Feb 24th, 5:00 PM - 6:00 PM

Microseismic Mapping of the Aftershock Sequences Following the Magnitude 5.8 Lincoln, MT Earthquake

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Evaluation of Aftershock Sequences Following the M5.8 Lincoln, MT Earthquake

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Introduction

Seismic mapping has played an integral role regarding our ability to monitor and evaluate tectonic activity in Montana, as well as at a global scale. Microseismic mapping enhances this capability by recording low magnitude earthquakes by using a densely populated seismic network. This dense network captures events of lesser magnitude because the wave energy released by such events does not attenuate quick enough, whereas in a sparsely populated network this energy would have to travel further to reach a station at the surface. Here, seismic stations were specifically deployed around the location of the 2017 M 5.8 Lincoln, MT earthquake. Continuous seismic data has been recorded by stations from the University of Montana Seismic Network (UMSN), the Montana Regional Seismic Network (MRSN), and temporary stations from the United States Geological Survey (USGS). Continuous data from the UMSN was not previously implemented in large scale catalogs, but it may reveal hundreds, if not thousands, of additional earthquakes not previously recorded by widely dispersed seismic networks. The creation of a catalog including data from the concentrated array of stations around the Lincoln mainshock-aftershock sequence will augment the current existing catalog from the USGS, refine the hypocentral location of individual events, and provide data to analyze aftershock evolution and fault mechanics of this region. This catalog aims to provide accessible data for earthquakes in west-central Montana between 06 July 2017 until the end of 2022.

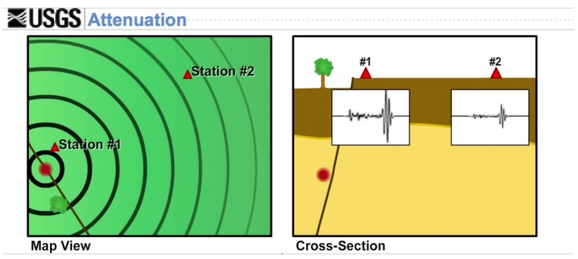

*Figure 1: Representation of seismic wave attenuation. **USGS**.*

Objectives

- Use QuakeMigrate software to detect and locate the magnitudes of aftershock events in west-central Montana following the 2017 event
- Accurately identify and locate additional earthquakes between the time of the mainshock, 06 July 2017, and the end of 2022
- Generate a catalog of the recorded coordinates and magnitudes of the additional earthquakes from the mainshock-aftershock sequence
- Identify a new magnitude of completeness
- Make the catalog accessible to the public for utilization in future studies of west-central Montana

Methods

FIELD WORK

- Data downloaded from stations

SOFTWARE

- QuakeMigrate (QM)
- Four Stages
  - I. Generate Look-Up Table
  - II. Detect
  - III. Trigger
  - IV. Locate

Results

TRIGGER STAGE

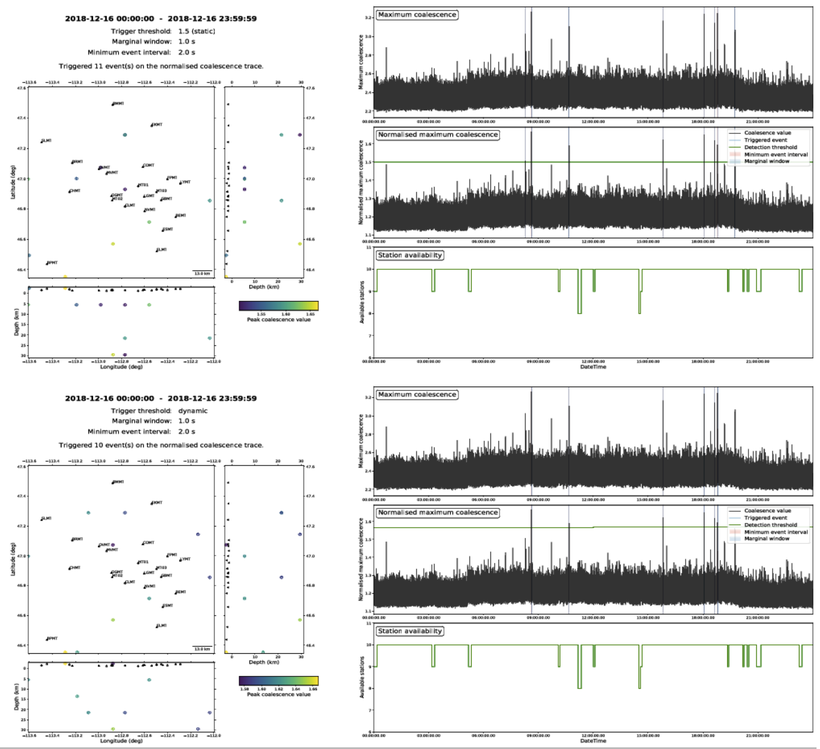

Figure 2: Summary outputs from the trigger stage. A) Displays the output with a static trigger threshold method that has a value of 1.5. B) Displays the output with a dynamic trigger threshold method.

