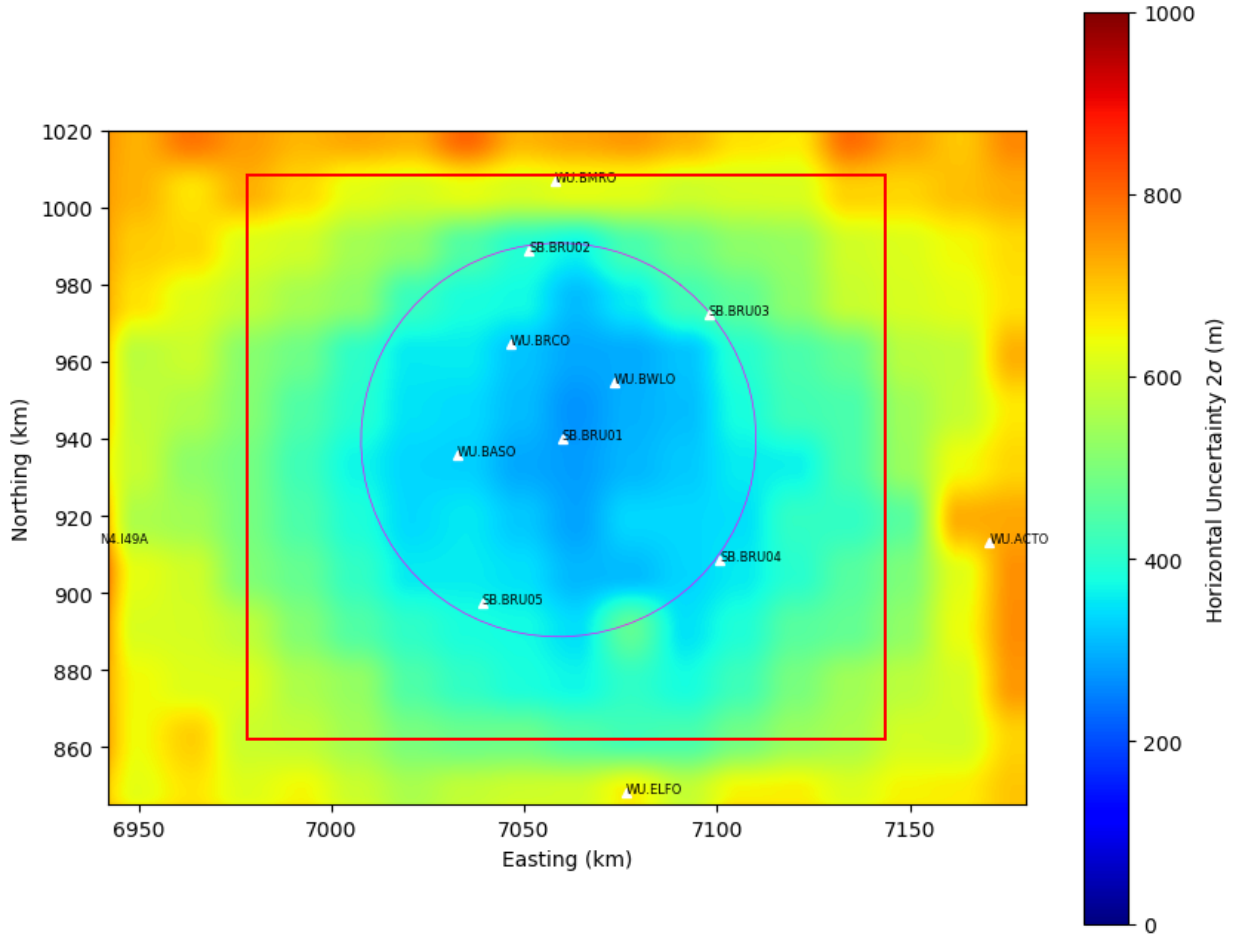

Figure 10. Modeled horizontal location uncertainty of events within the AOI

9. Magnitude of Completeness

Magnitude of completeness ("Mc") within the AOI is modeled for the NWMO South Bruce network to understand the minimum magnitude above which all seismic events can be detected and located, given the current array geometry and the assumed velocity model, instrument noise floors, background noise model, and attenuation parameters. For an assumed event depth, Mc modeling measures the spectral amplitude levels at different stations following a waveform propagation modeling, taking into account seismic attenuation attributes and assuming a point-source model (Brune, 1970). This is performed for a large number of synthetic events with variable magnitudes across a gridded space. The

event signal to noise ratios ("SNR") are measured at monitoring stations for each grid point, considering the mean noise level at each station of the network. The Mc at a grid point is determined as the minimum magnitude at which the estimated SNR on at least four stations satisfies a pre-set detectability threshold. Figure 11 shows the spatial variation of Mc within the AOI for the NWMO South Bruce network. All seismic events down to magnitude of ~Mw1.0, on average, are expected to be detected by the array. Smaller earthquakes may still be detected and located but with a lower accuracy and completeness.

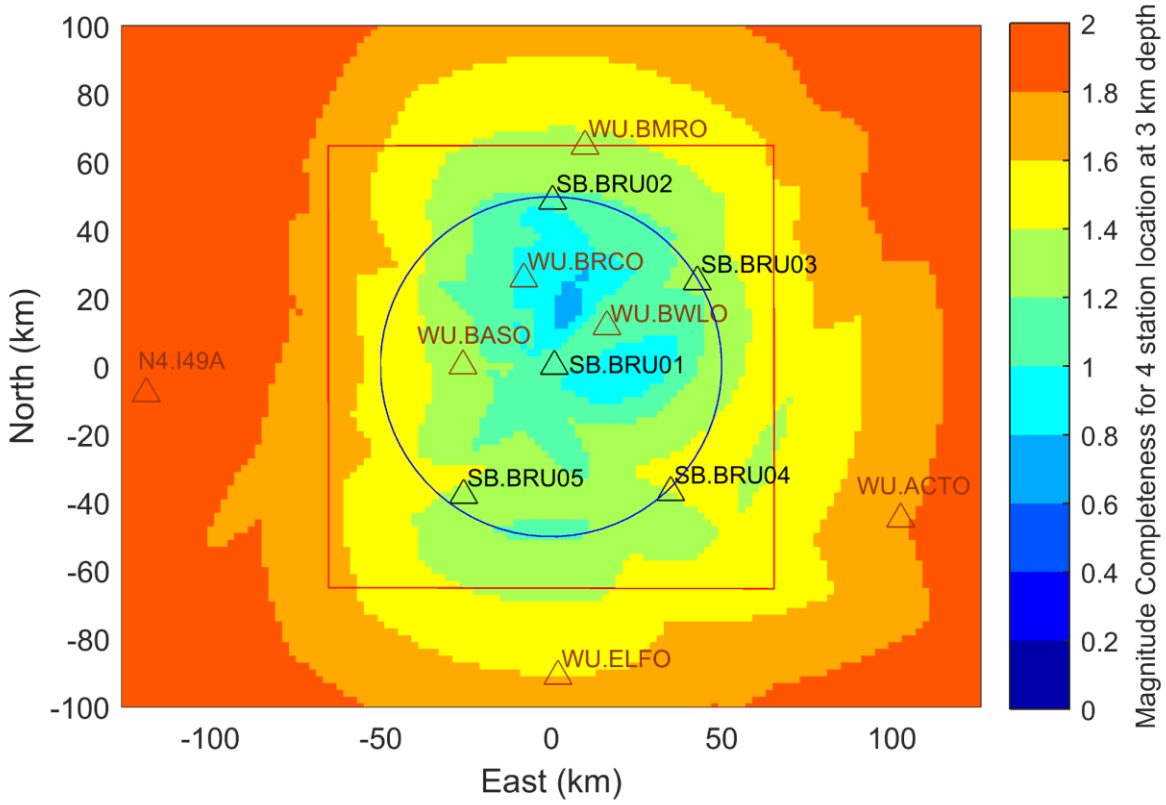

Figure 11. Magnitude of completeness (Mc) model of the NWMO South Bruce network for events at a depth of 6 km. Blue circle represents the microseismic monitoring boundary (50 km radius around the South Bruce site) and the red square shows NWMO South Bruce AOI. Black triangles represent locations of NWMO South Bruce stations and brown triangles indicate the locations of public stations included in the Program.

10. Data Delivery

Nanometrics has delivered the monitoring data obtained from November 2021 to the end of calendar year 2022. The data has been uploaded to an SFTP server along with metadata, a data transmittal letter and the Annual Seismic Monitoring Report. The delivered data includes:

1. A catalog of earthquakes and quarry blasts detected within the AOI (event origin date and time, hypocenter location, magnitude, location error ellipses etc.)
2. Seismic phase pick information in JSON-formatted files
3. Event waveform data in miniSEED formatted files
4. Continuous raw waveforms delivered in form of 1-hour long miniSEED files for each station and channel

11. Summary

Nanometrics operates a seismic monitoring network in the South Bruce area on behalf of NWMO, as part of the Microseismic Monitoring Program ("Program"). An annual overview of network operation activities and observed seismic activities are presented in this report.

The monitoring network consists of five broadband seismograph stations within the AOI. The first station was installed on July 7th, 2021 and the remaining four stations were installed in November 2021 after the completion of site surveys and permitting. Seven additional public stations located around the AOI are also incorporated into the Program.

All stations stream data to the Nanometrics Data Center in the cloud in near real time. The acquired data are processed using an automatic event detection algorithm. The automatic processing system declares an event when a minimum of four time-correlated seismic phase arrivals are picked at a minimum of four stations. Event waveforms are reviewed by experienced analysts to identify those associated with seismic activities. A 3D velocity model was used for locating events. A modeling of event location accuracy indicated that the events detected within the AOI are estimated to have a minimum horizontal location uncertainty of ~330 m. Overall, the vertical uncertainty is expected to be higher than the horizontal uncertainty due to its higher sensitivity to the station proximity

From November 1st, 2021 to December 31st, 2022, a total of 94,981 automatic events were detected by the monitoring networks. The vast majority of these events were either false positives (incorrect classification of random noise) or anthropogenic activities (e.g., mining/quarry blasts) occurring outside the AOI. As a result of manual reviews, 13 events with local magnitudes ranging from 0.84ML to 1.90ML were identified within the AOI. These events attained depths ranging from -0.492 km to 6.749 km relative to mean sea level.

