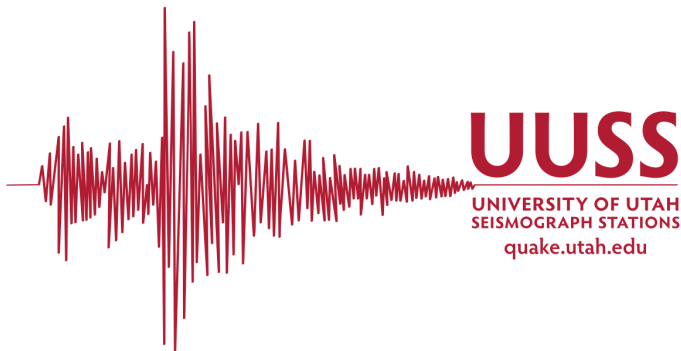


# The 2019 Sequence of Earthquakes Near Bluffdale, Utah

Barrett Johnson, Jim Pechmann, & Keith Koper  
University of Utah

11 July 2019

Utah Seismic Safety Commission



# Utah Seismicity and the 2019 Bluffdale Earthquakes

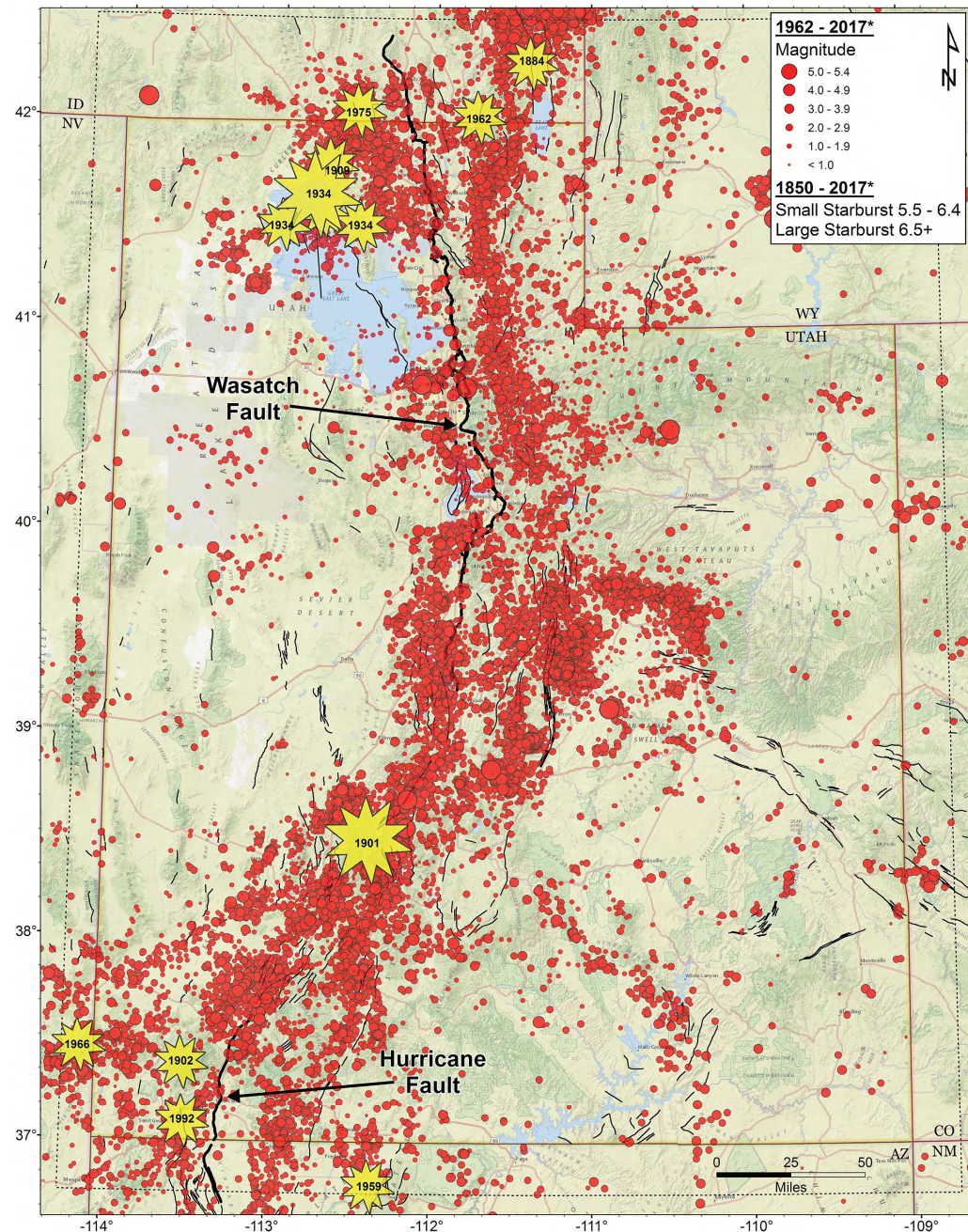
- Have there been more earthquakes than normal in Utah in 2019?
- Are the recent Bluffdale earthquakes unusual?
- How many earthquakes have there been in the Bluffdale area this year?
- Are the Bluffdale earthquakes occurring on the Wasatch fault?
- Do small earthquakes make a big one less likely?

