

# Observations of Regional and Telesismic Events at SURF

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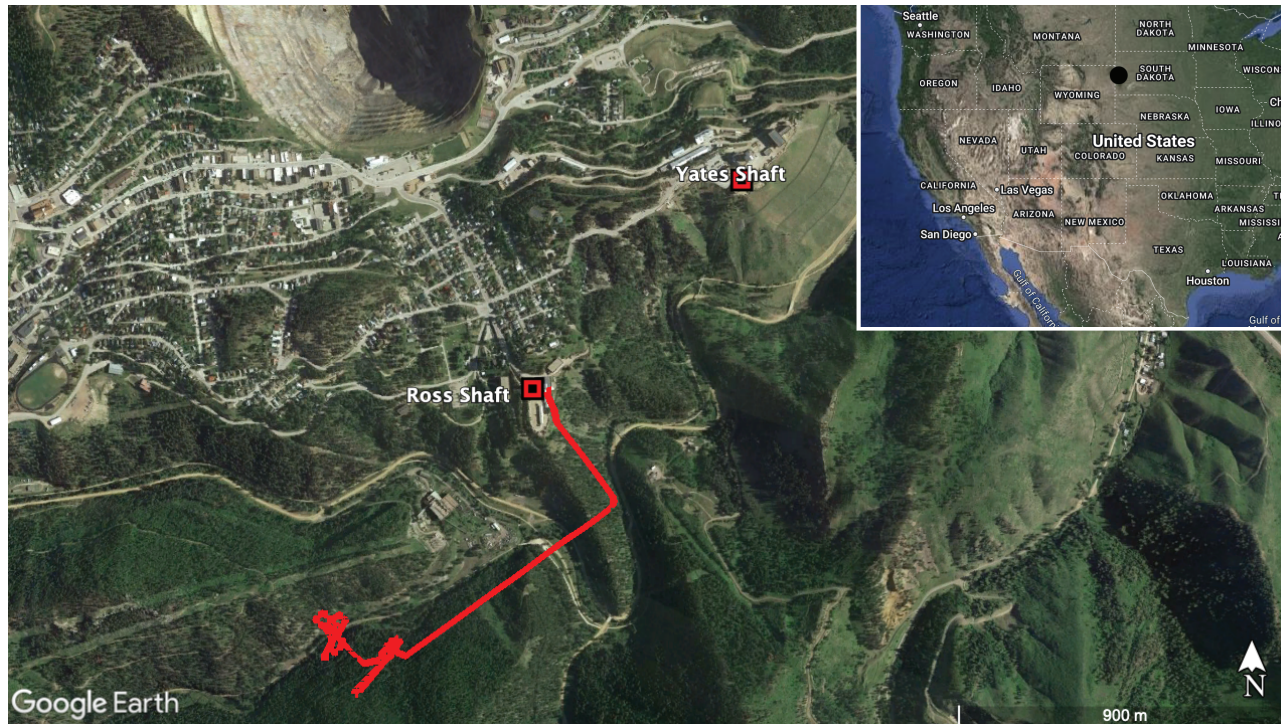




# 3D DAS Array at SURF

Sanford Underground Research Facility (former Homestake Mine) in Lead, SD

- Allows for deep large-scale DAS deployment
- "Quiet" environment
- Deployment in crystalline rock





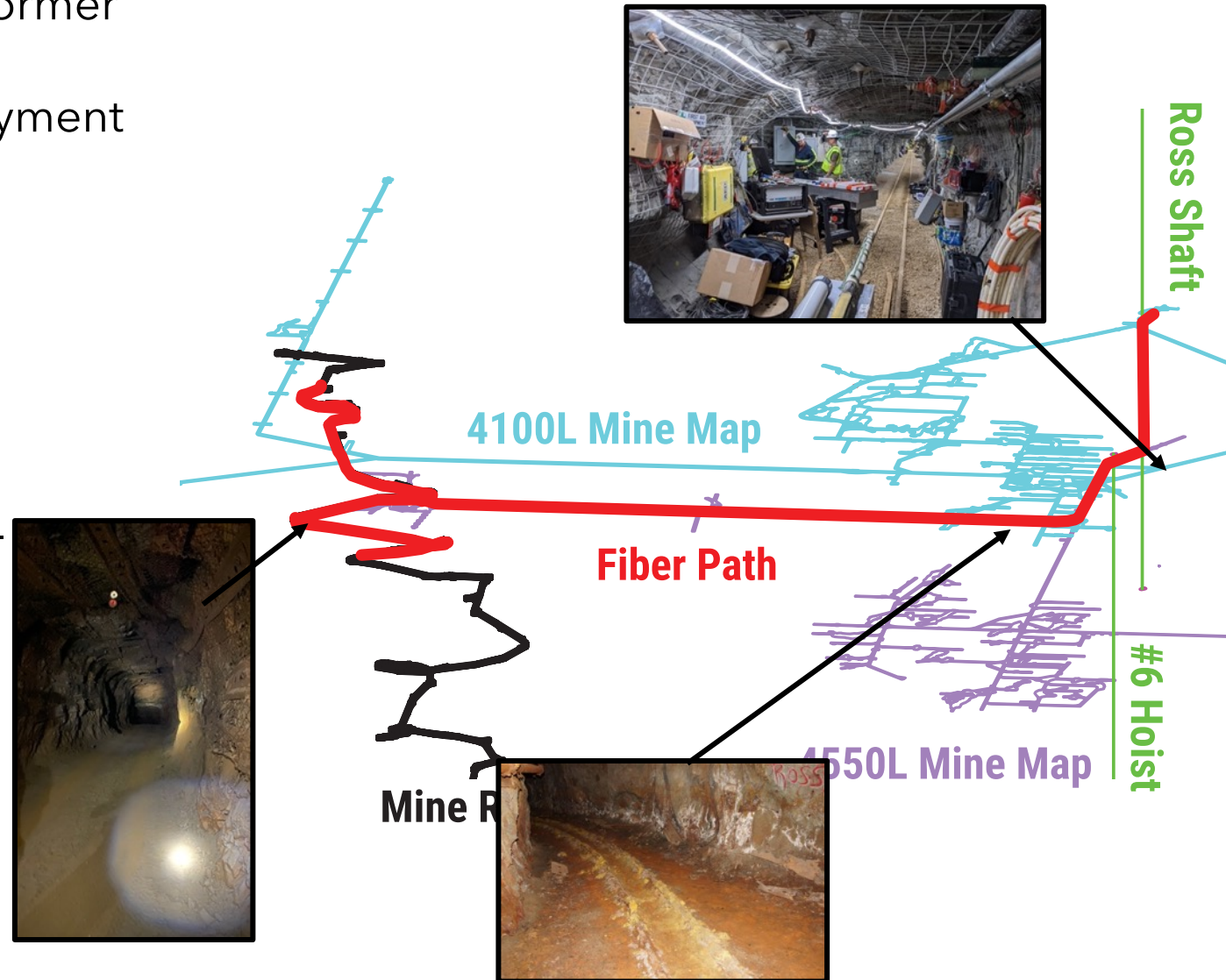
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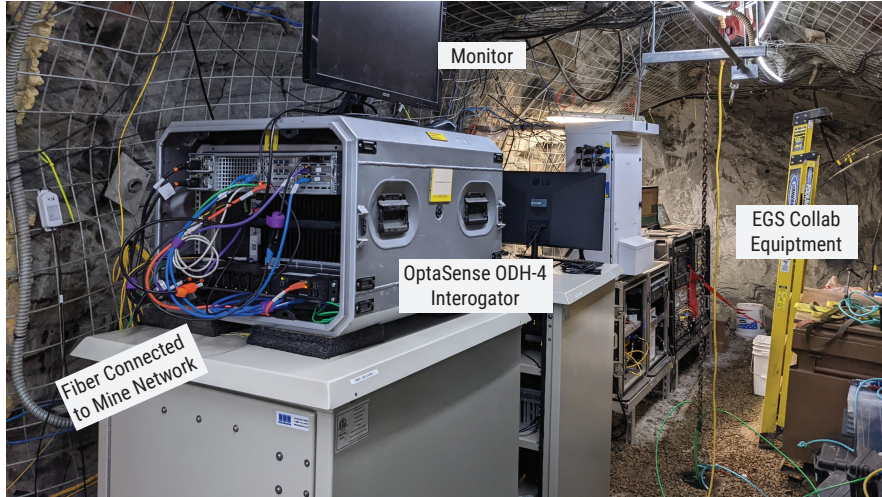
## 3D DAS array

- ~5000 m of fiber, including a 3D spiral-like layout along the ramp system
- Interrogator on 4100L connected to mine fiber
- Fiber deployment starts at 4550L
- Multiple fiber deployment styles & environments