Magnitude of completeness (Mc) within the AOI is modeled for the NWMO network to understand the minimum magnitude above which all seismic events can be detected. This assessment suggests that earthquakes of magnitude M>1.0 within the AOI are expected to be detected by the array. Smaller earthquakes may still be detected and located but with a lower accuracy and completeness.

12. References

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Appendix A: Daily Station Data Availability

November 2021

Station	2021-11-01	2021-11-02	2021-11-03	2021-11-04	2021-11-05	2021-11-06	2021-11-07
SB.BRU01	100	99.8	100	100	100	100	100
SB.BRU02	0	0	0	0	0	0	0
SB.BRU03	0	0	0	0	0	0	74.5
SB.BRU04	0	0	0	0	0	0	0
SB.BRU05	0	0	0	0	0	0	0
	2021-11-08	2021-11-09	2021-11-10	2021-11-11	2021-11-12	2021-11-13	2021-11-14
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	99.8	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	97.9	100	100	100	100	100	100
SB.BRU05	0	99.8	100	100	100	100	100
	2021-11-15	2021-11-16	2021-11-17	2021-11-18	2021-11-19	2021-11-20	2021-11-21
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2021-11-22	2021-11-23	2021-11-24	2021-11-25	2021-11-26	2021-11-27	2021-11-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

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	2021-11-29	2021-11-30					
SB.BRU01	100	100					
SB.BRU02	100	100					
SB.BRU03	100	100					
SB.BRU04	100	100					
SB.BRU05	100	100					

December 2021

Station	2021-12-01	2021-12-02	2021-12-03	2021-12-04	2021-12-05	2021-12-06	2021-12-07
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2021-12-08	2021-12-09	2021-12-10	2021-12-11	2021-12-12	2021-12-13	2021-12-14
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2021-12-15	2021-12-16	2021-12-17	2021-12-18	2021-12-19	2021-12-20	2021-12-21
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

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	2021-12-22	2021-12-23	2021-12-24	2021-12-25	2021-12-26	2021-12-27	2021-12-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2021-12-29	2021-12-30	2021-12-31				
SB.BRU01	100	100	100				
SB.BRU02	100	100	100				
SB.BRU03	100	100	100				
SB.BRU04	100	100	100				
SB.BRU05	100	100	100				

January 2022

Station	2022-01-01	2022-01-02	2022-01-03	2022-01-04	2022-01-05	2022-01-06	2022-01-07
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-01-08	2022-01-09	2022-01-10	2022-01-11	2022-01-12	2022-01-13	2022-01-14
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100

SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	99.6	100	100

	2022-01-15	2022-01-16	2022-01-17	2022-01-18	2022-01-19	2022-01-20	2022-01-21
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	99.6
	2022-01-22	2022-01-23	2022-01-24	2022-01-25	2022-01-26	2022-01-27	2022-01-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-01-29	2022-01-30	2022-01-31				
SB.BRU01	100	100	100				
SB.BRU02	100	100	100				
SB.BRU03	100	100	100				
SB.BRU04	100	100	100				
SB.BRU05	100	100	100				

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February 2022

Station	2022-02-01	2022-02-02	2022-02-03	2022-02-04	2022-02-05	2022-02-06	2022-02-07
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	99.6	100	100	100	100	100	100
	2022-02-08	2022-02-09	2022-02-10	2022-02-11	2022-02-12	2022-02-13	2022-02-14
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-02-15	2022-02-16	2022-02-17	2022-02-18	2022-02-19	2022-02-20	2022-02-21
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-02-22	2022-02-23	2022-02-24	2022-02-25	2022-02-26	2022-02-27	2022-02-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100

SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

March 2022

Station	2022-03-01	2022-03-02	2022-03-03	2022-03-04	2022-03-05	2022-03-06	2022-03-07
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-03-08	2022-03-09	2022-03-10	2022-03-11	2022-03-12	2022-03-13	2022-03-14
SB.BRU01	99.7	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-03-15	2022-03-16	2022-03-17	2022-03-18	2022-03-19	2022-03-20	2022-03-21
SB.BRU01	97.2	100	100	99.9	100	100	99.6
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-03-22	2022-03-23	2022-03-24	2022-03-25	2022-03-26	2022-03-27	2022-03-28
SB.BRU01	100	100	100	100	100	100	100

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SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

	2022-03-29	2022-03-30	2022-03-31				
SB.BRU01	100	100	100				
SB.BRU02	100	100	100				
SB.BRU03	100	100	100				
SB.BRU04	100	100	100				
SB.BRU05	100	100	100				

April 2022

Station	2022-04-01	2022-04-02	2022-04-03	2022-04-04	2022-04-05	2022-04-06	2022-04-07
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-04-08	2022-04-09	2022-04-10	2022-04-11	2022-04-12	2022-04-13	2022-04-14
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

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	2022-04-15	2022-04-16	2022-04-17	2022-04-18	2022-04-19	2022-04-20	2022-04-21
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	99.9	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

	2022-04-22	2022-04-23	2022-04-24	2022-04-25	2022-04-26	2022-04-27	2022-04-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-04-29	2022-04-30					
SB.BRU01	100	100					
SB.BRU02	100	100					
SB.BRU03	100	100					
SB.BRU04	100	100					
SB.BRU05	100	100					

May 2022

Station	2022-05-01	2022-05-02	2022-05-03	2022-05-04	2022-05-05	2022-05-06	2022-05-07
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

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	2022-05-08	2022-05-09	2022-05-10	2022-05-11	2022-05-12	2022-05-13	2022-05-14
SB.BRU01	100	100	99.9	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

	2022-05-15	2022-05-16	2022-05-17	2022-05-18	2022-05-19	2022-05-20	2022-05-21
SB.BRU01	100	100	96.3	100	100	100	100
SB.BRU02	100	100	98.9	100	100	100	100
SB.BRU03	100	100	98.9	100	100	100	100
SB.BRU04	100	100	99.3	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-05-22	2022-05-23	2022-05-24	2022-05-25	2022-05-26	2022-05-27	2022-05-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-05-29	2022-05-30	2022-05-31				
SB.BRU01	100	100	100				
SB.BRU02	100	100	100				
SB.BRU03	100	100	100				
SB.BRU04	100	100	100				
SB.BRU05							

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June 2022

Station	2022-06-01	2022-06-02	2022-06-03	2022-06-04	2022-06-05	2022-06-06	2022-06-07
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-06-08	2022-06-09	2022-06-10	2022-06-11	2022-06-12	2022-06-13	2022-06-14
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-06-15	2022-06-16	2022-06-17	2022-06-18	2022-06-19	2022-06-20	2022-06-21
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100

SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-06-22	2022-06-23	2022-06-24	2022-06-25	2022-06-26	2022-06-27	2022-06-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

	2022-06-29	2022-06-30					
SB.BRU01	100	100					
SB.BRU02	100	100					
SB.BRU03	100	100					
SB.BRU04	100	100					
SB.BRU05	100	100					

July 2022

Station	2022-07-01	2022-07-02	2022-07-03	2022-07-04	2022-07-05	2022-07-06	2022-07-07
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-07-08	2022-07-09	2022-07-10	2022-07-11	2022-07-12	2022-07-13	2022-07-14
SB.BRU01	100	100	100	100	100	100	100

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SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-07-15	2022-07-16	2022-07-17	2022-07-18	2022-07-19	2022-07-20	2022-07-21
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

	2022-07-22	2022-07-23	2022-07-24	2022-07-25	2022-07-26	2022-07-27	2022-07-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-07-29	2022-07-30	2022-07-31				
SB.BRU01	100	100	100				
SB.BRU02	100	100	100				
SB.BRU03	100	100	100				
SB.BRU04	100	100	100				
SB.BRU05	100	100	100				

August 2022

Station	2022-08-01	2022-08-02	2022-08-03	2022-08-04	2022-08-05	2022-08-06	2022-08-07
SB.BRU01	100	100	100	100	100	100	100

SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-08-08	2022-08-09	2022-08-10	2022-08-11	2022-08-12	2022-08-13	2022-08-14
SB.BRU01	100	100	100	97.9	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

	2022-08-15	2022-08-16	2022-08-17	2022-08-18	2022-08-19	2022-08-20	2022-08-21
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-08-22	2022-08-23	2022-08-24	2022-08-25	2022-08-26	2022-08-27	2022-08-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-08-29	2022-08-30	2022-08-31				
SB.BRU01	100	100	100				
SB.BRU02	100	100	100				
SB.BRU03	100	100	100				

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SB.BRU04	100	100	100				
SB.BRU05	100	100	100				

September 2022

Station	2022-09-01	2022-09-02	2022-09-03	2022-09-04	2022-09-05	2022-09-06	2022-09-07
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-09-08	2022-09-09	2022-09-10	2022-09-11	2022-09-12	2022-09-13	2022-09-14
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-09-15	2022-09-16	2022-09-17	2022-09-18	2022-09-19	2022-09-20	2022-09-21
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-09-22	2022-09-23	2022-09-24	2022-09-25	2022-09-26	2022-09-27	2022-09-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100

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SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

	2022-09-29	2022-09-30					
SB.BRU01	100	100					
SB.BRU02	100	100					
SB.BRU03	100	100					
SB.BRU04	100	100					
SB.BRU05	100	100					

October 2022

Station	2022-10-01	2022-10-02	2022-10-03	2022-10-04	2022-10-05	2022-10-06	2022-10-07
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-10-08	2022-10-09	2022-10-10	2022-10-11	2022-10-12	2022-10-13	2022-10-14
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-10-15	2022-10-16	2022-10-17	2022-10-18	2022-10-19	2022-10-20	2022-10-21
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100