# HISTORICAL & INSTRUMENTAL SEISMICITY IN THE UTAH REGION (1850 - 2017)

Red dots:  
 $M < 5.5$ , 1962-2017

Yellow stars:  
 $M \geq 5.5$ , 1850-2017  
(sizes proportional  
to magnitude,  $M$ )

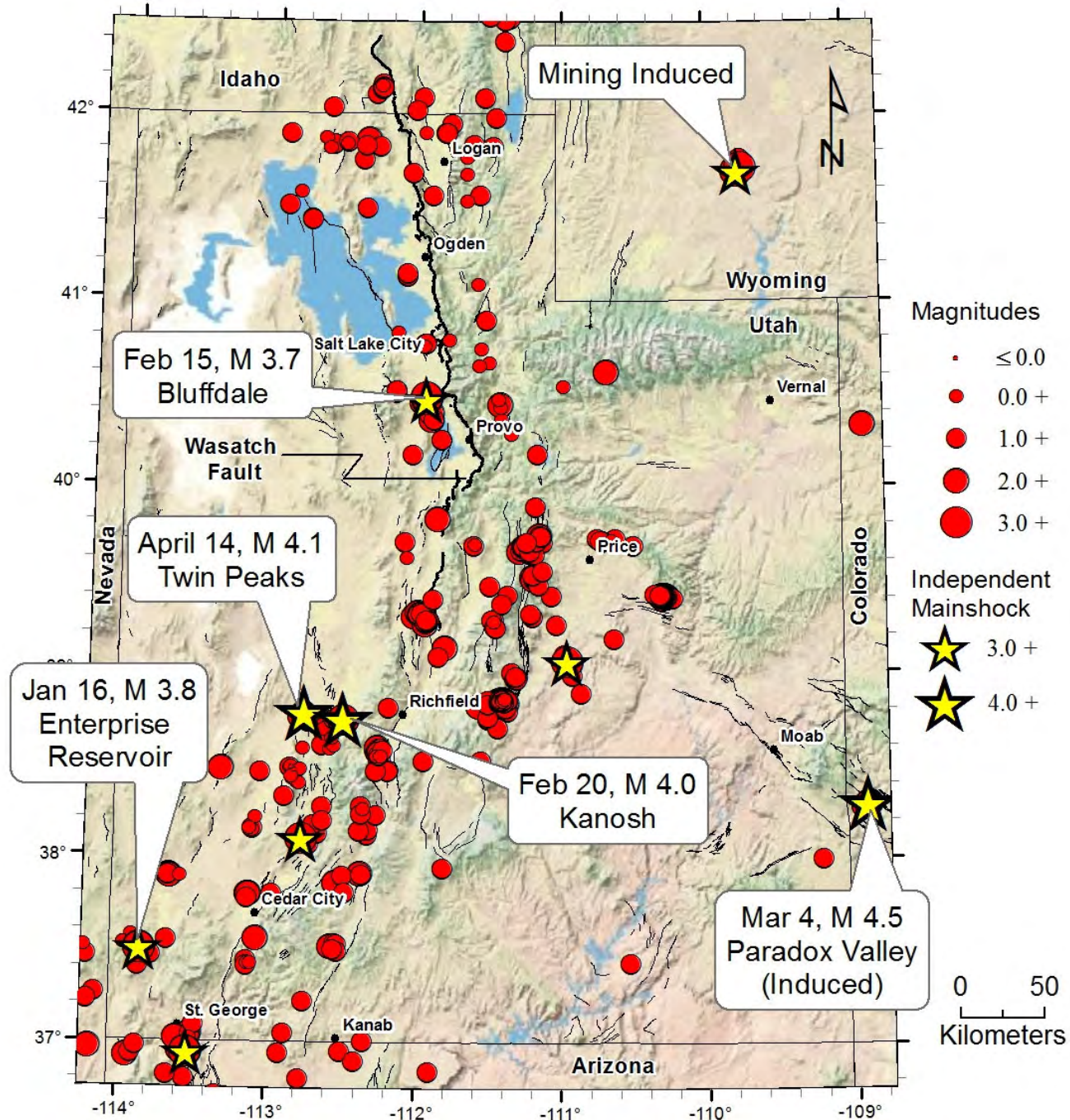
57,580 earthquakes  
( $>$  half since 2000)