# DAS Data Collection



**Interrogator:** OptaSense ODH-4

**Fiber Length:** 5160m of single-mode fiber

**Seismic Mode:** 16m GL 4m channel spacing 500sps/1 min files

**Tapping Mode:** 4m GL 1m channel spacing 2000sps/ 30-second files

## 2022

**Recording Time:** May 5th -19th, 2022

**Data Size:** 3.2 TB HDF5 (h5) file format

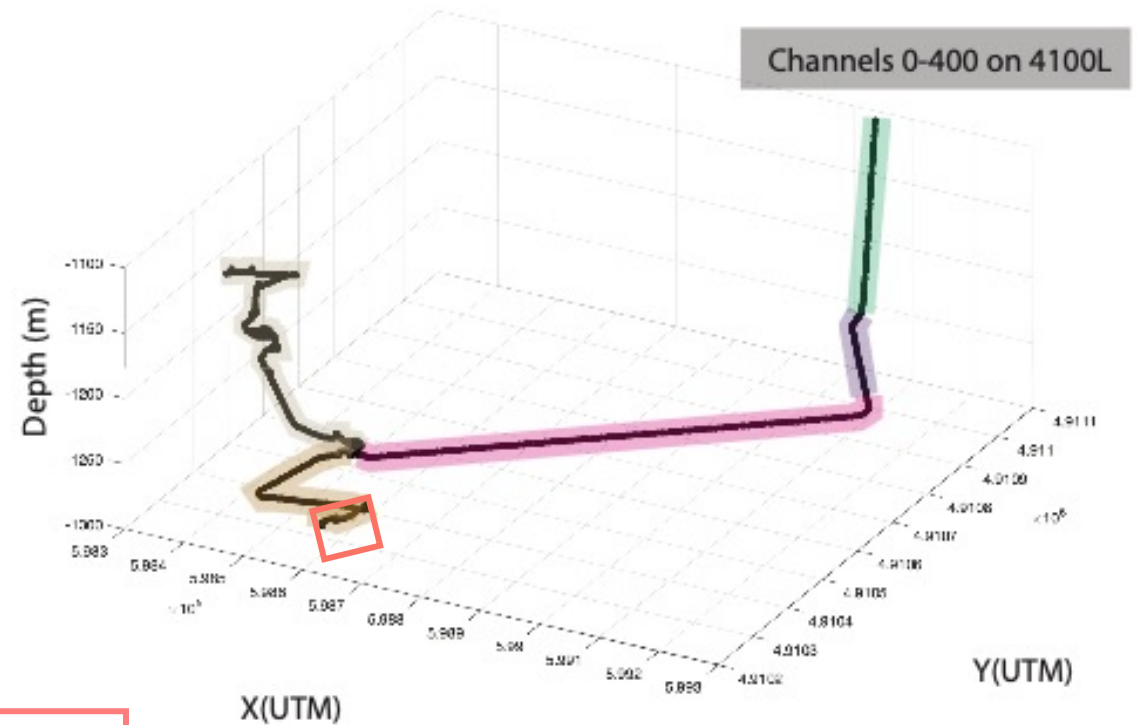
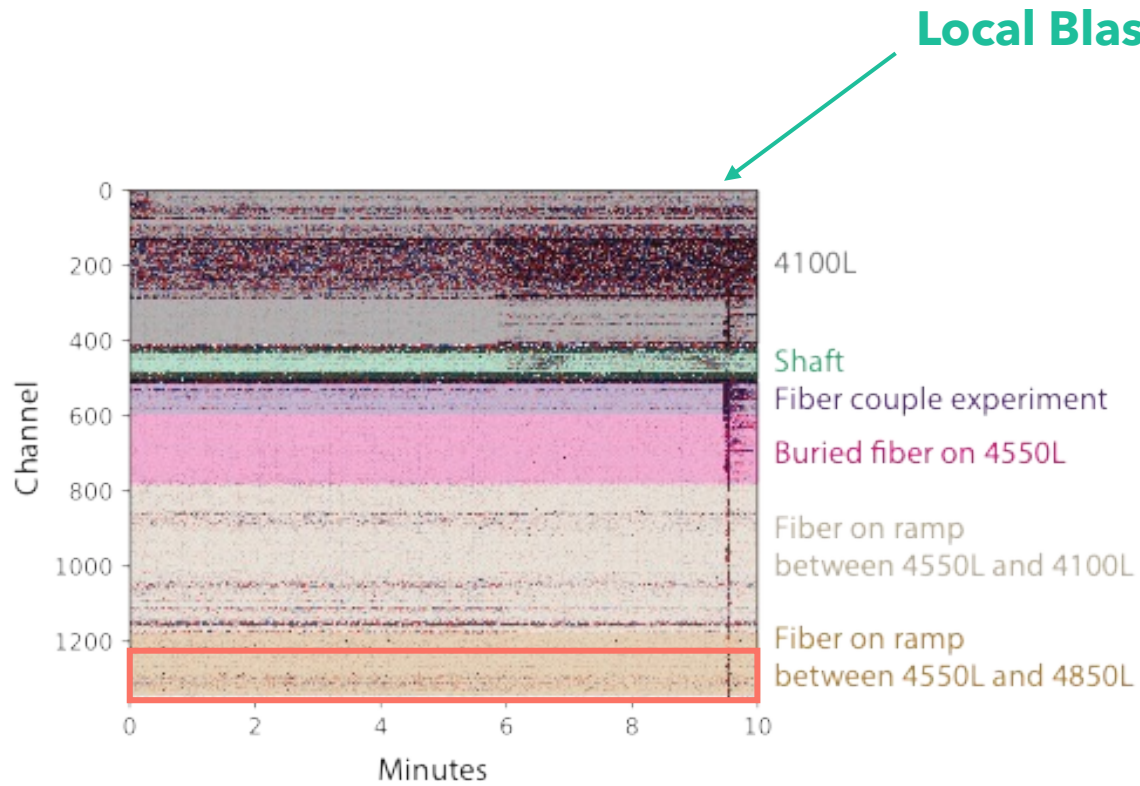
## 2023

**Recording Time:** Feb 1st – Mar 4th, 2023

**Data Size:** 7 TB HDF5 (h5) file format



# DAS Strain Response

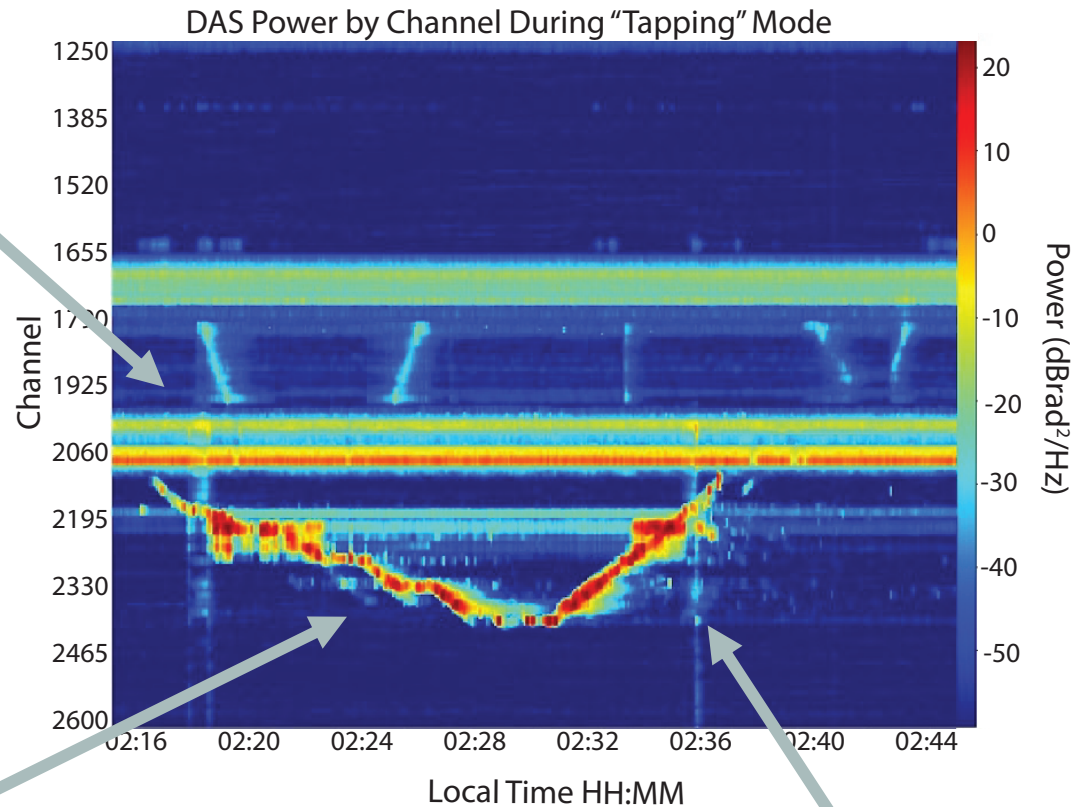


\* In 2023 the last ~50 channels are trenched and cemented



# Mine Monitoring

Cage moving up and down in the shaft



## Mine Monitoring Applications

- Airdoor
- Air flow in ramp (fans)
- Mining equipment
- Excavation (blasting)

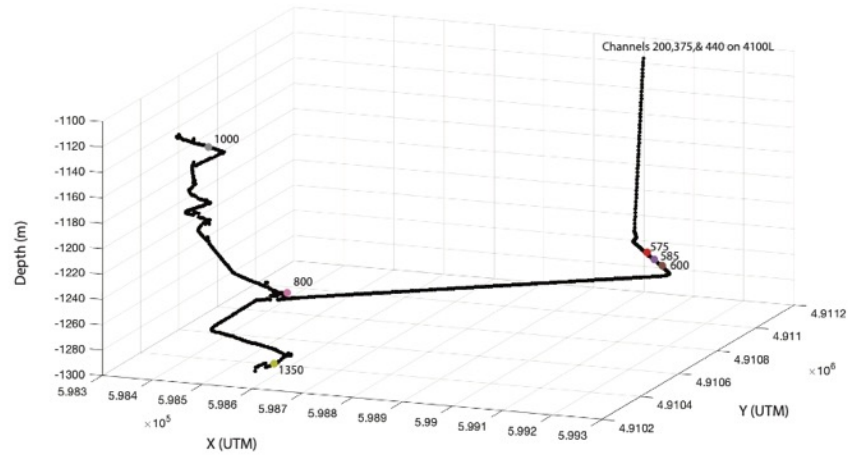
Cart & people along cable stopping to re-deploy seismometer batteries