SB.BRU05	100	100	100	100	100	100	100

	2022-10-22	2022-10-23	2022-10-24	2022-10-25	2022-10-26	2022-10-27	2022-10-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100
	2022-10-29	2022-10-30	2022-10-31				
SB.BRU01	100	100	100				
SB.BRU02	100	100	100				
SB.BRU03	100	100	100				
SB.BRU04	100	100	100				
SB.BRU05	100	100	100				

November 2022

Station	2022-11-01	2022-11-02	2022-11-03	2022-11-04	2022-11-05	2022-11-06	2022-11-07
SB.BRU01	100	100	100	100	100	100	98.7
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

Station	2022-11-08	2022-11-09	2022-11-10	2022-11-11	2022-11-12	2022-11-13	2022-11-14
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

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Station	2022-11-15	2022-11-16	2022-11-17	2022-11-18	2022-11-19	2022-11-20	2022-11-21
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

Station	2022-11-22	2022-11-23	2022-11-24	2022-11-25	2022-11-26	2022-11-27	2022-11-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

Station	2022-11-29	2022-11-30
SB.BRU01	100	100
SB.BRU02	100	100
SB.BRU03	100	100
SB.BRU04	100	100
SB.BRU05	100	100

December 2022

Station	2022-12-01	2022-12-02	2022-12-03	2022-12-04	2022-12-05	2022-12-06	2022-12-07
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

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Station	2022-12-08	2022-12-09	2022-12-10	2022-12-11	2022-12-12	2022-12-13	2022-12-14
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

Station	2022-12-15	2022-12-16	2022-12-17	2022-12-18	2022-12-19	2022-12-20	2022-12-21
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

Station	2022-12-22	2022-12-23	2022-12-24	2022-12-25	2022-12-26	2022-12-27	2022-12-28
SB.BRU01	100	100	100	100	100	100	100
SB.BRU02	100	100	100	100	100	100	100
SB.BRU03	100	100	100	100	100	100	100
SB.BRU04	100	100	100	100	100	100	100
SB.BRU05	100	100	100	100	100	100	100

Station	2022-12-29	2022-12-30	2022-12-31
SB.BRU01	100	100	100
SB.BRU02	100	100	100
SB.BRU03	100	100	100
SB.BRU04	100	100	100
SB.BRU05	100	100	100

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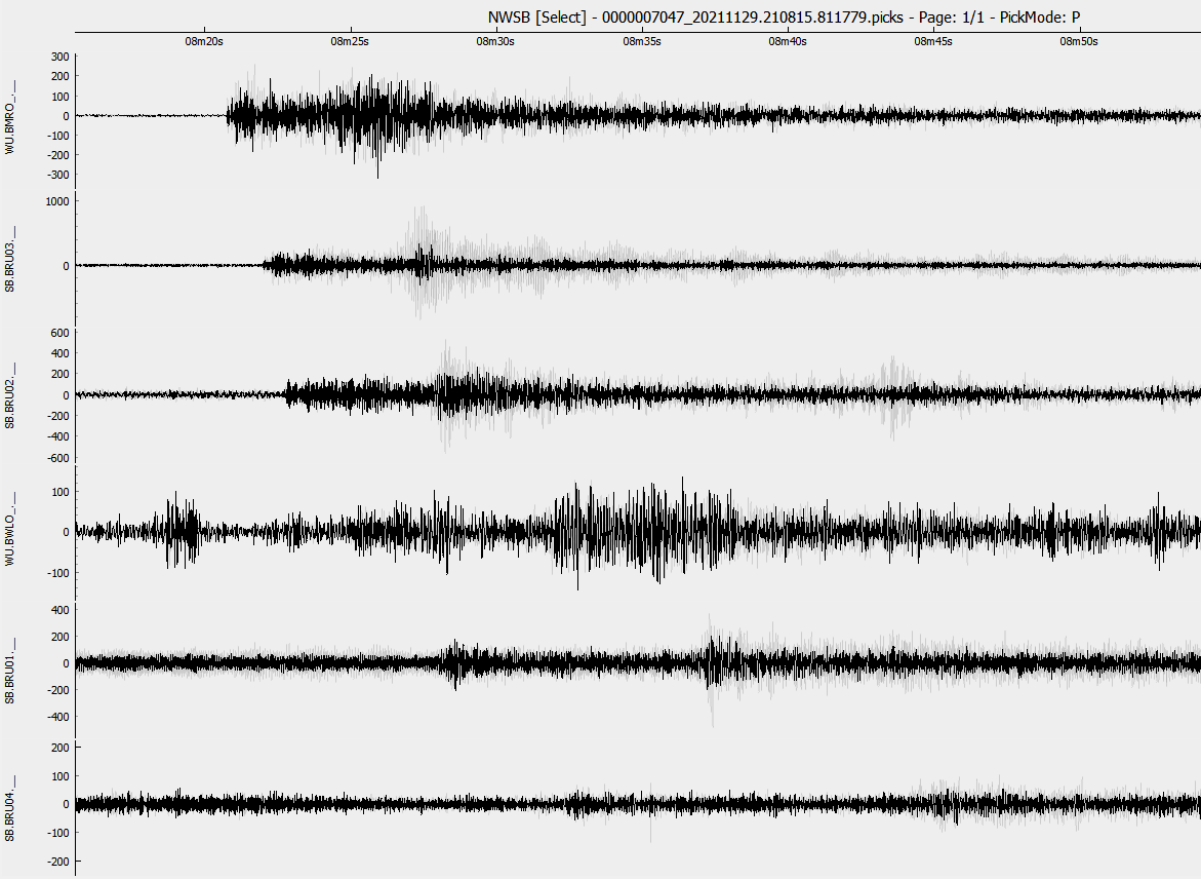
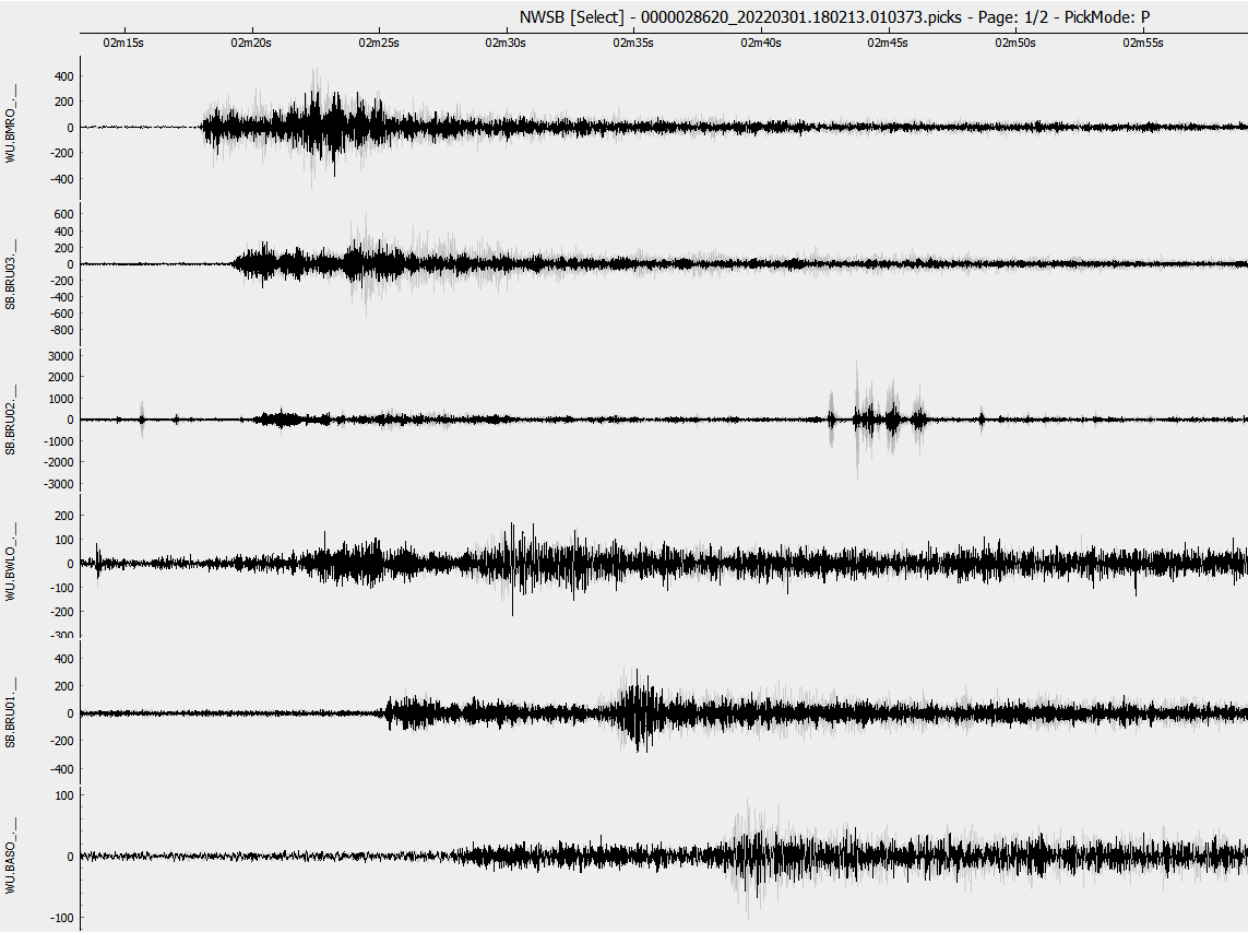
Appendix B: Waveforms of Events Detected within the AOI

This section displays the waveforms of events detected within the AOI by the NWMO South Bruce monitoring network. Waveforms are filtered with a 10 Hz bandpass unless otherwise specified.