\*Source: University of Utah Seismograph Stations earthquake catalog  
(number of earthquakes = 57,580)



# Seismicity of the Utah Region January 1, 2019 - April 20, 2019

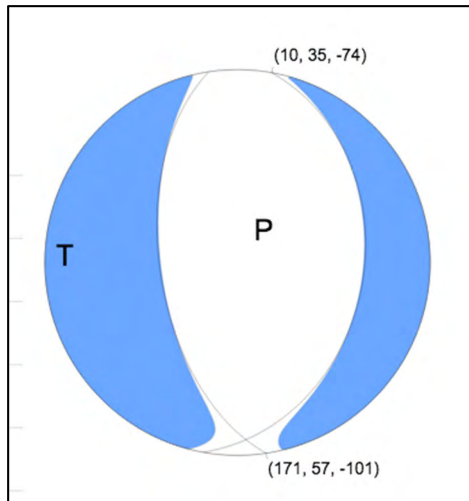


**Observed vs. “Normal” Numbers of Utah  
Region Independent Mainshocks  
Jan 1 – Apr 26, 2019**

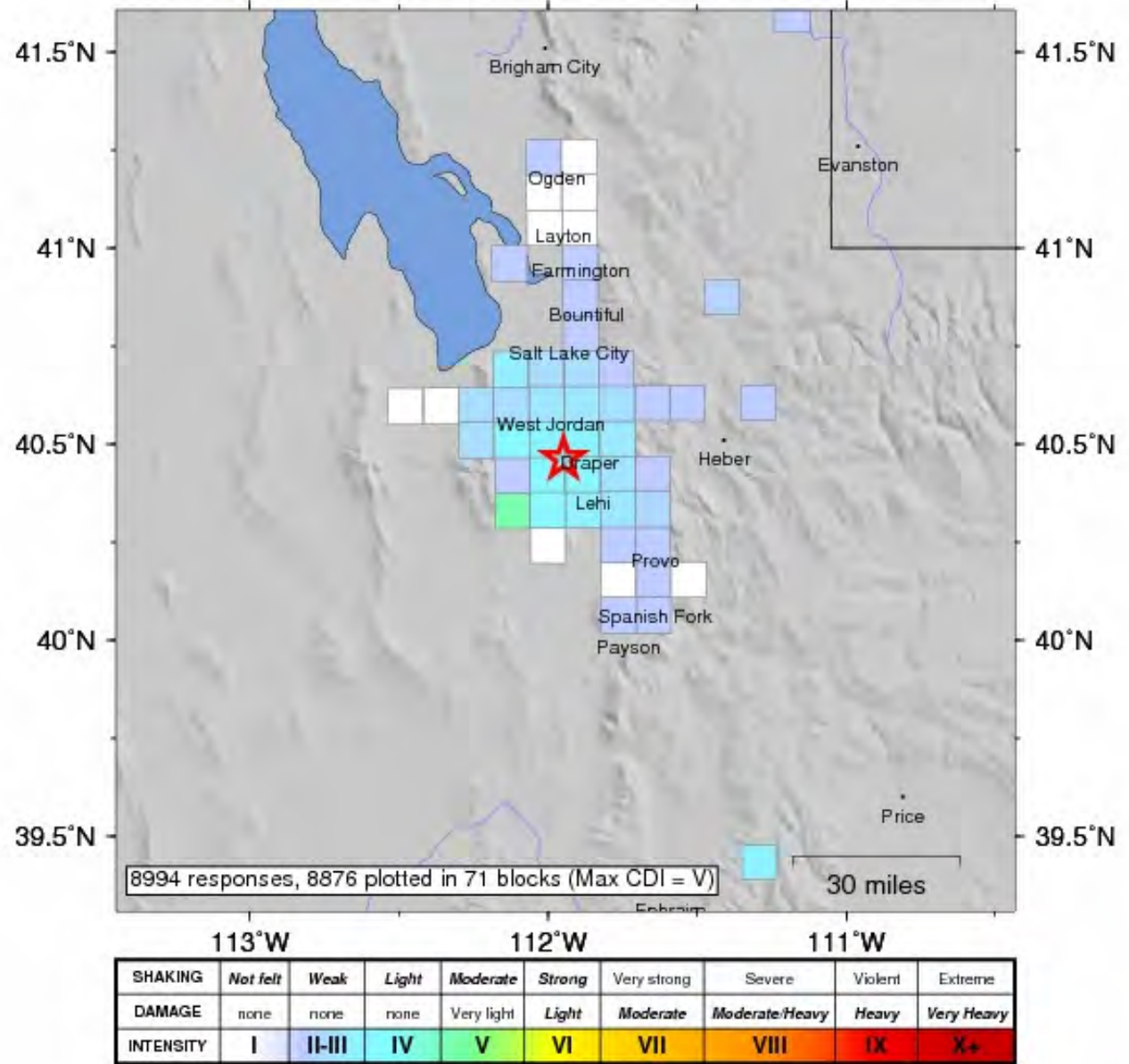
<b>Magnitude Range</b>	<b>Average Rate (events/yr)</b>	<b>Expected Number</b>	<b>Observed Number</b>
<b><math>\geq 3.0</math></b>	<b>12.5</b>	<b>4</b>	<b>7</b>
<b><math>\geq 4.0</math></b>	<b>1.1</b>	<b>0 or 1</b>	<b>2</b>
<b><math>\geq 5.0</math></b>	<b>0.1</b>	<b>&lt; 1</b>	<b>0</b>

# U.S. Geol. Survey Did You Feel It Map: Bluffdale Earthquake M 3.7, Feb 15, 2019

8994 responses  
> 8900 credible felt reports, distances up to at least 25 miles



USGS Community Internet Intensity Map  
WASATCH FRONT URBAN CORRIDOR, UTAH  
Feb 15 2019 12:09:51 PM UTC 40.4632N 111.948W M3.7 Depth: 8 km ID:uu60312667