Air door opening and closing

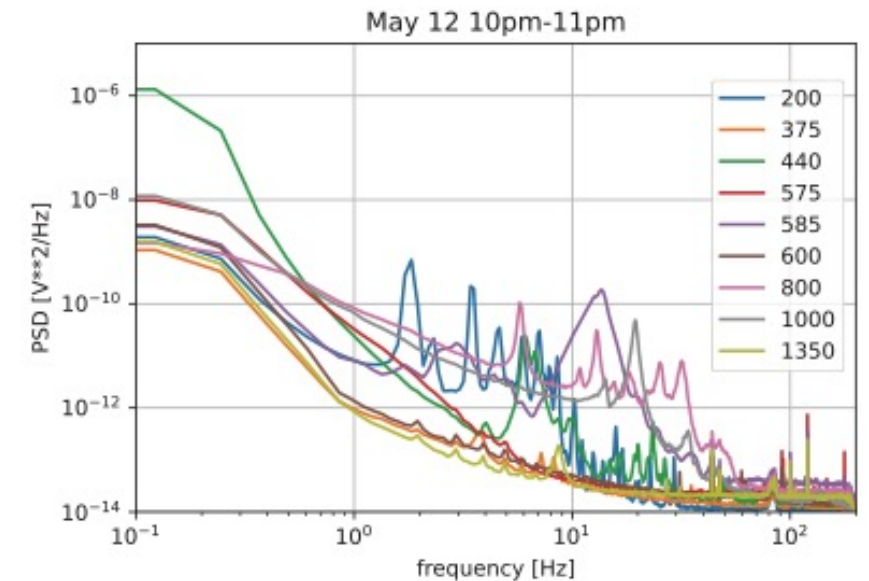
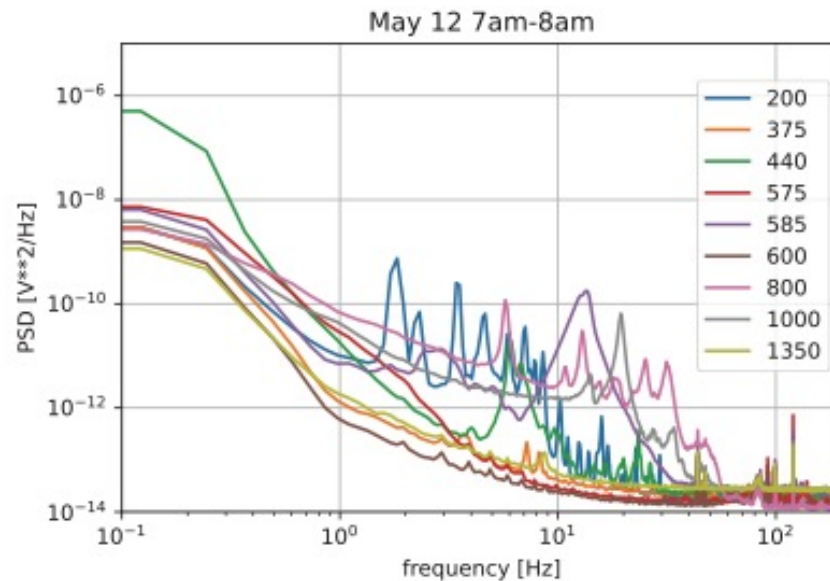


# A side note on fiber deployment

Fiber Channel Locations Used for Noise Analysis



- Large variation between sections of the fiber
- Slight variation between the time of day

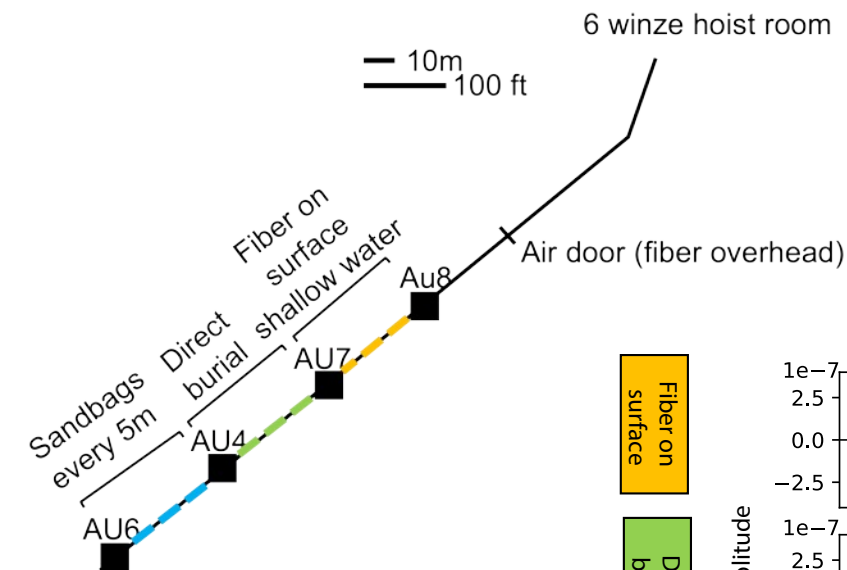




# A side note on fiber deployment

## Fiber Deployment on 4550L

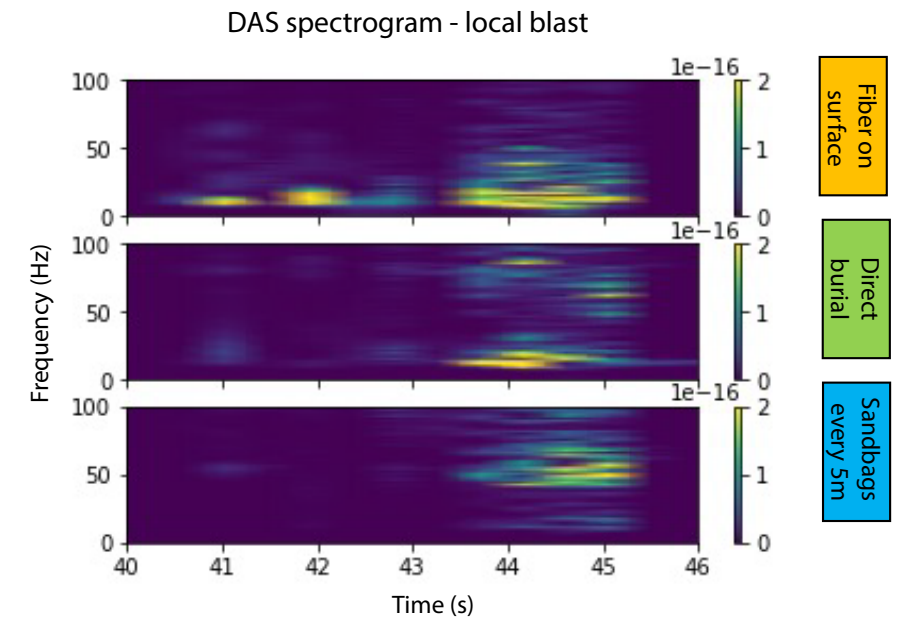
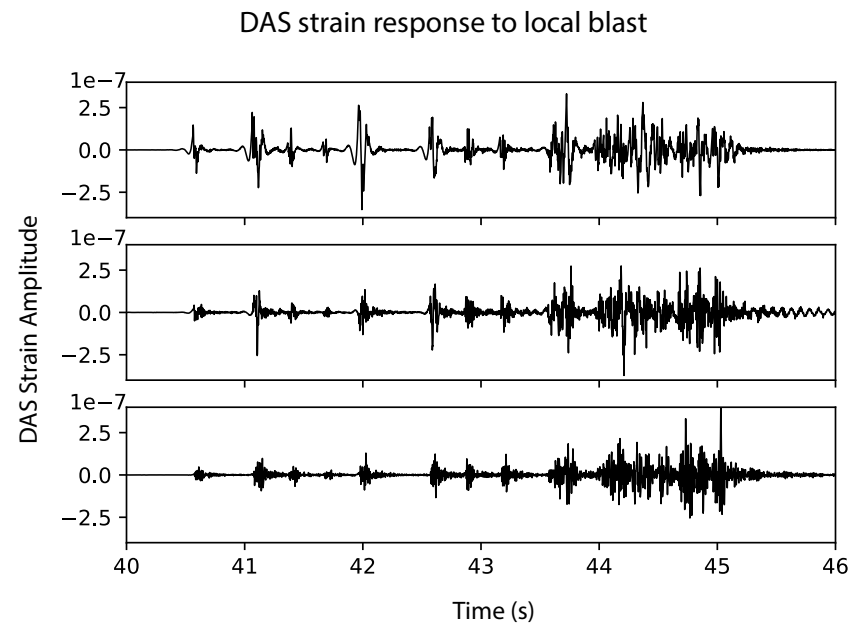
- Dedicated ~150m and 3 geophones to exploring fiber deployment methods
- 2x daily local blasting provides a source to evaluate strain response