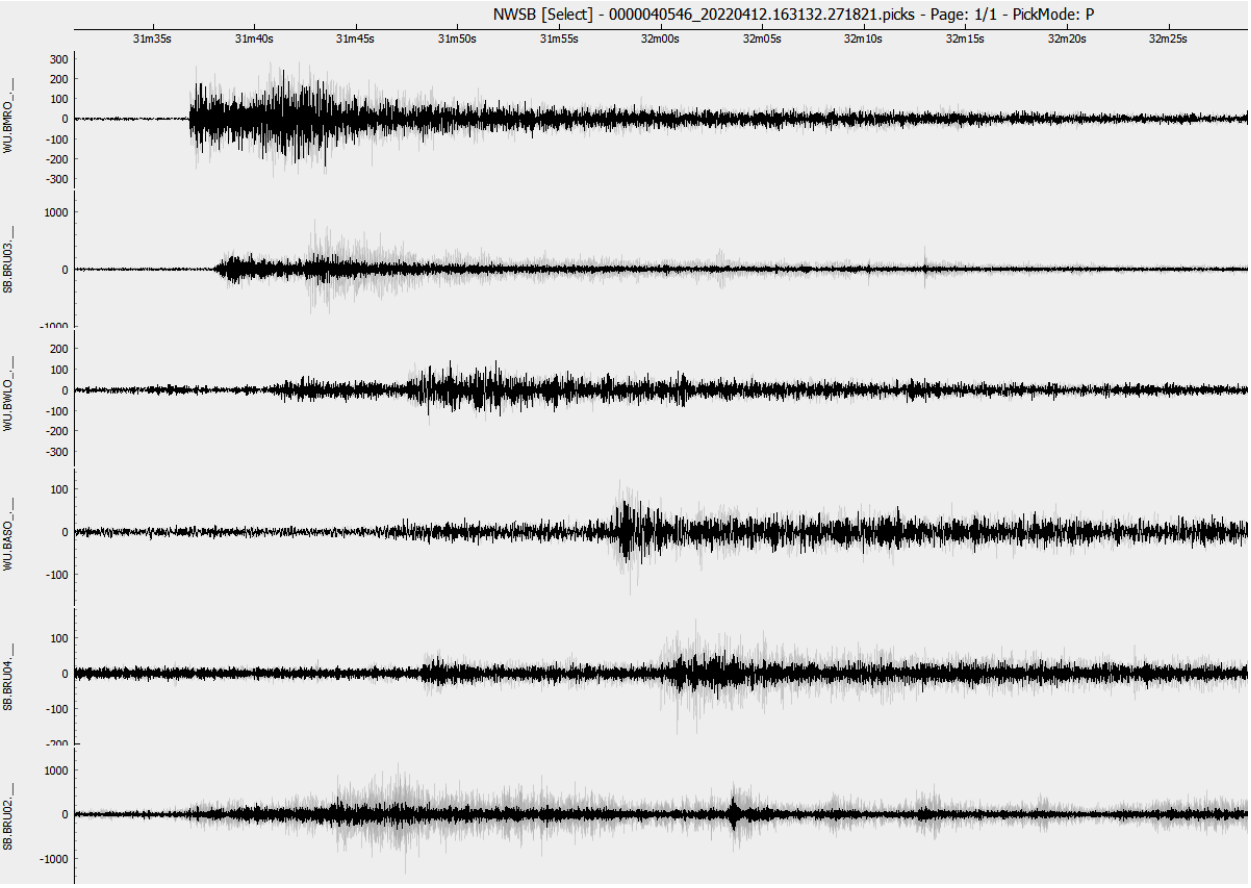
Date:	2021-11-29
Time:	21:08:15 UTC
Latitude:	44.5574 ºN
Longitude:	80.8539 ºW
Depth:	5.73km
Magnitude:	1.53Ml
Tag:	quarry_blast



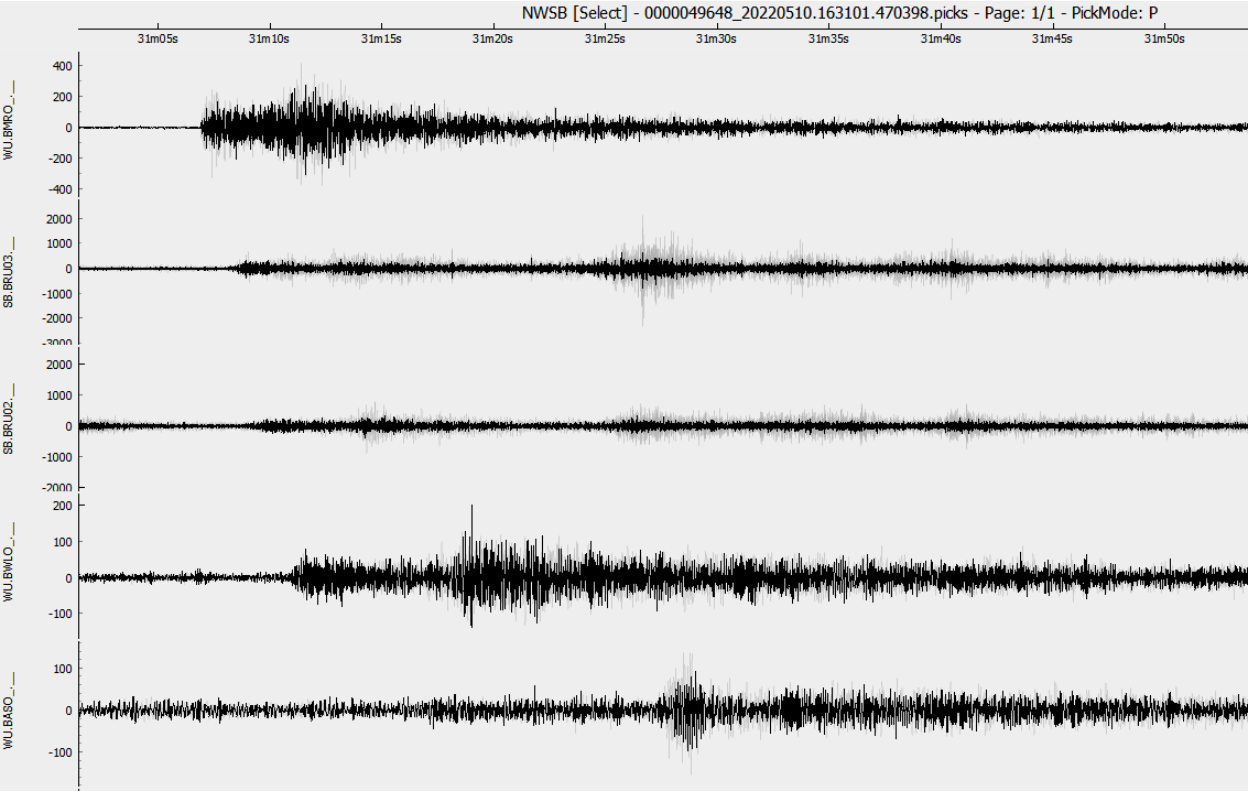
Date: 2022-03-01
Time: 18:02:13 UTC
Latitude: 44.5575 ºN
Longitude: 80.8472 ºW
Depth: 2.61km
Magnitude: 1.37Ml
Tag: quarry_blast



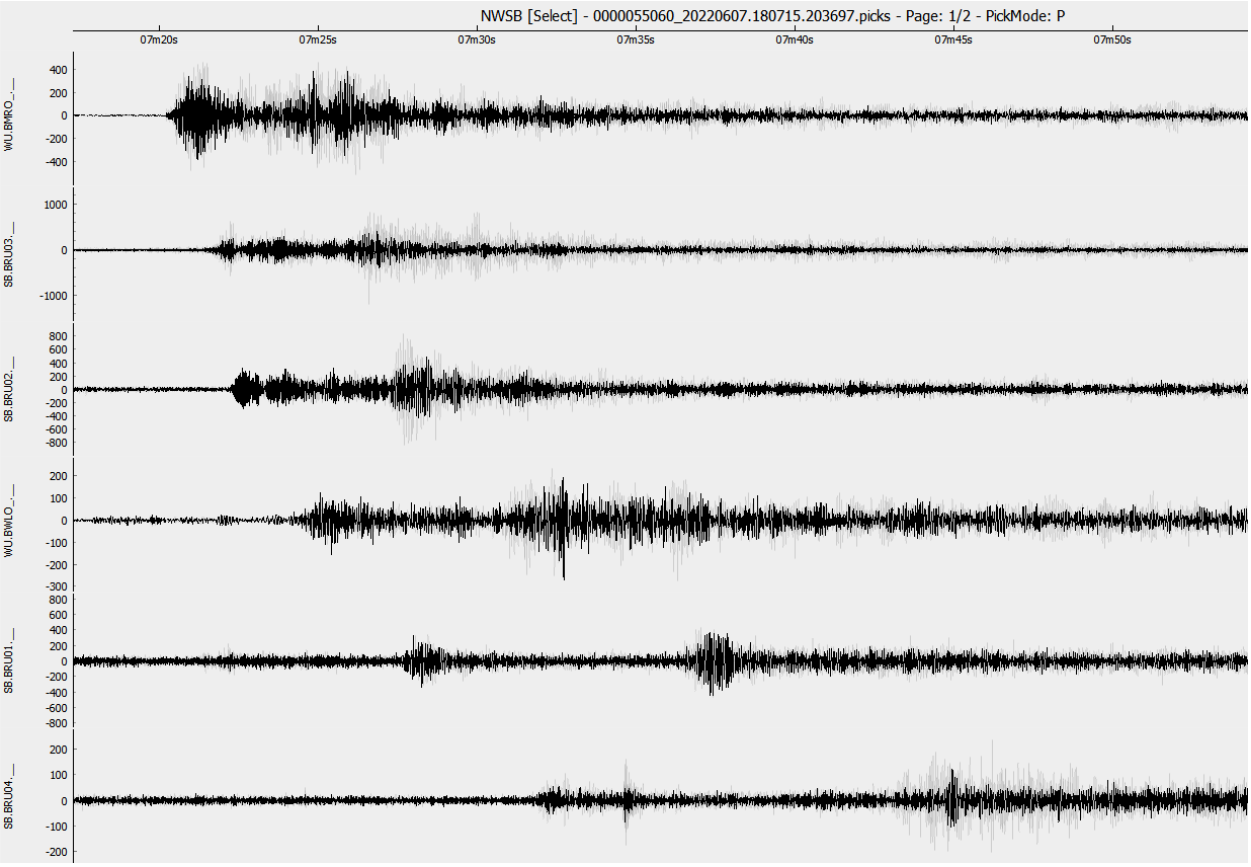
Date: 2022-04-12
Time: 16:31:32 UTC
Latitude: 44.5281 ºN
Longitude: 80.9062 ºW
Depth: 6.97km
Magnitude: 1.42Ml
Tag: quarry_blast