LOCATE STAGE

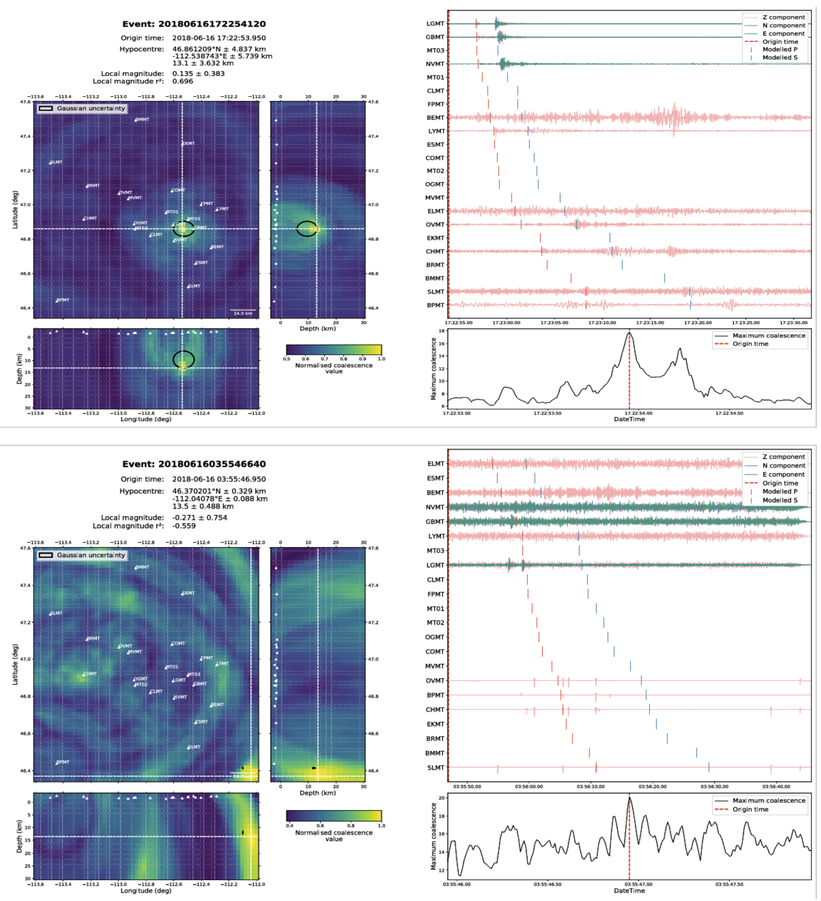

Figure 3: Summary outputs of two events from 12-16-2018. This stage presents the waveform data used to process the outputs, the coordinates and depth of the event, and the estimated uncertainties. A) Represents a quality event output. B) Represents an event with excess noise.

Catalog

= QuakeMigrate

= USGS

16 June 2018

EventDateTime	Longitude	Latitude	Depth(km)	ML
2018-06-16T05:37:27.910000Z	-112.53343	46.891788	11.7	0.181
2018-06-16T17:22:53.950000Z	-112.53874	46.861209	13.1	0.135
2018-06-16T03:22:47.340000Z	-113.53276	47.016275	27.5	-0.18

15 September 2018

EventDateTime	Longitude	Latitude	Depth(km)	ML
2018-09-15T02:27:58.490000Z	-112.5361	46.868402	12.3	-0.385
2018-09-15T03:52:23.090000Z	-112.44695	46.857476	11.5	-0.153
2018-09-15T04:44:25.350000Z	-112.53339	46.906181	10.9	0.524
2018-09-15T04:44:59.340000Z	-112.53347	46.873797	12.7	0.0191
2018-09-15T06:15:42.180000Z	-112.44958	46.857481	11.3	-0.292
2018-09-15T06:24:48.780000Z	-112.45219	46.859285	11.3	-0.547
2018-09-15T06:41:10.710000Z	-112.53347	46.873797	12.5	-0.338
2018-09-15T15:32:58.470000Z	-112.53347	46.873797	12.9	-0.465
2018-09-15T17:31:16.110000Z	-112.53348	46.870199	9.3	0.325
2018-09-15T23:23:21.450000Z	-112.50723	46.873765	13.5	0.0389

EventDateTime	Latitude	Longitude	Depth (km)	mag	magType
2018-09-15T04:44:25.210Z	46.9125	-112.521333	16.19	0.97	ml

16 December 2018

EventDateTime	Longitude	Latitude	Depth(km)	ML
2018-12-16T15:48:58.640000Z	-112.58609	46.767693	9.9	1.41

EventDateTime	Latitude	Longitude	Depth (km)	mag	magType
2018-12-16T16:00:38.380Z	46.9725	-112.587833	28.77	1.53	ml
2018-12-16T15:48:58.510Z	46.7565	-112.592167	13.11	1.85	ml
2018-12-16T00:40:31.840Z	46.904833	-112.525167	11.48	1.2	ml

Tables 1-4: Display the events that were recorded my QuakeMigrate (blue) and the events recorded by the USGS (green) on the corresponding says

Future Work

- Compare QM to USGS recordings
- Refine P-wave and S-wave arrival times
- Compute focal mechanisms
- Use HypoDD and HypoInverse software
- Application of QM in the Swan Valley
  - Brittle-Ductile Transition

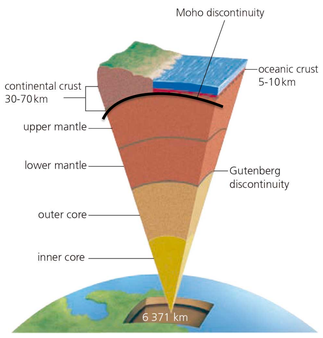

Figure 4: Showing the layers of the Earth. Black line shows the Mohorovičić discontinuity (Moho) Source: blinklearning.com

Acknowledgements

Winder, T., Bacon, C.A., Smith, J.D., Hudson, T., Greenfield, T. and White, R.S., 2020. QuakeMigrate: a Modular, Open-Source Python Package for Automatic Earthquake Detection and Location. AGUFM, 2020. pp.S38-0013.