Fiber on surface

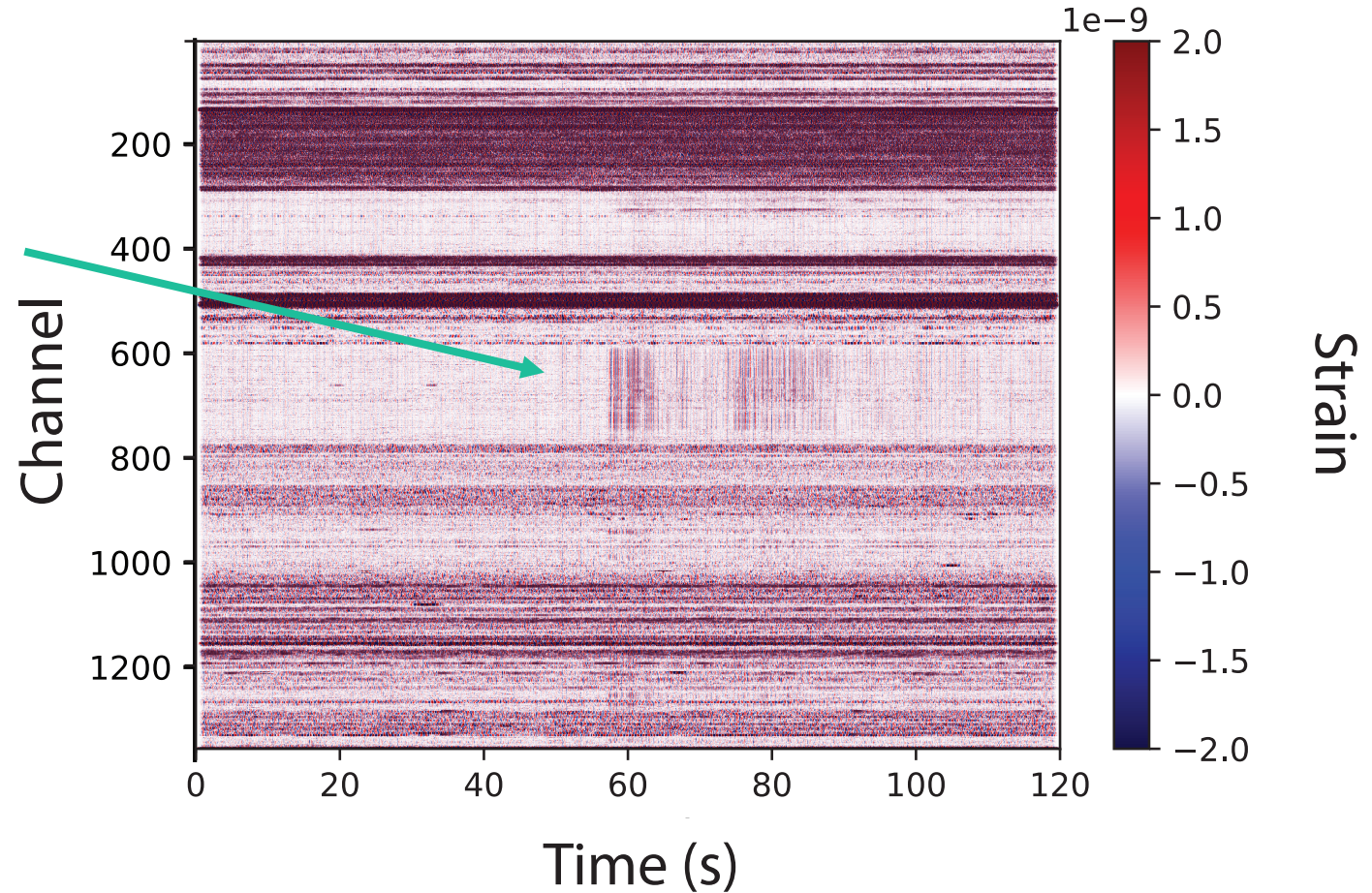
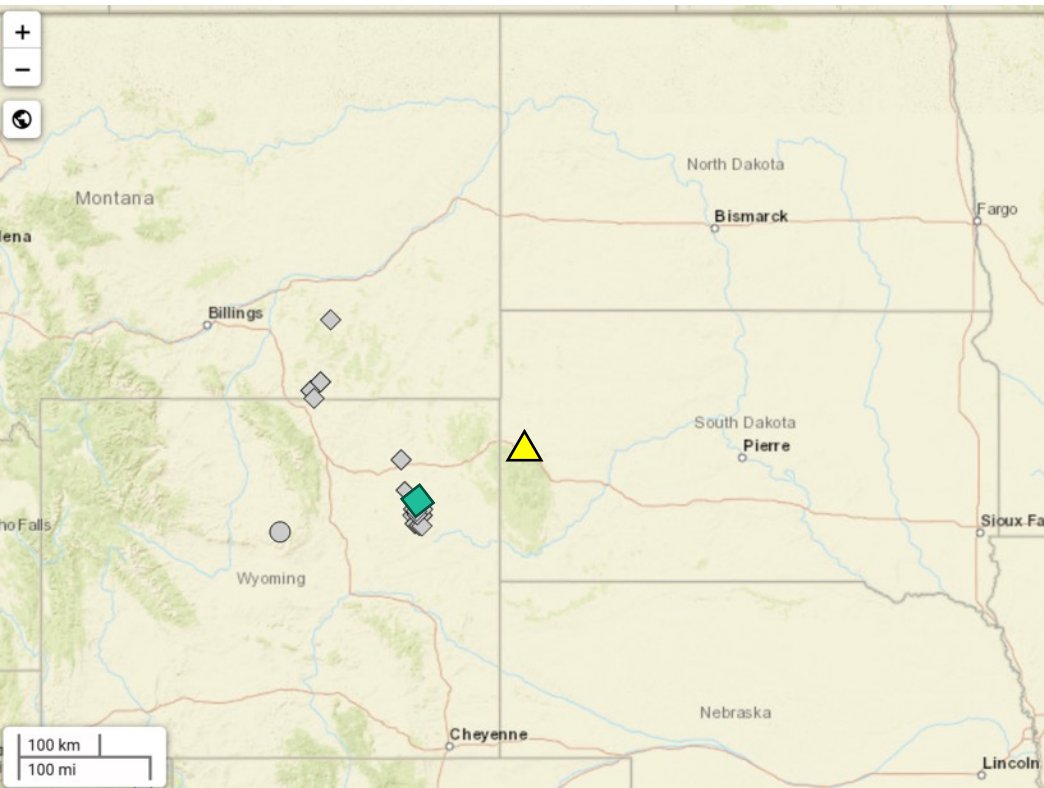
Direct burial

Sandbags every 5m



# Regional Events

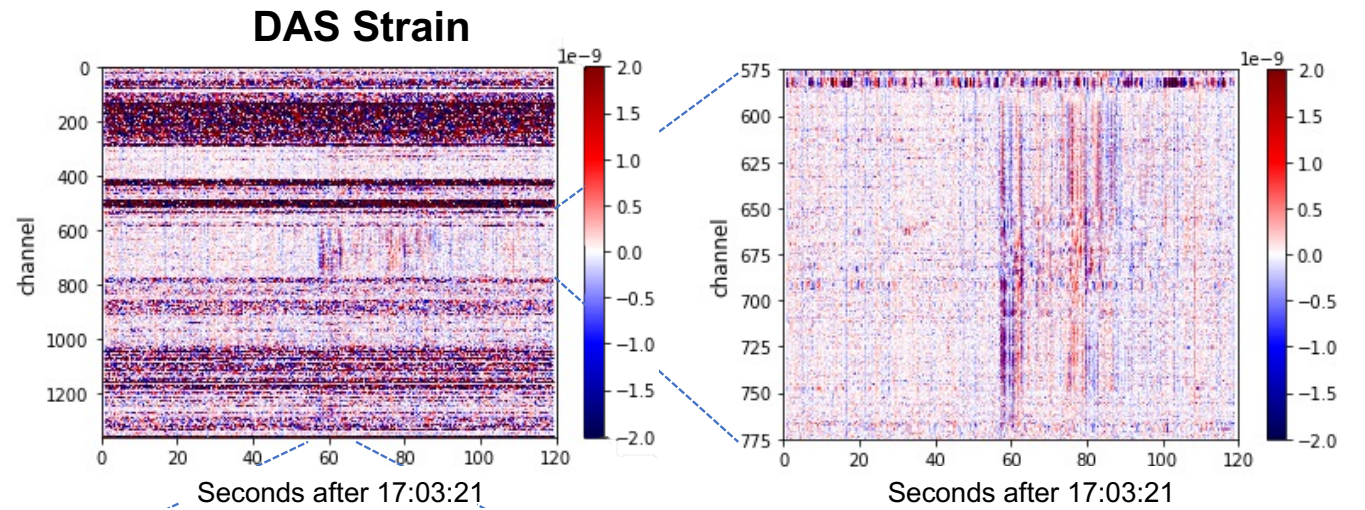
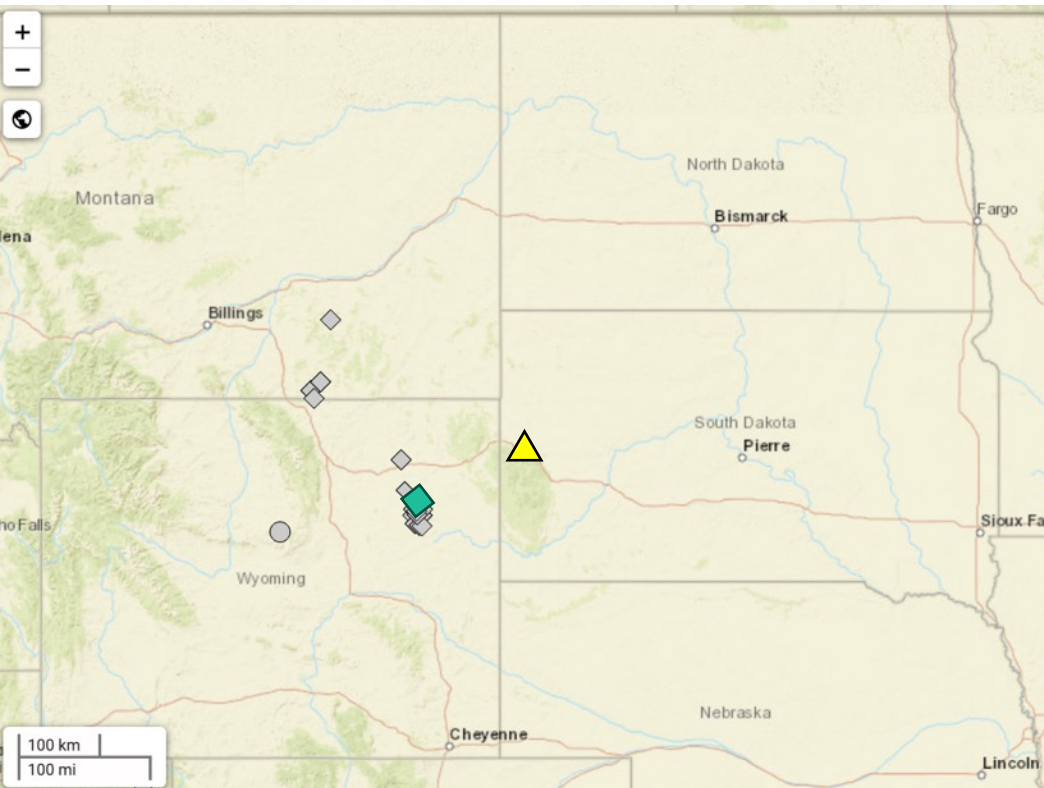
**Magnitude 3.4 Blast**  
**2022-05-07 17:03:21 UTC**