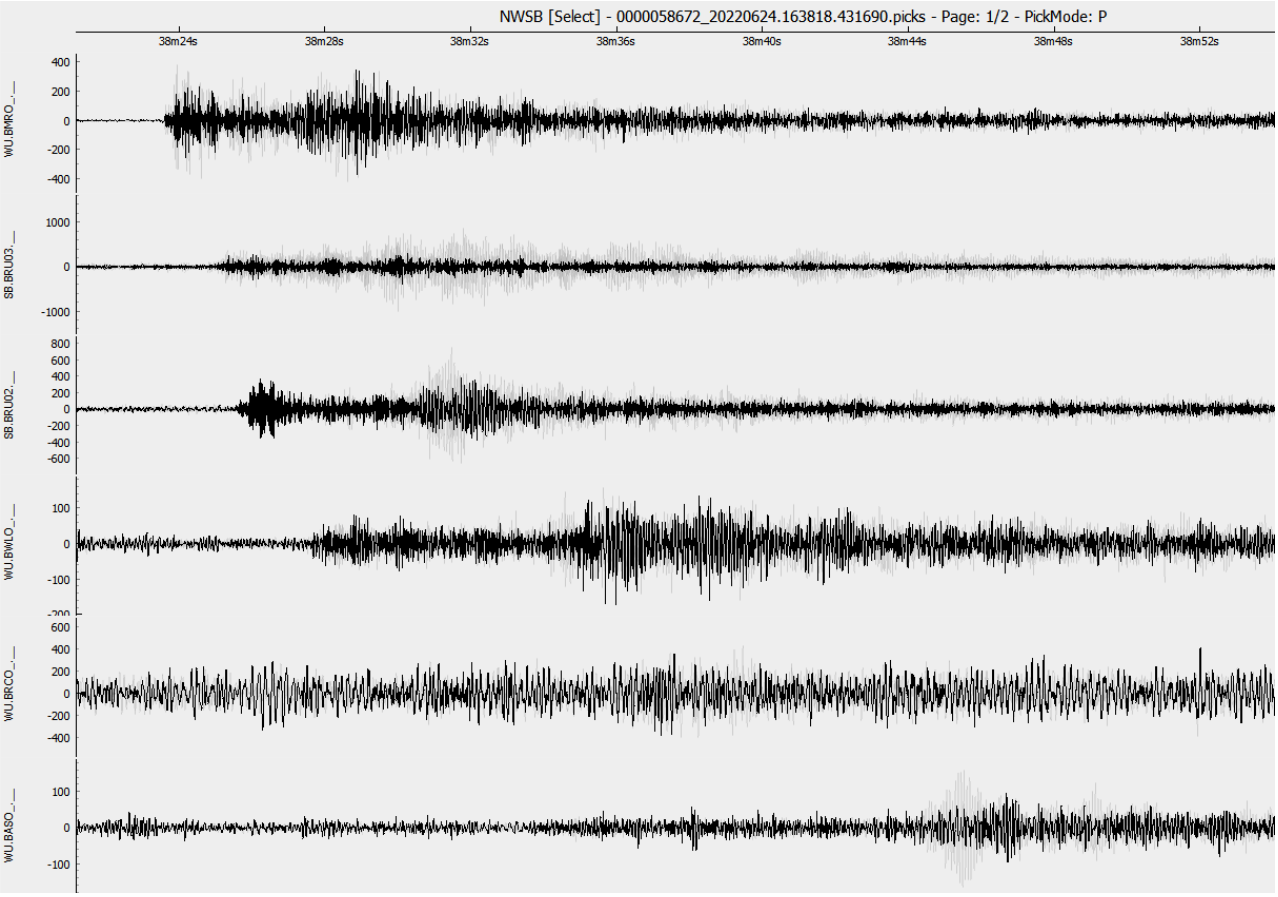
Date: 2022-05-10
Time: 16:31:01 UTC
Latitude: 44.5821 ºN
Longitude: 80.8106 ºW
Depth: 1.30km
Magnitude: 1.72Ml
Tag: quarry_blast



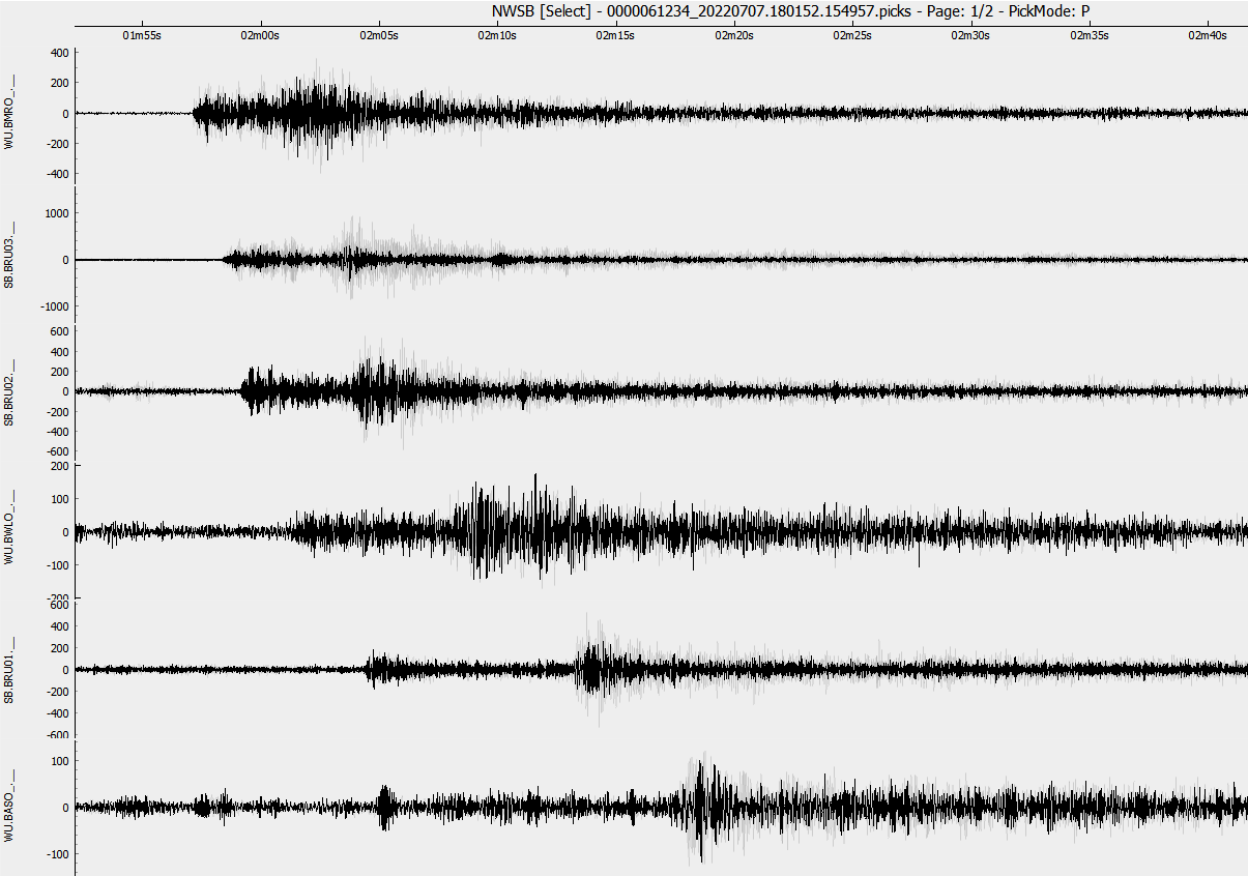
Date:	2022-06-07
Time:	18:07:15 UTC
Latitude:	44.5804 ºN
Longitude:	80.8269 ºW
Depth:	1.30km
Magnitude:	1.27Ml
Tag:	quarry_blast