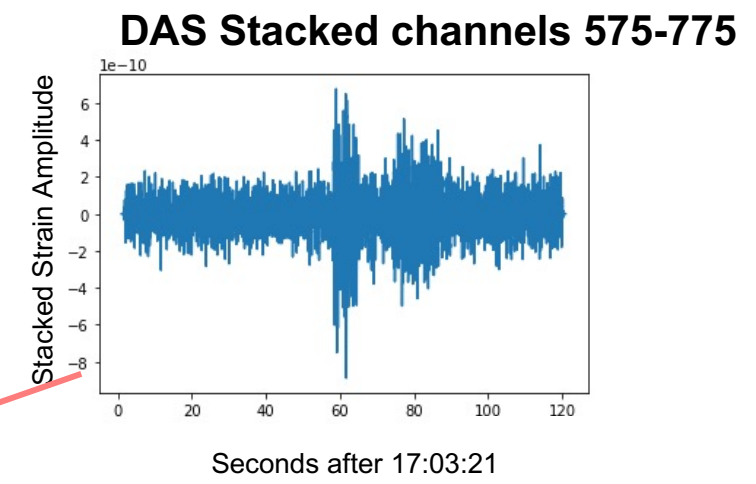
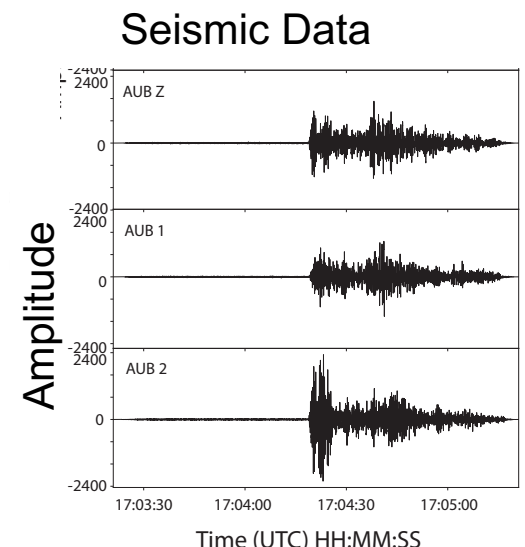
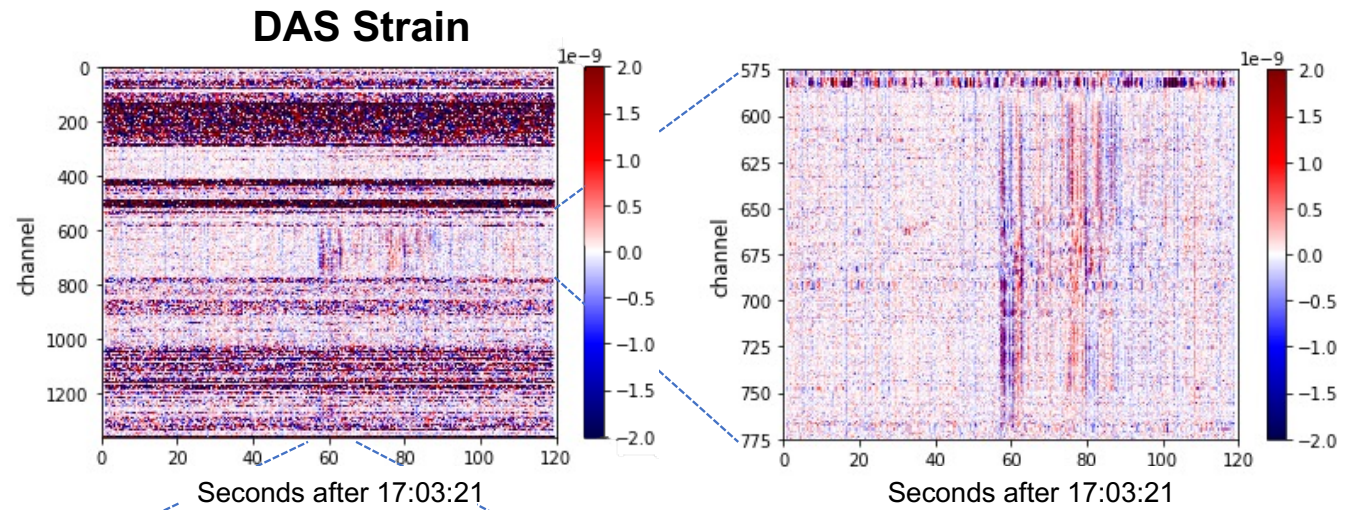
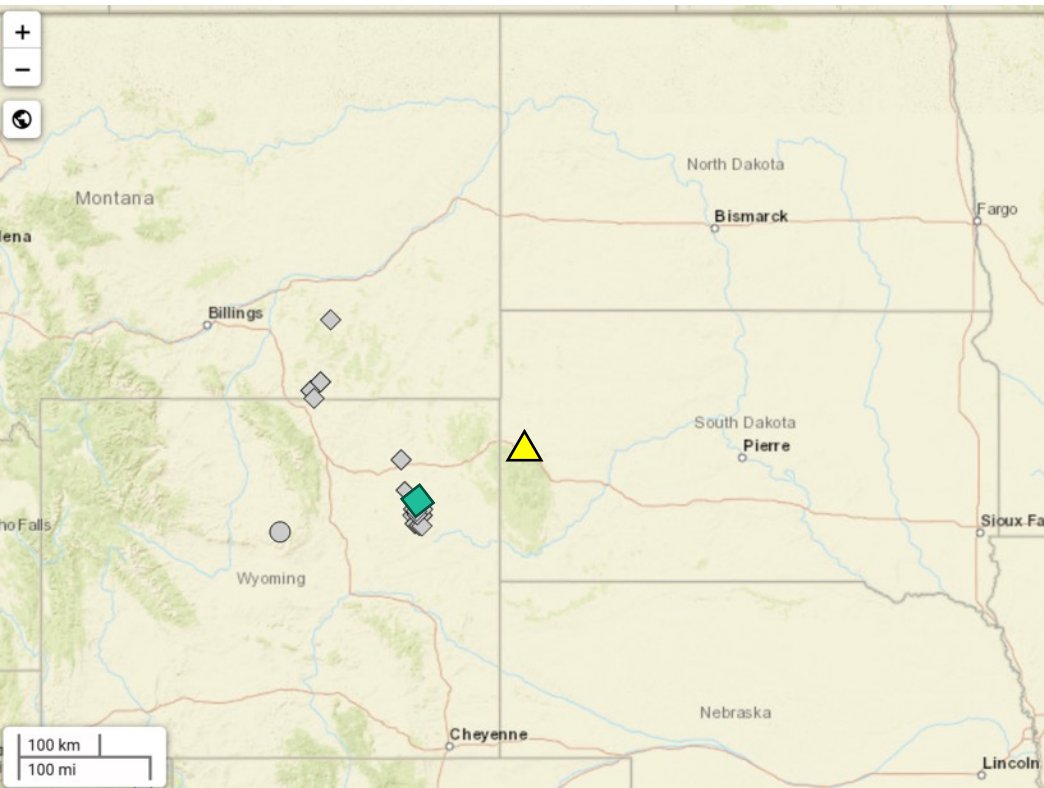
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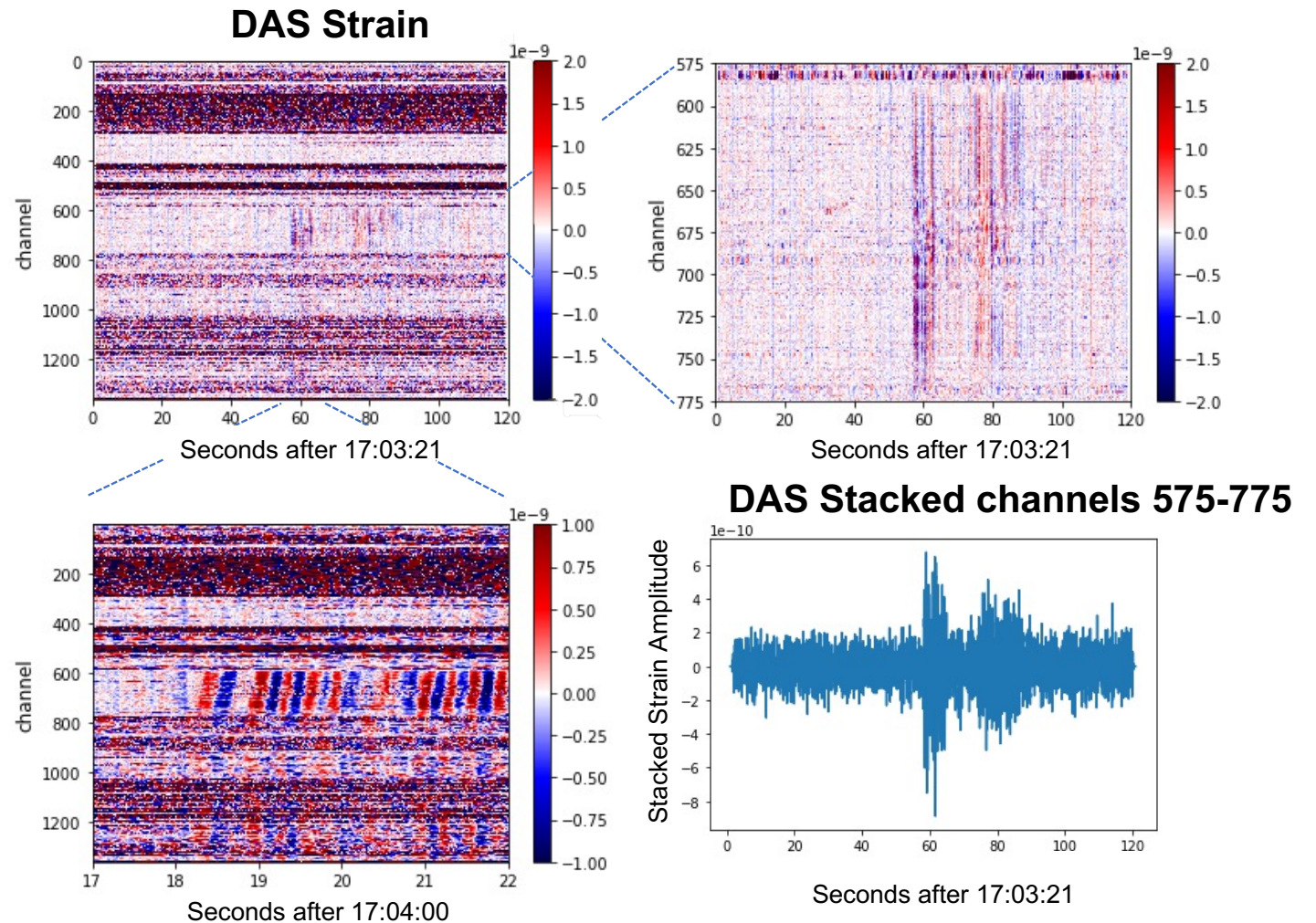