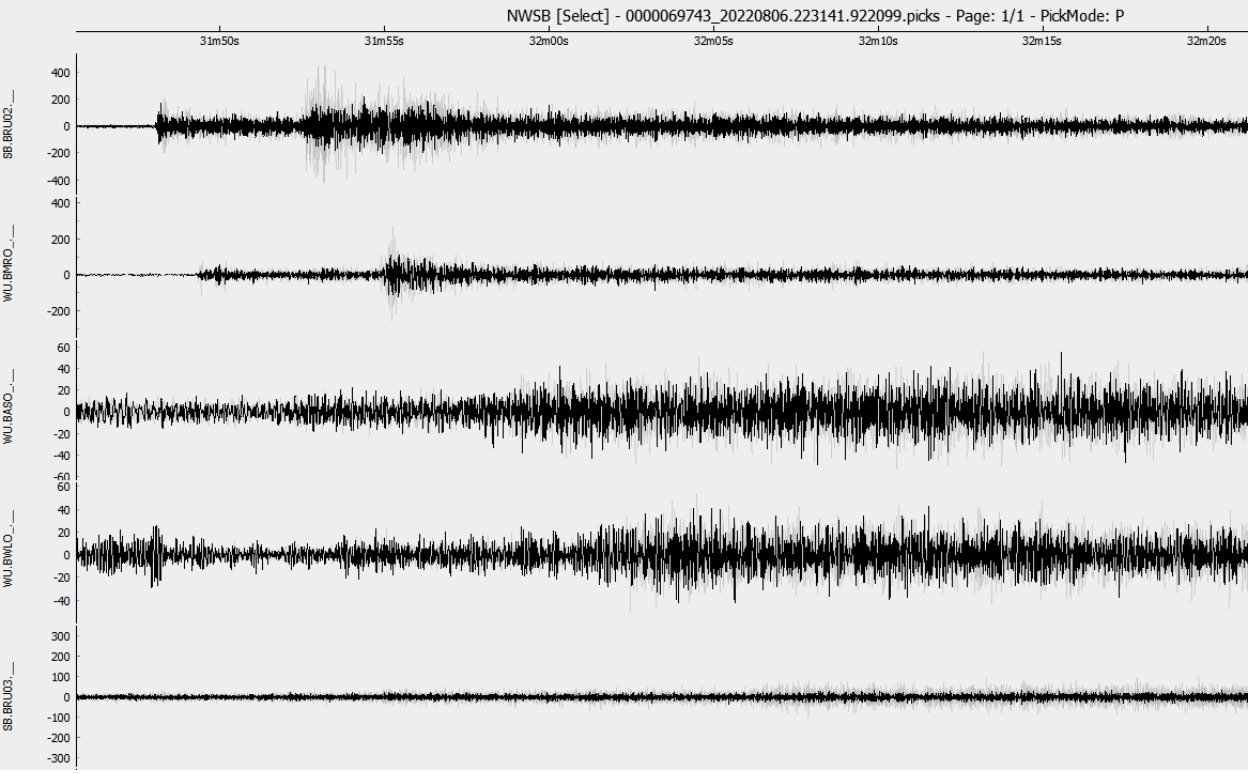
Date: 2022-06-24
Time: 16:38:18 UTC
Latitude: 44.5701 ºN
Longitude: 80.8122 ºW
Depth: 2.61km
Magnitude: 1.65Ml
Tag: quarry_blast



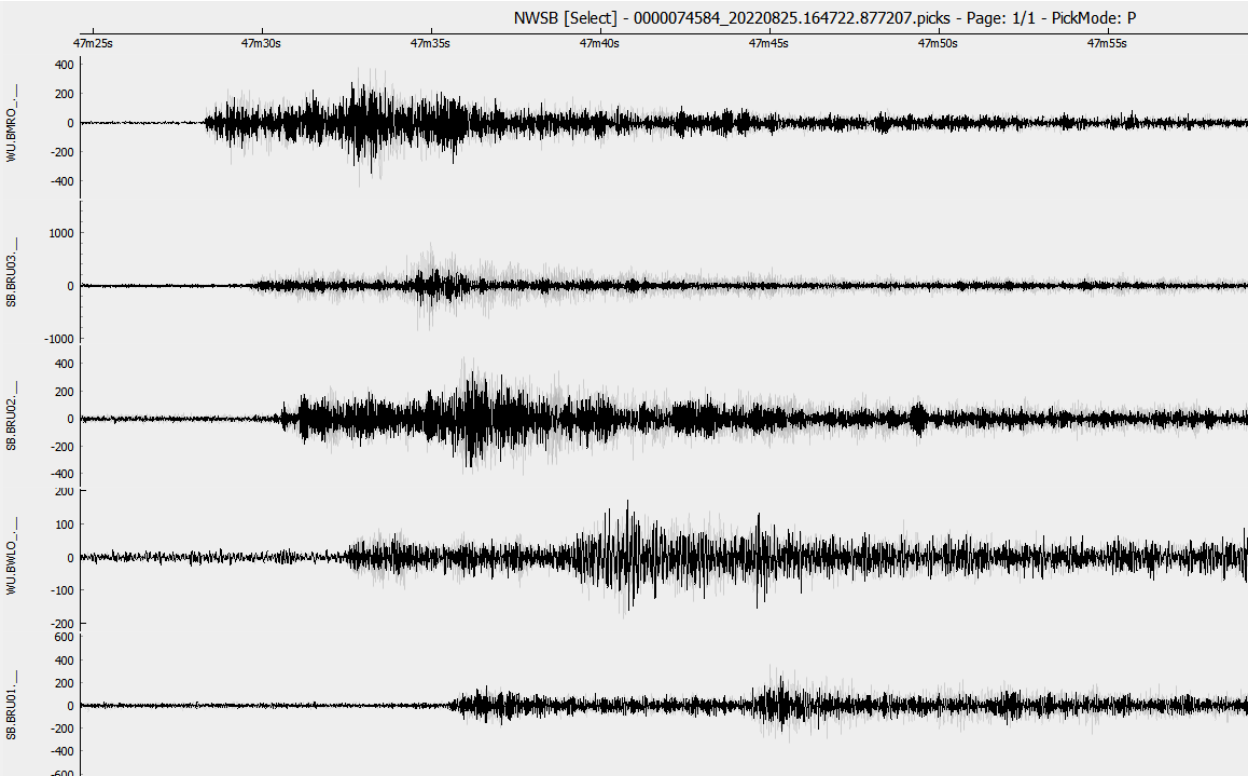
Date: 2022-07-07
Time: 18:01:52 UTC
Latitude: 44.5567 ºN
Longitude: 80.8487 ºW
Depth: 6.76km
Magnitude: 1.34Ml
Tag: quarry_blast



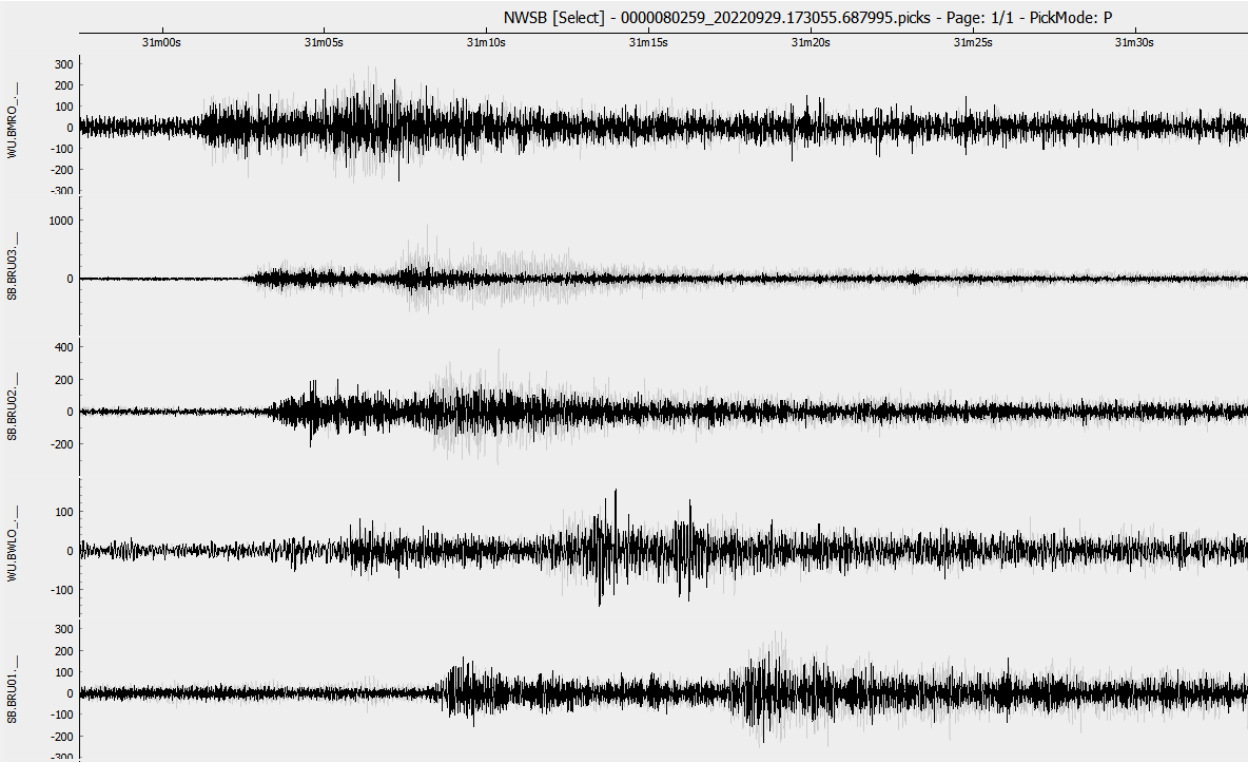
Date: 2022-08-06
Time: 22:31:41 UTC
Latitude: 44.5186 ºN
Longitude: 81.7605 ºW
Depth: 6.75km
Magnitude: 0.84Ml