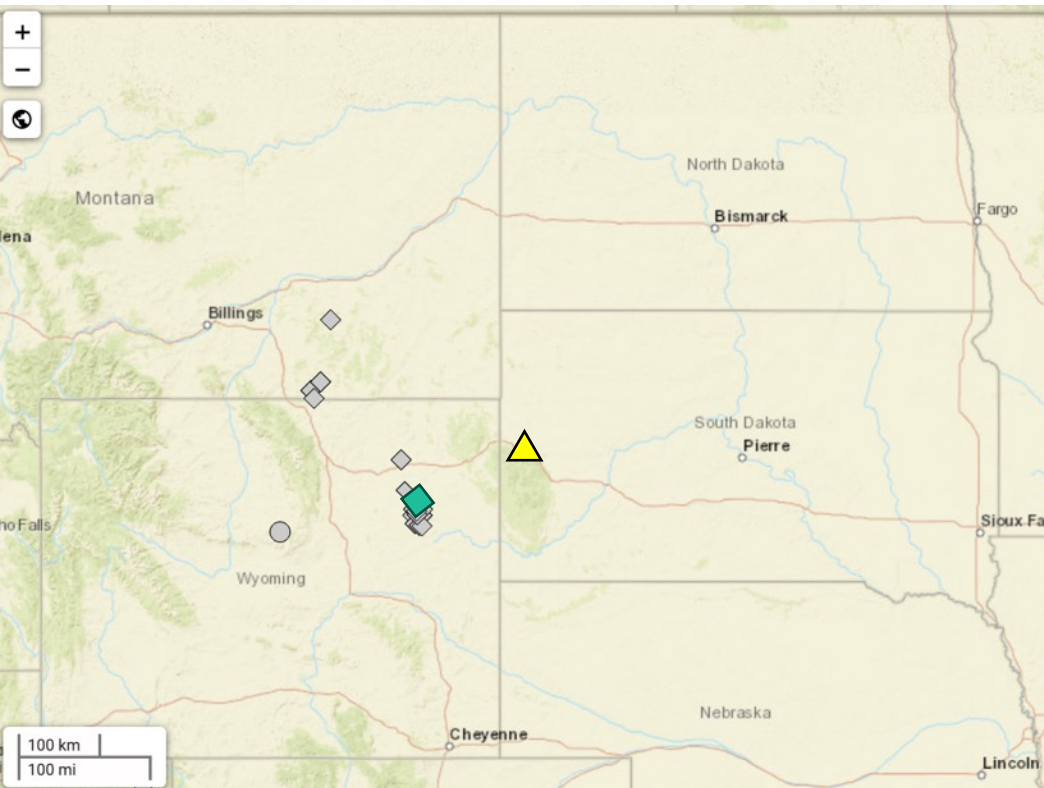
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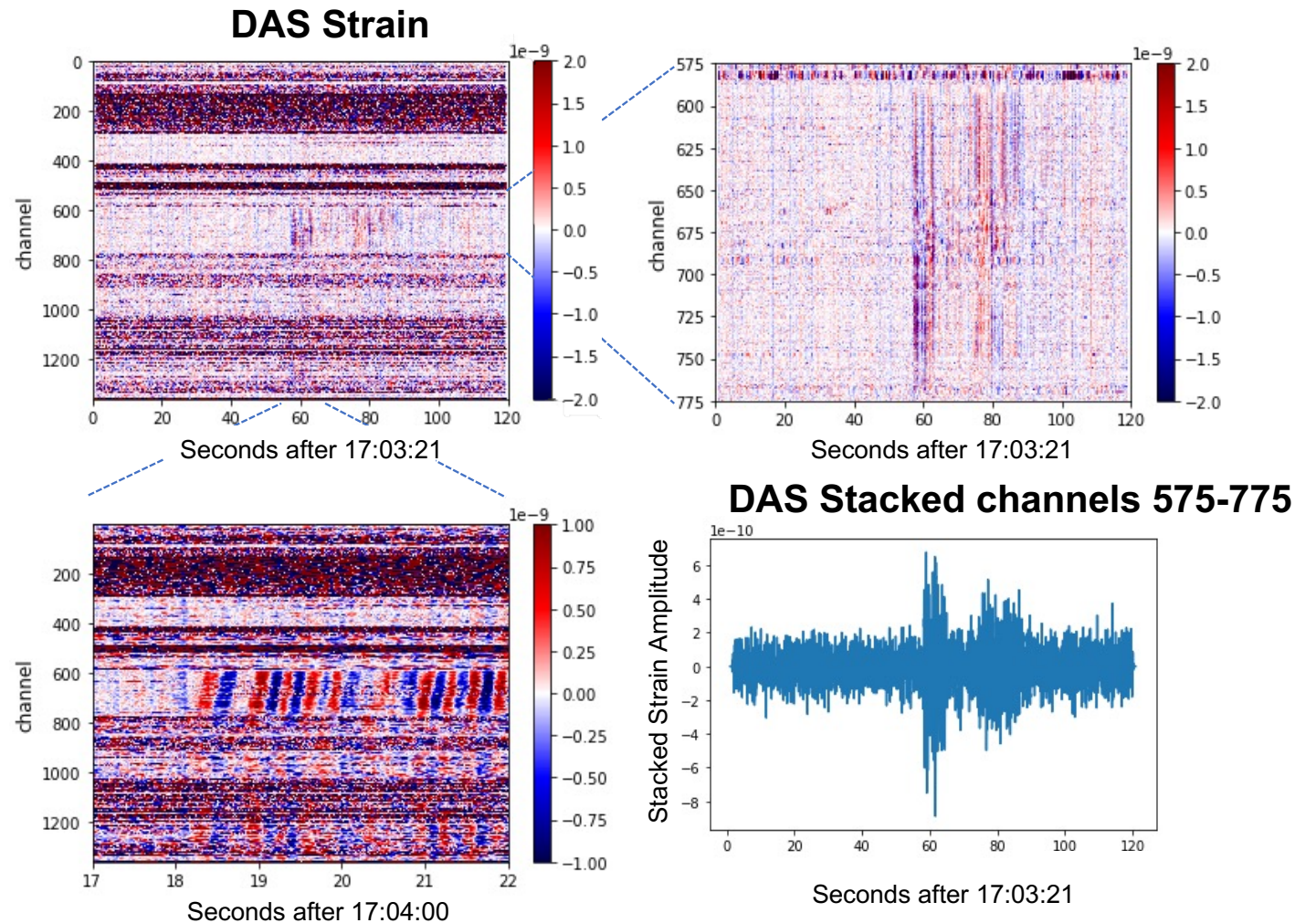
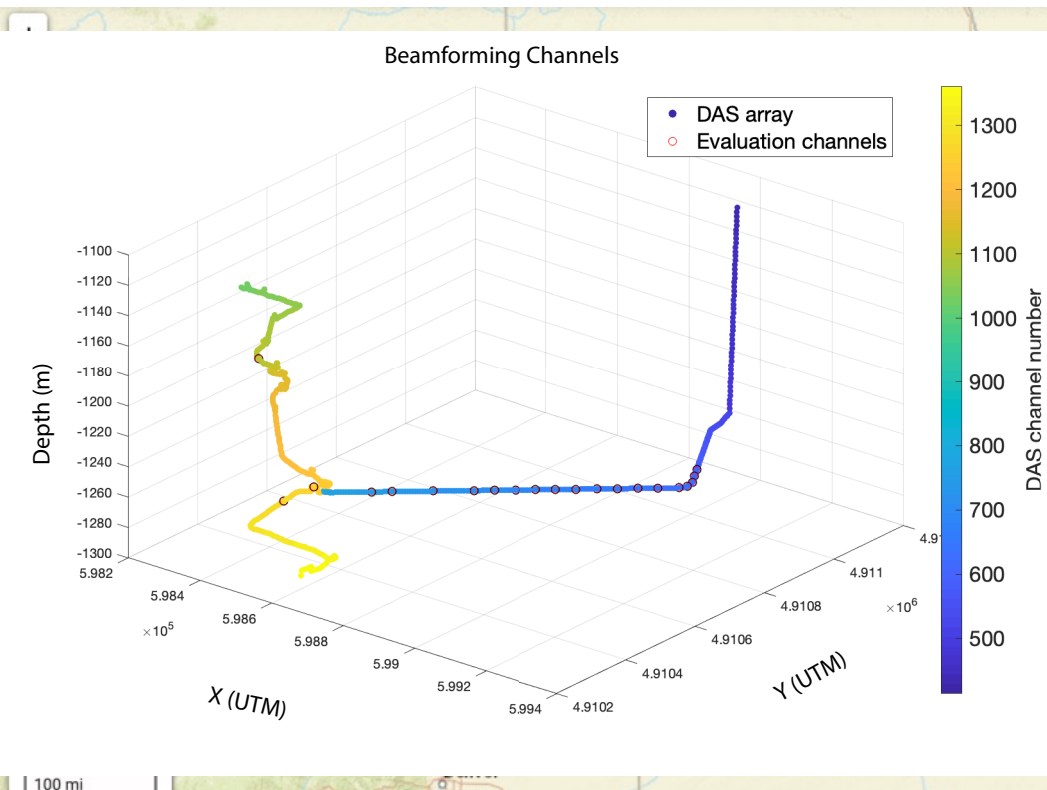
# Regional Events