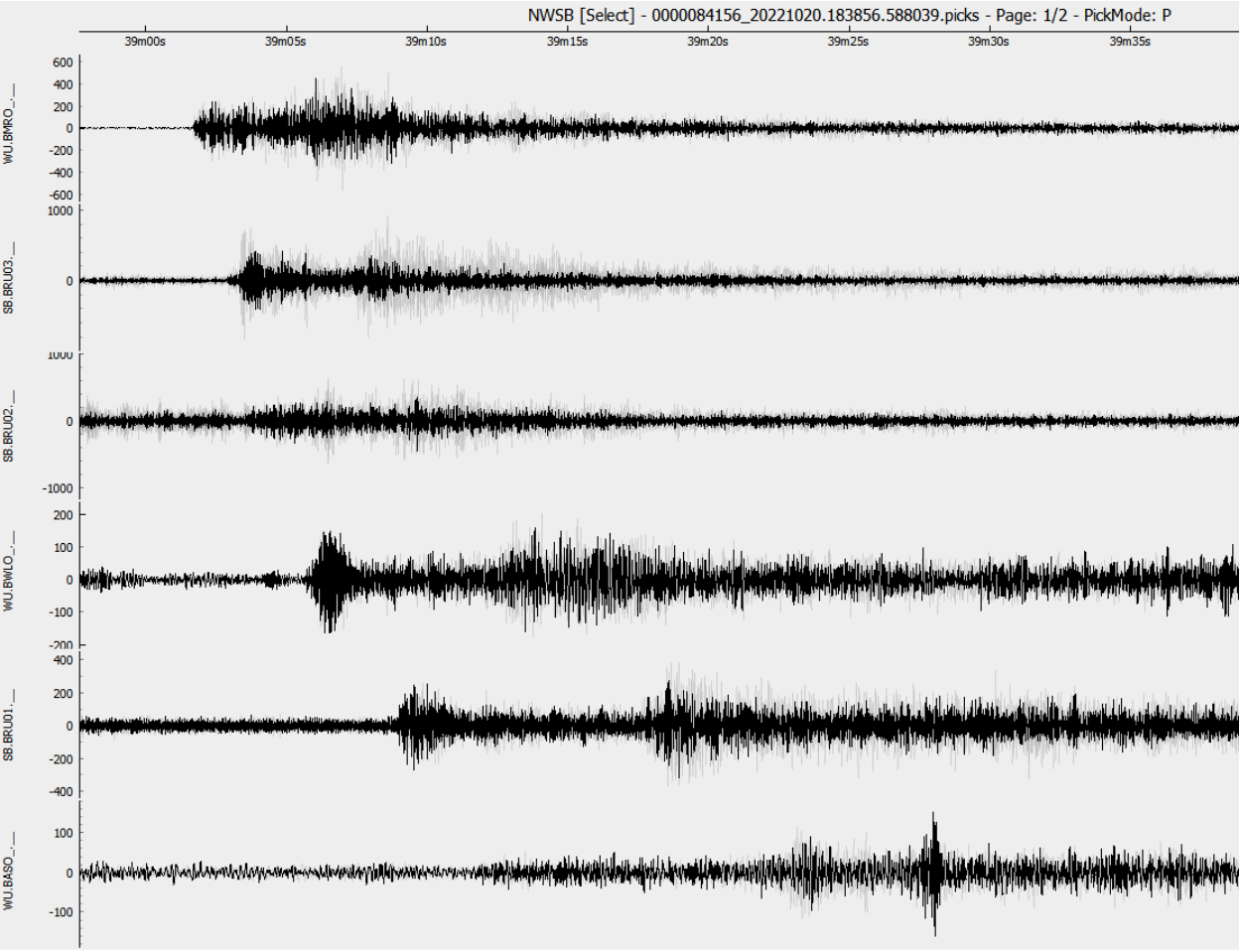
Date: 2022-08-25
Time: 16:47:22 UTC
Latitude: 44.5804 ºN
Longitude: 80.8269 ºW
Depth: 10.90km
Magnitude: 0.98Ml
Tag: quarry_blast



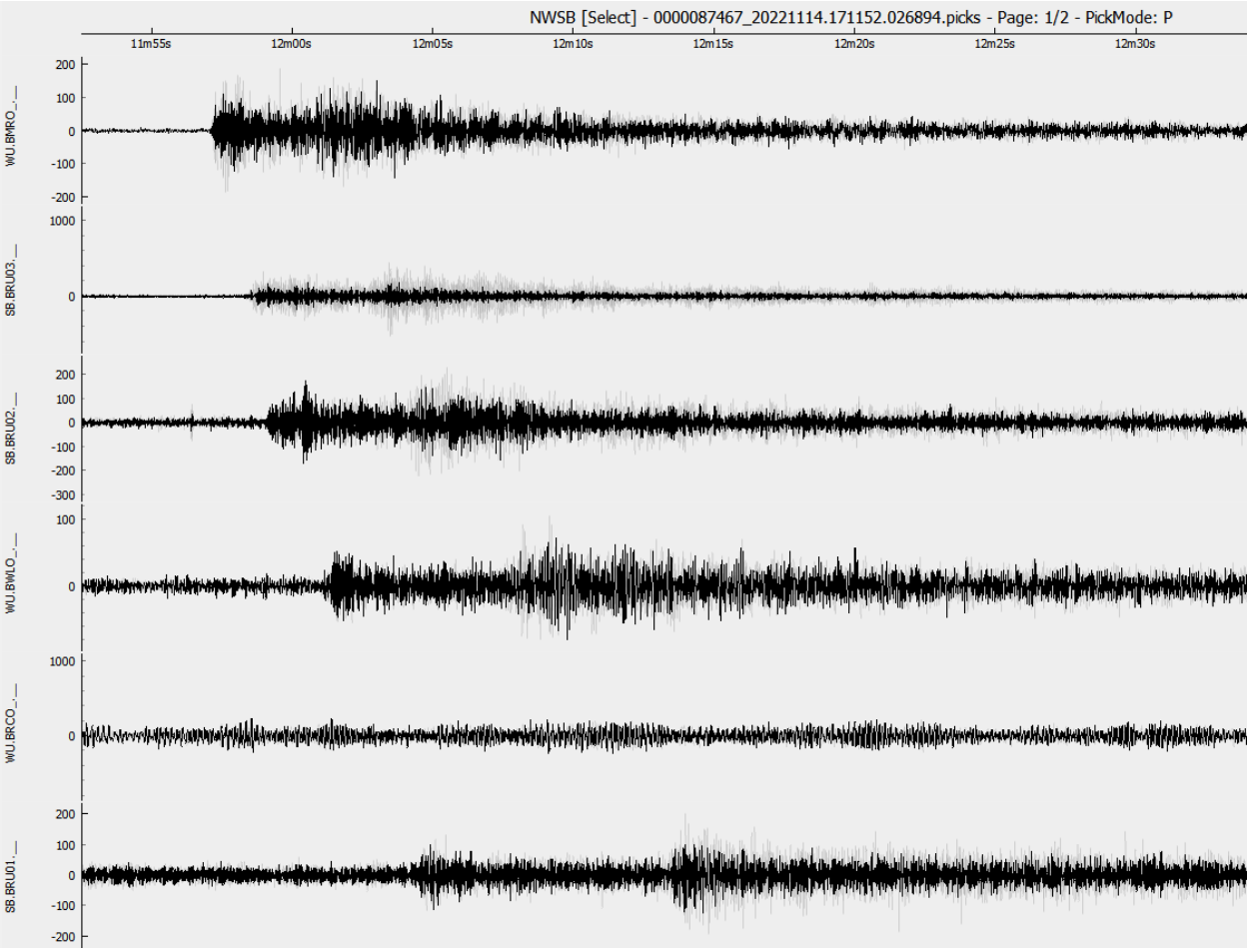
Date:	2022-09-29
Time:	17:30:55 UTC
Latitude:	44.5703 ºN
Longitude:	80.8440 ºW
Depth:	19.90km
Magnitude:	1.90Ml
Tag:	quarry_blast



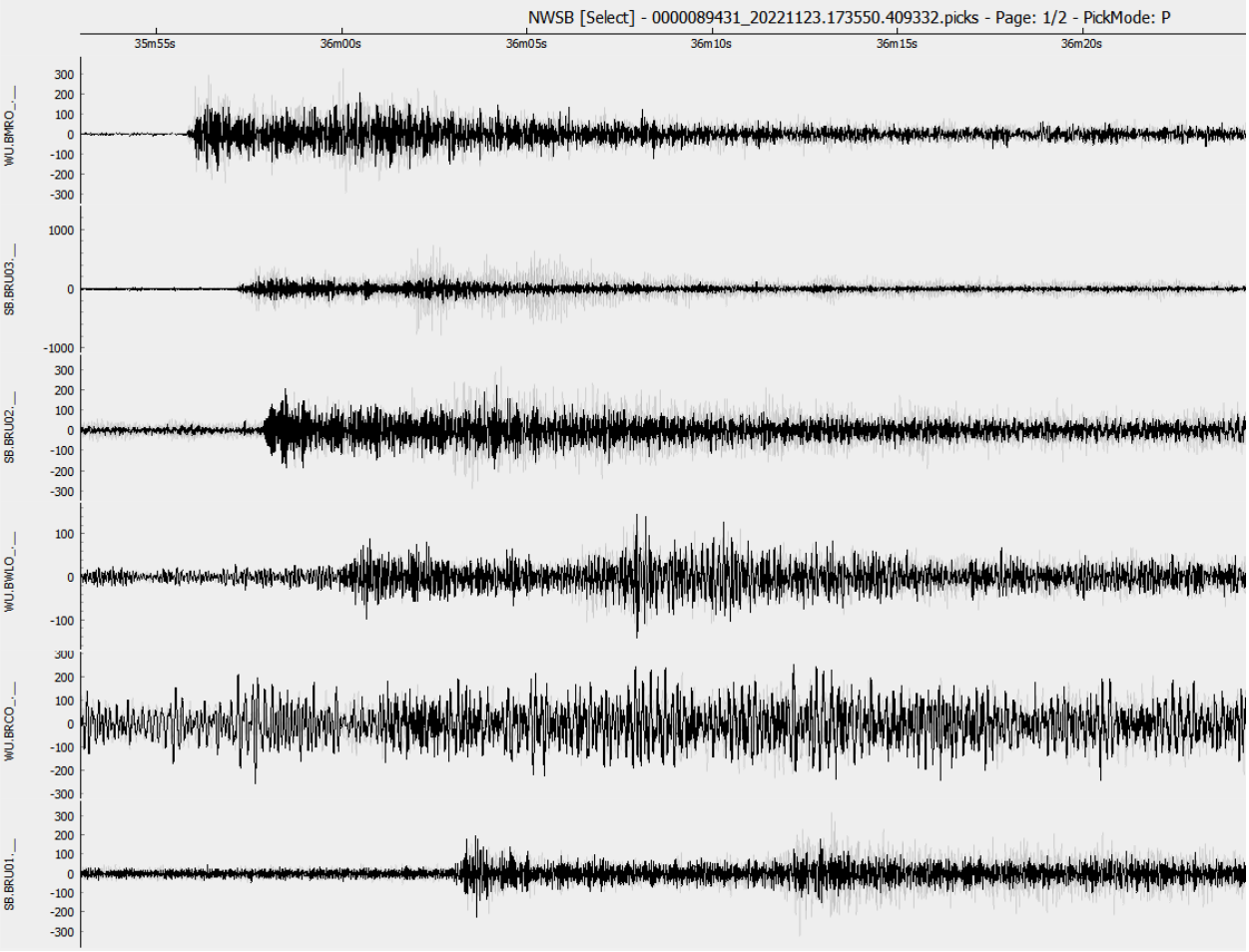
Date:	2022-10-20
Time:	18:38:56 UTC
Latitude:	44.5694 ºN
Longitude:	80.8296 ºW
Depth:	1.30km
Magnitude:	1.60Ml
Tag:	quarry_blast