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# Regional Events

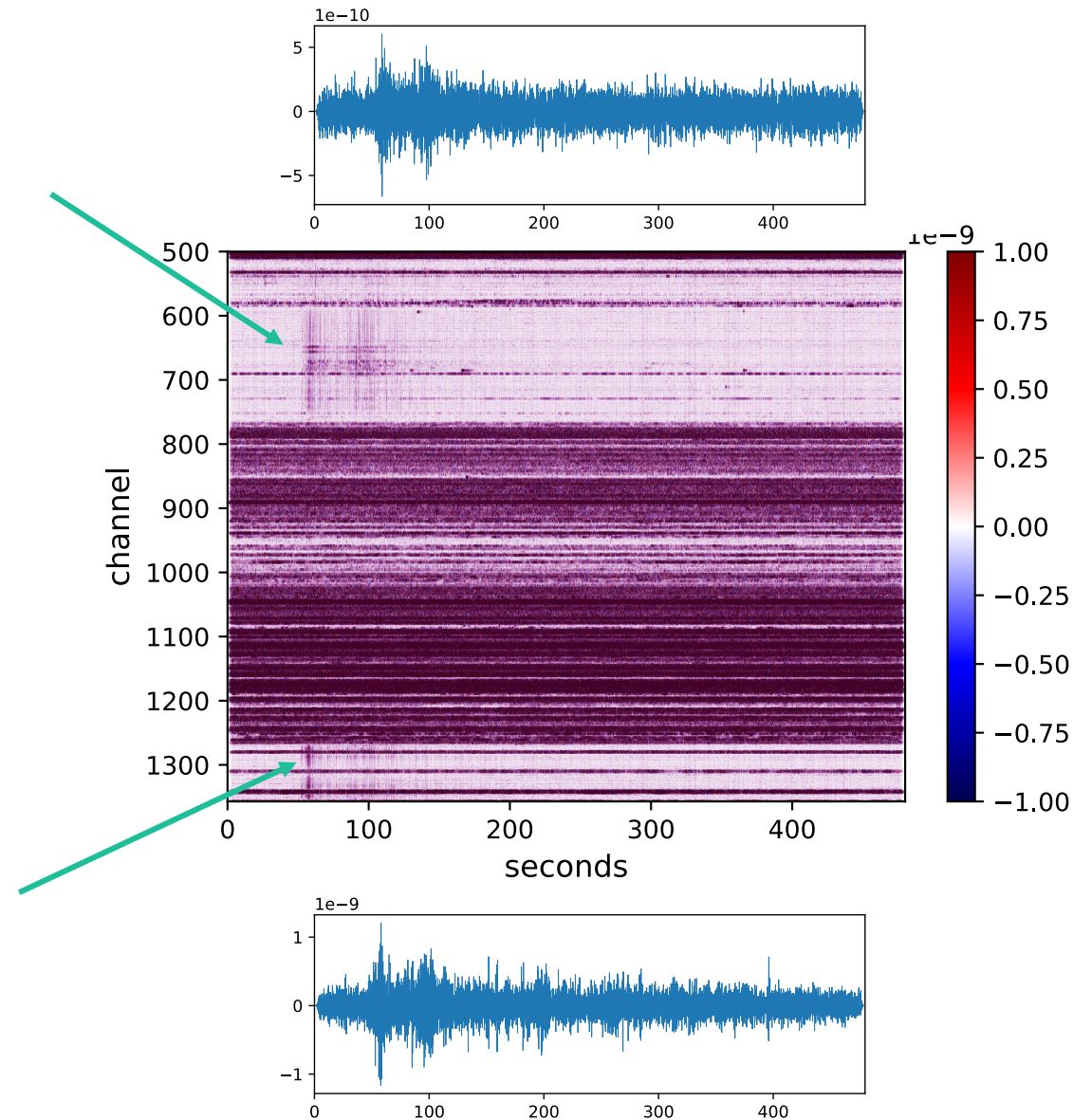
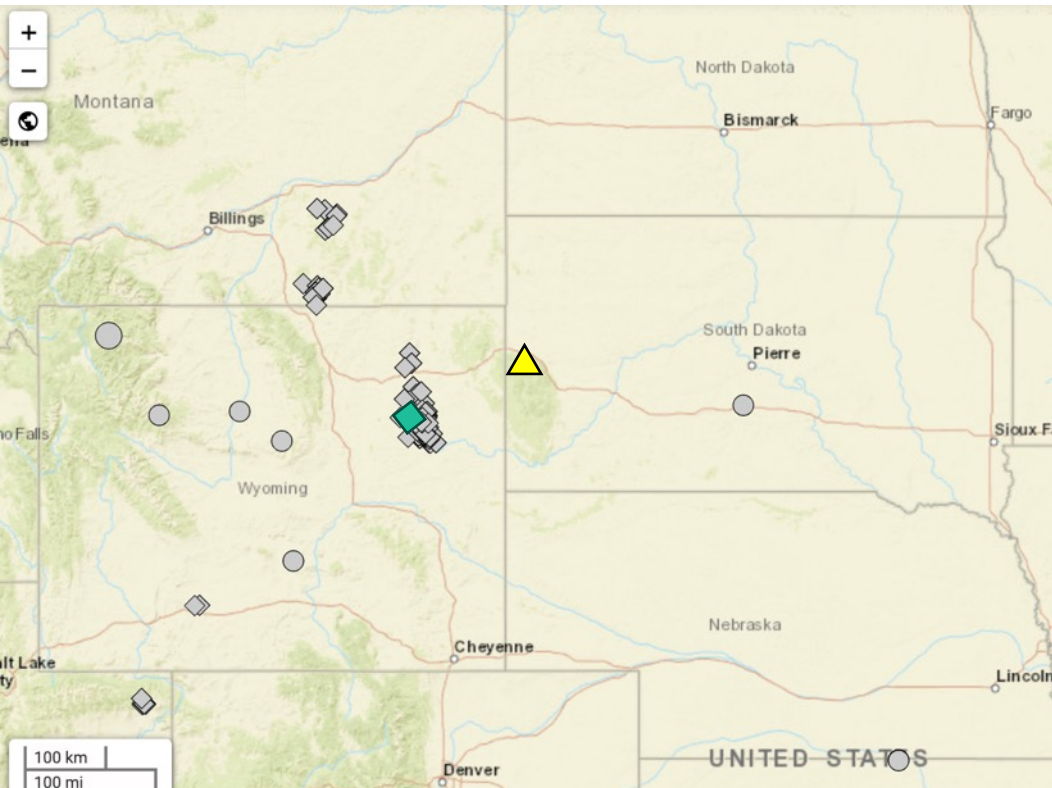
**Magnitude 3.4 Blast**  
**2022-05-07 17:03:52 UTC**





# Regional Events 2023

**Magnitude 3.4 Blast**  
**2023-02-05 20:00:13 UTC**



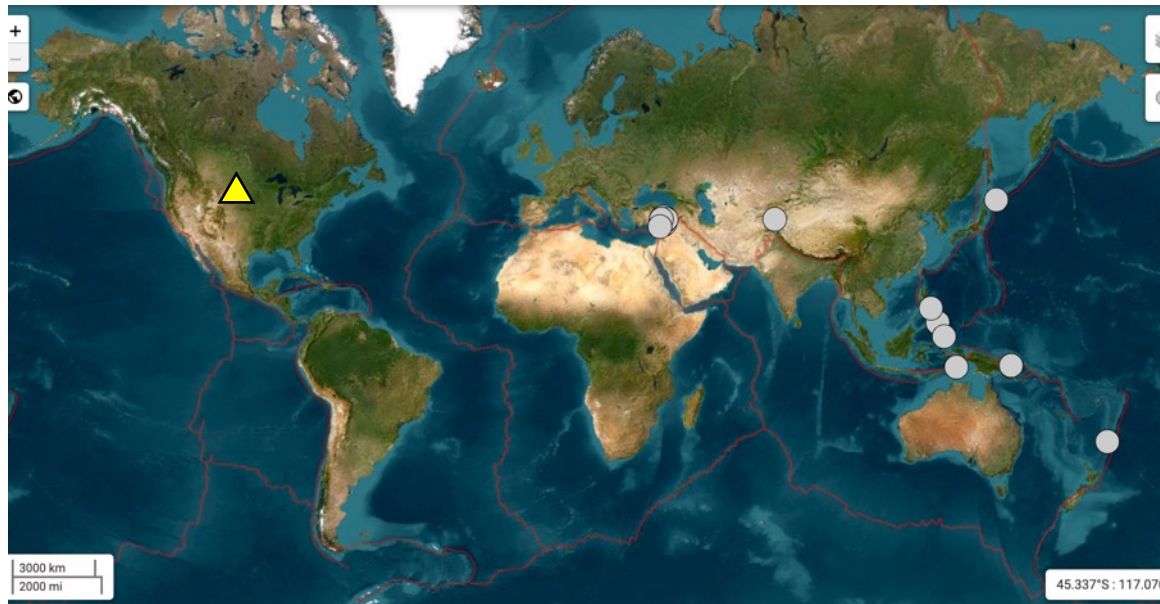
# Teleseismic Earthquakes: Global Earthquake Data