Date: 2022-11-14
Time: 17:11:52 UTC
Latitude: 44.5634 ºN
Longitude: 80.8417 ºW
Depth: 7.41km
Magnitude: 1.74Ml
Tag: quarry_blast



Date:	2022-11-23
Time:	17:35:50 UTC
Latitude:	44.5834 ºN
Longitude:	80.8209 ºW
Depth:	9.38km
Magnitude:	1.63Ml
Tag:	quarry_blast



Appendix C: CHIS Events (November 1 2021 - December 31 2022)

DateTime (UTC)	Lat	Long	Depth (km)	Mag	Description
2022-12-30 10:53:48	45.5508	-80.5342	5	1.39	14 km WSW of The Archipelago, ON
2022-12-30 05:47:21	45.5428	-80.5137	2	1.86	12 km WSW of The Archipelago, ON
2022-12-29 15:06:12	45.4866	-80.5789	5	1.69	20 km SW of The Archipelago, ON
2022-12-29 15:04:04	45.5129	-80.5214	5	1.35	15 km SW of The Archipelago, ON
2022-12-29 14:45:53	45.547	-80.5209	5	1.44	13 km WSW of The Archipelago, ON
2022-12-28 13:27:22	45.5425	-80.5195	5	1.5	13 km WSW of The Archipelago, ON
2022-12-20 15:44:47	45.0955	-79.5591	0	1.92	Blast, 20 km WNW of Bracebridge, ON
2022-12-14 19:00:35	43.9031	-78.6964	0	1.3	Blast, 1 km SW of Bowmanville, ON
2022-12-13 20:12:51	44.6466	-80.9885	0	1.73	Blast, 9 km ENE of Shallow Lake, ON
2022-12-05 17:05:13	45.406	-79.6063	5	1.13	15 km SW of McMurrich/Monteith, ON
2022-11-25 02:34:10	45.3516	-81.1399	5	1.68	42 km NNE of Lion's Head, ON
2022-11-23 17:35:51	44.564	-80.851	0	1.5	Blast, 1 km ESE of Owen Sound Mine, ON
2022-11-20 16:30:38	42.903	-82.503	5	2.4	5 km WNW of Corunna, ON, felt
2022-11-08 20:47:39	45.613	-79.458	0	2.1	Blast, 5 km WSW of Burk's Falls, ON
2022-10-27 16:36:17	45.44	-79.282	0	1.9	Blast, 10 km SSE of Perry, ON
2022-10-26 16:08:16	45.674	-80.339	2	1.4	9 km NNE of The Archipelago, ON
2022-10-13 17:43:29	45.353	-79.967	0	2.1	Blast, 5 km E of Parry Sound, ON
2022-10-12 4:19:10	42.151	-79.96	5	1.9	11 km ENE of Erie, PA
2022-10-10 10:46:18	42.869	-78.786	5	1.7	8 km E of Buffalo, NY
2022-09-27 8:54:16	42.852	-78.786	5	1.8	8 km ESE of Buffalo, NY
2022-09-23 10:15:24	42.862	-78.796	5	2.1	7 km ESE of Buffalo, NY
2022-08-24 4:22:54	43.279	-82.212	5	1.7	19 km NW of Kettle Point, ON
2022-08-20 13:20:28	45.461	-79.595	2	1.2	11 km WSW of McMurrich/Monteith, ON

2022-08-10 17:20:08	44.533	-79.148	0	2.1	Blast, 11 km N of Beaverton, ON
2022-08-06 22:31:41	44.548	-81.79	5	1.2	34 km WNW of Port Elgin, ON
2022-08-04 18:05:41	43.885	-78.694	0	1.6	Blast, Bowmanville Mine, ON
2022-08-03 0:04:00	44.742	-79.024	2	1.4	35 km ENE of Orillia, ON
2022-07-28 18:35:12	45.076	-79.275	0	2.2	Blast, 4 km NE of Bracebridge, ON
2022-07-18 18:52:45	44.836	-78.802	0	1.9	Blast, 38 km NNW of Bobcaygeon, ON
2022-07-18 17:11:48	43.557	-80.005	0	1.8	Blast, 9 km SSE of Acton, ON
2022-07-18 13:48:39	44.612	-79.093	0	1.6	Blast, 21 km NNE of Beaverton, ON
2022-07-13 22:17:45	45.132	-78.837	0	1.6	Blast, 13 km SSE of Algonquin Highlands, ON
2022-07-08 17:08:11	43.54	-79.992	0	1.8	Blast, 11 km SSE of Acton, ON
2022-07-05 19:41:51	45.277	-79.652	0	2.2	Blast, 2 km NNW of Rosseau, ON
2022-06-30 18:01:09	43.887	-78.683	0	1.4	Blast, 1 km ENE of Bowmanville Mine, ON
2022-06-23 19:07:26	45.652	-79.72	0	1.9	Blast, 1 km NNW of Croft part A, ON
2022-06-23 18:08:58	43.883	-78.678	0	1.4	Blast, 1 km E of Bowmanville Mine, ON
2022-06-23 17:55:44	43.875	-78.679	0	1.3	Blast, 2 km SE of Bowmanville Mine, ON
2022-06-21 18:42:26	45.87	-79.898	0	2.3	Blast, 22 km SW of Restoule, ON
2022-06-20 16:12:20	44.636	-81	0	1.6	Blast, 7 km ENE of Shallow Lake, ON
2022-06-10 17:48:08	44.619	-79.1	0	1.8	Blast, 21 km NNE of Beaverton, ON
2022-06-09 16:54:24	45.448	-79.968	0	2.1	Blast, 8 km SSW of McKellar, ON
2022-05-27 9:48:47	44.924	-79.232	2	0.7	11 km E of Gravenhurst, ON
2022-05-26 11:45:10	44.915	-79.243	2	2.1	10 km E of Gravenhurst, ON
2022-05-23 19:49:11	42.857	-82.448	5	2.5	3 km S of Corunna, ON, felt
2022-05-19 17:12:10	45.08	-78.708	0	2.0	Blast, 16 km WNW of Haliburton Village, ON
2022-05-18 15:30:01	44.738	-79.417	0	1.8	Blast, 6 km NNW of Amigo Beach, ON
2022-05-13 17:14:16	43.537	-79.971	0	1.6	Blast, 12 km WNW of Milton, ON
2022-05-13 16:29:05	44.694	-80.925	0	1.8	Blast, 14 km N of Owen Sound, ON
2022-05-10 16:31:02	44.567	-80.861	0	1.9	Blast, Owen Sound Mine, ON
2022-05-09 19:33:18	45.877	-82.106	0	2.1	Blast, 7 km NE of M'Chigeeng 22 (West Bay 22), ON
2022-05-05 15:30:02	44.729	-79.419	0	1.9	Blast, 5 km NNW of Amigo Beach, ON
2022-04-29 15:59:26	45.911	-83.199	0	2.4	Blast, 2 km E of Meldrum Bay Mine, ON

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2022-04-27 15:11:31	45.341	-79.977	0	2.0	Blast, 5 km ESE of Parry Sound, ON
2022-04-20 17:14:07	45.055	-81.4	0	1.5	Blast, 14 km WNW of Lion's Head, ON
2022-04-14 17:34:29	44.386	-80.252	0	2.1	Blast, 13 km S of Collingwood, ON
2022-04-12 1:31:58	45.969	-79.389	2	1.9	3 km SW of Trout Creek, ON
2022-04-08 17:16:29	43.092	-80.89	0	1.6	Blast, 1 km SE of Woodstock Mine, ON
2022-03-31 14:20:00	44.966	-78.879	2	2.2	28 km SE of Lake of Bays, ON
2022-03-15 23:10:40	45.46	-79.58	5	1.0	10 km WSW of McMurrich/Monteith
2022-03-09 18:56:38	44.541	-79.099	0	2.0	Blast, 13 km NNE of Beaverton, ON, felt
2022-03-02 18:29:11	45.298	-79.285	0	1.9	Blast, 5 km SW of Huntsville, ON
2022-03-02 1:00:46	44.855	-78.997	2	0.7	33 km SE of Bracebridge, ON
2022-02-21 10:37:50	42.929	-82.564	5	1.8	11 km WNW of Corunna, ON
2022-02-15 7:28:09	43.325	-79.279	5	2.5	18 km N of St. Catharines - Niagara Falls, ON
2022-02-12 13:02:31	43.907	-79.065	2	2.4	6 km NNW of Ajax, ON, felt
2022-01-31 0:10:06	44.736	-78.931	5	1.2	27 km NW of Fenelon Falls, ON
2022-01-21 11:01:03	44.706	-79.522	2	0.8	10 km WNW of Amigo Beach, ON
2021-12-06 19:09:01	44.61	-79.094	0	2.1	Blast, 20 km NNE of Beaverton, ON
2021-12-02 19:01:38	45.091	-79.586	0	2.1	Blast, 19 km SSE of Rosseau, ON
2021-11-30 19:05:33	43.881	-78.689	0	1.5	Blast, 1 km SE of Bowmanville Mine, ON
2021-11-29 21:08:16	44.562	-80.871	0	1.5	Blast, 1 km SW of Owen Sound Mine, ON
2021-11-25 19:04:35	43.886	-78.686	0	1.6	Blast, 1 km ENE of Bowmanville Mine, ON
2021-11-17 16:10:07	44.586	-78.94	0	1.6	Blast, 17 km WNW of Fenelon Falls, ON
2021-11-04 14:37:22	44.642	-79.467	0	1.4	Blast, 4 km NE of Marchmont - Bass Lake, ON

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