February 2023 earthquake above magnitude 6

- 14 events
- Epicentral distance 73-118 degrees

May 5-18th 2022 earthquake above magnitude 6

- 4 events
- Epicentral distance 75-111 degrees

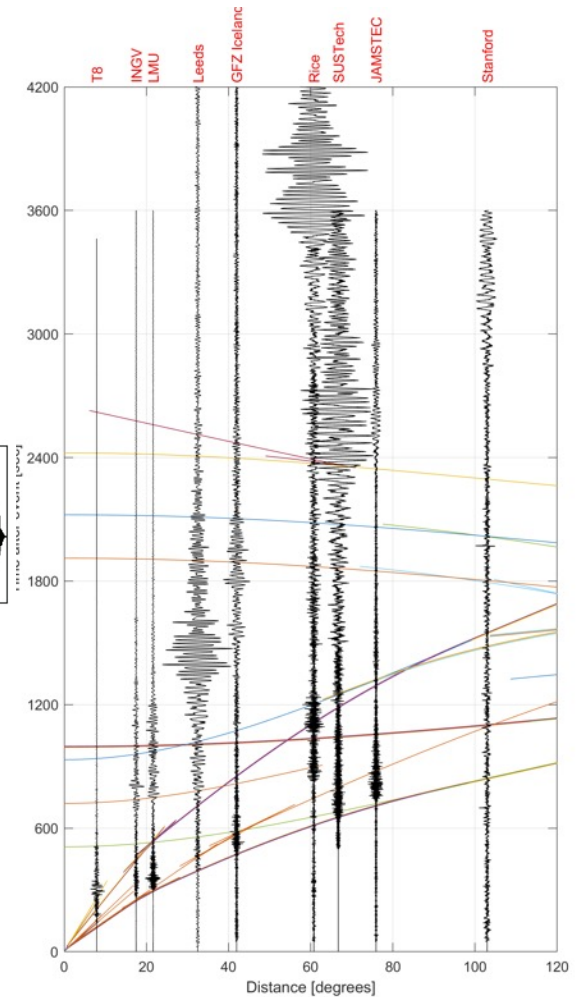
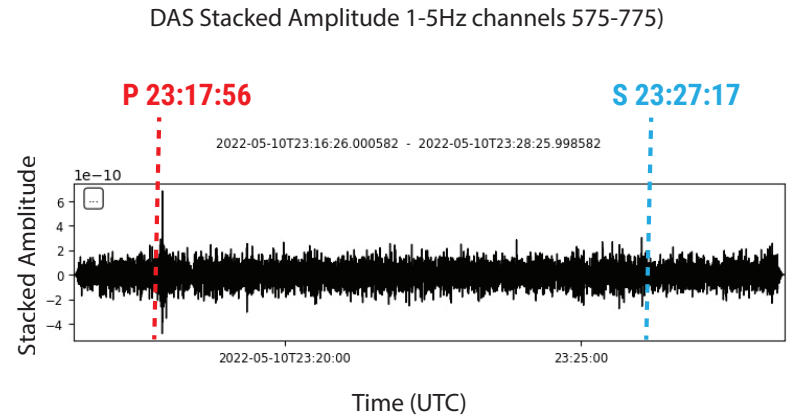
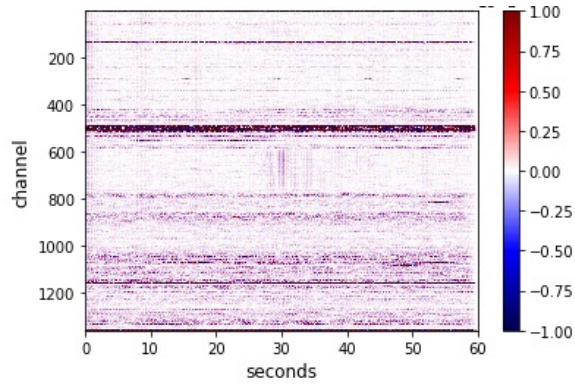
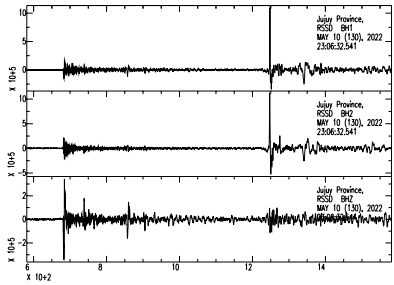




# Telesismic Earthquakes: Body Waves

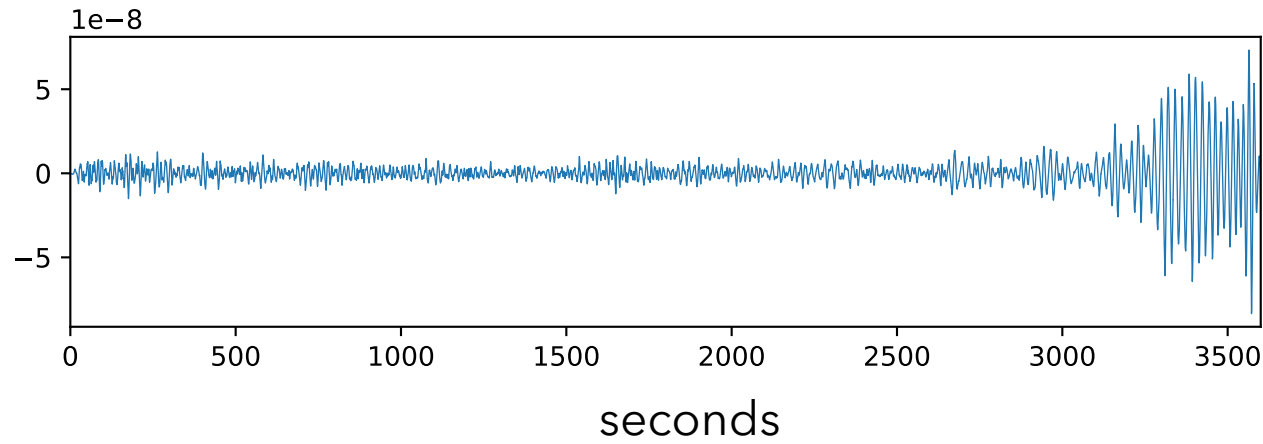
2022 6.8 Argentina Earthquake (distance = 75)

## Seismic



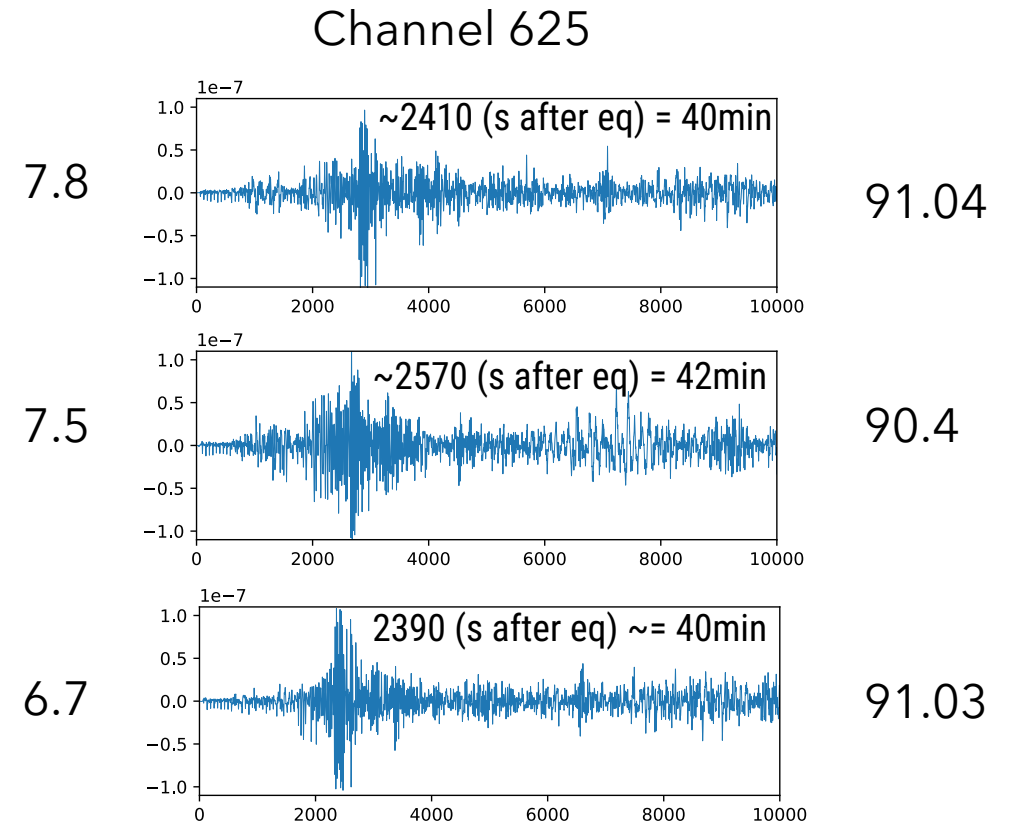
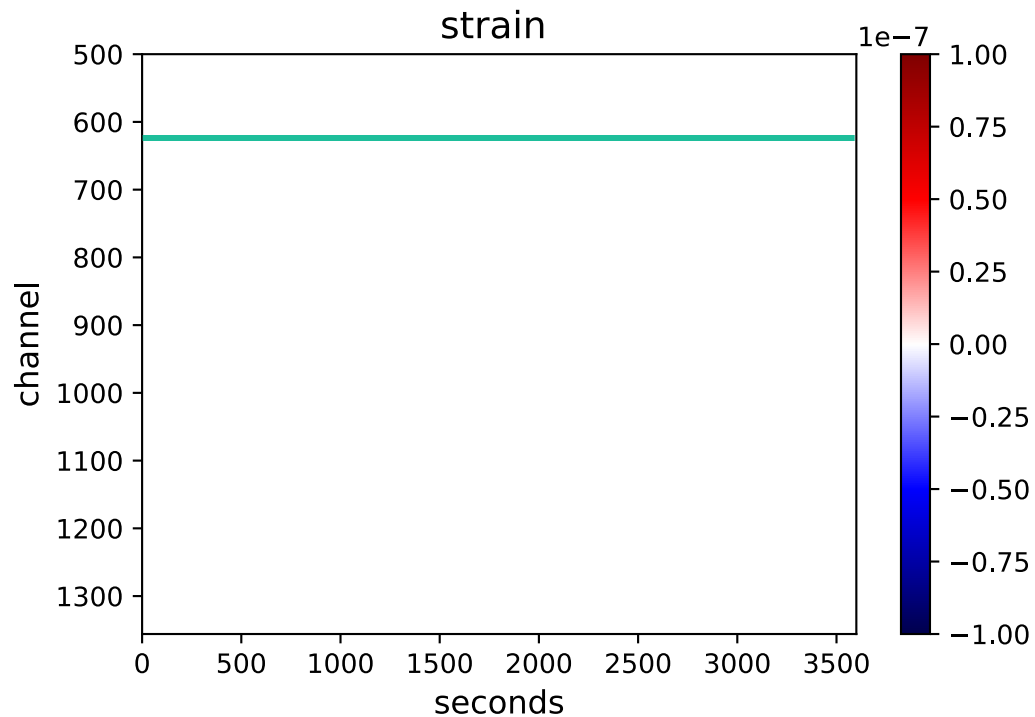
Global DAS Month (Wuestefeld et al. )

2023 7.8 Turkey Earthquake (distance = 91)



# Telesismic Earthquakes: Surface Waves

Turkey Earthquake(s)





# Conclusions

- Strain response (frequency and amplitude) sensitive to fiber deployment in SURF Mine
  - Burring cable or cementing cable works best
  - Beamforming of regional events will require better coupling in more fiber directions
- Teleseismic Earthquakes
  - Body wave arrivals are difficult to identify (magnitude, distance)
  - Surface waves are clear across most of the array (is this useful, can we see R2,R3)

# Acknowledgements

UW - Erin, Neal, Dante, Herb, Cliff Thurber

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SDSMT - Bill Roggenthen