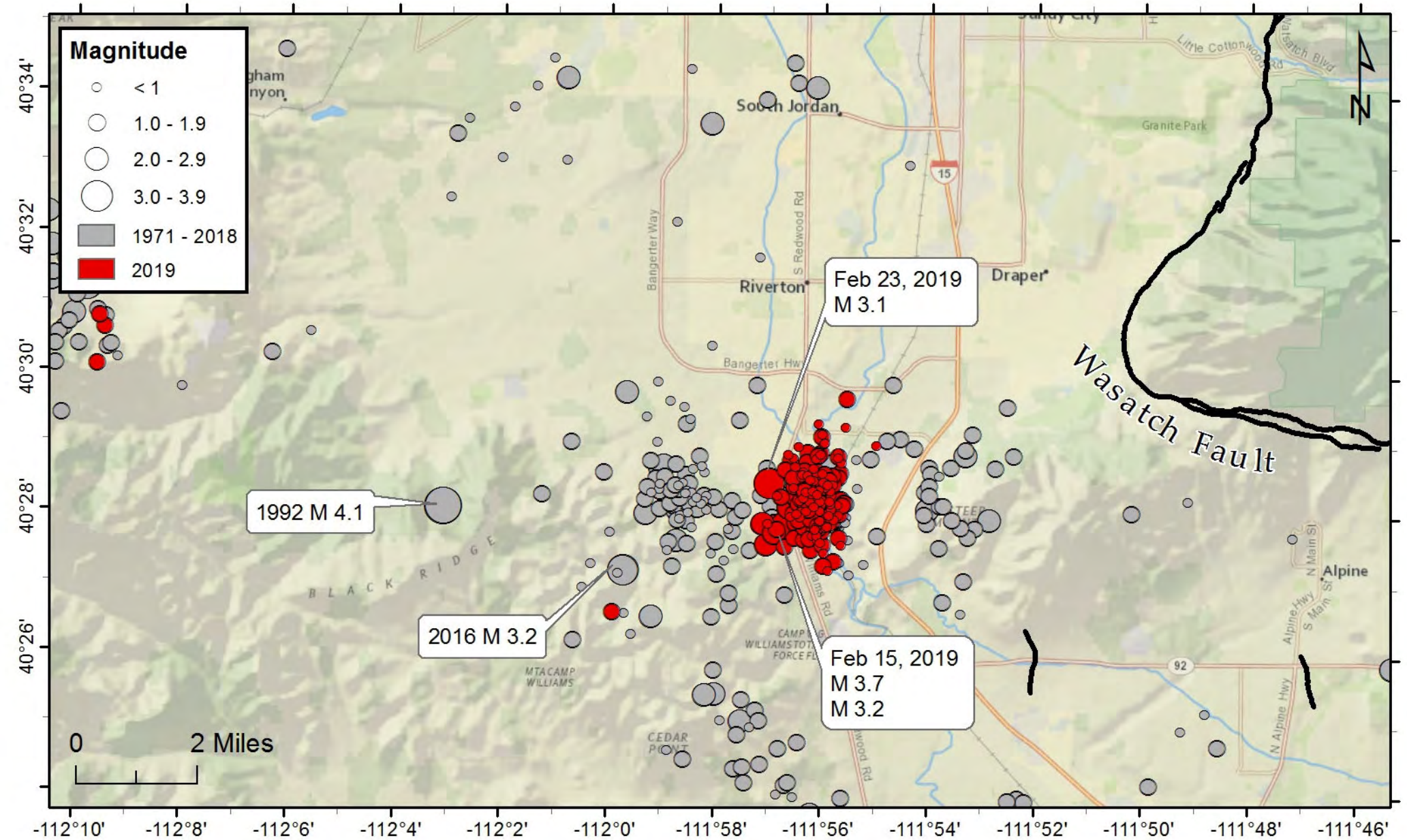


Processed: Fri Apr 26 15:31:17 2019 vmdylf1



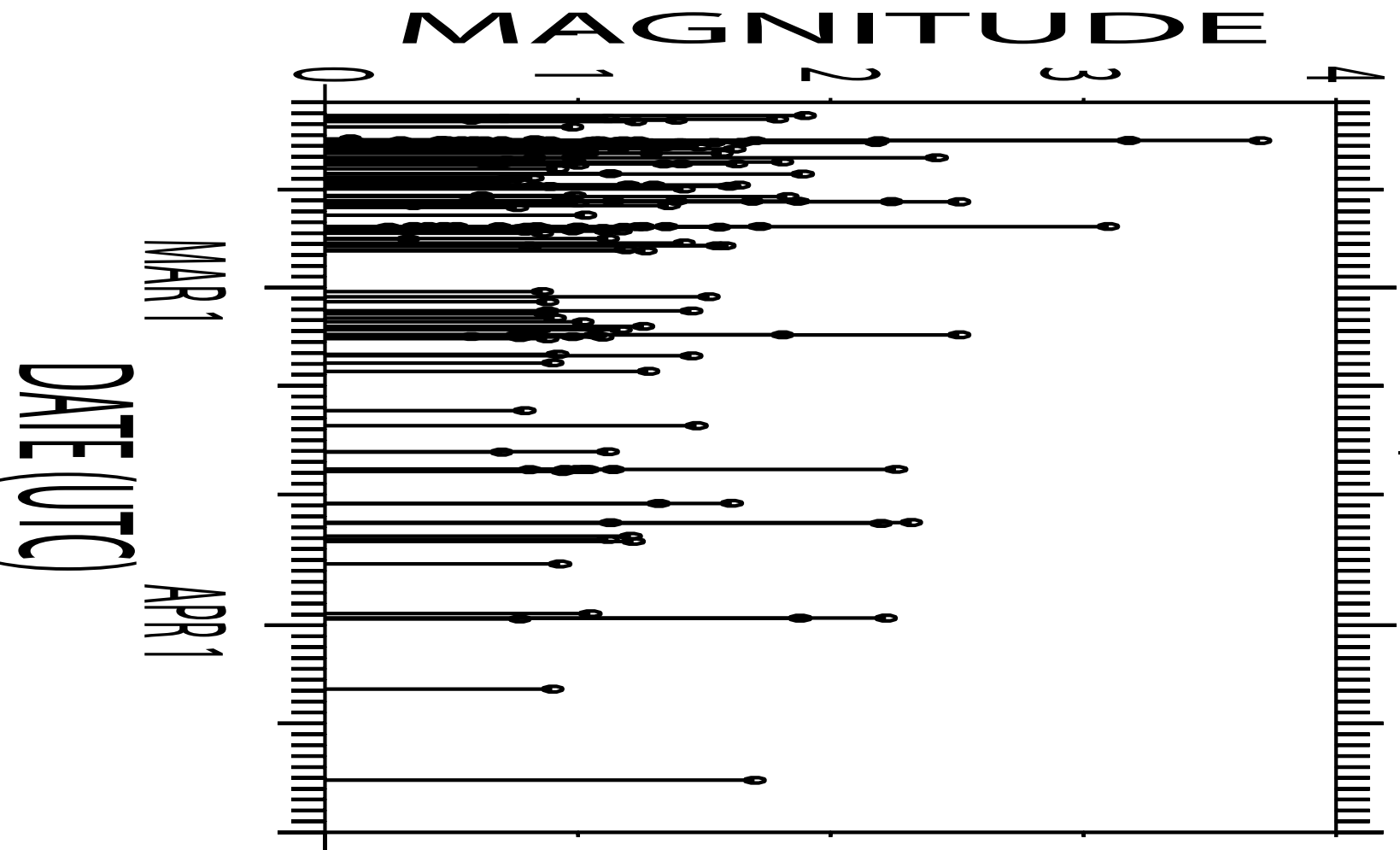
# Historical Seismicity near Bluffdale, Utah

1971 - April 20, 2019



# Buffalo Earthquakes

Feb 13 - April 20, 2019



Located earthquakes: 191

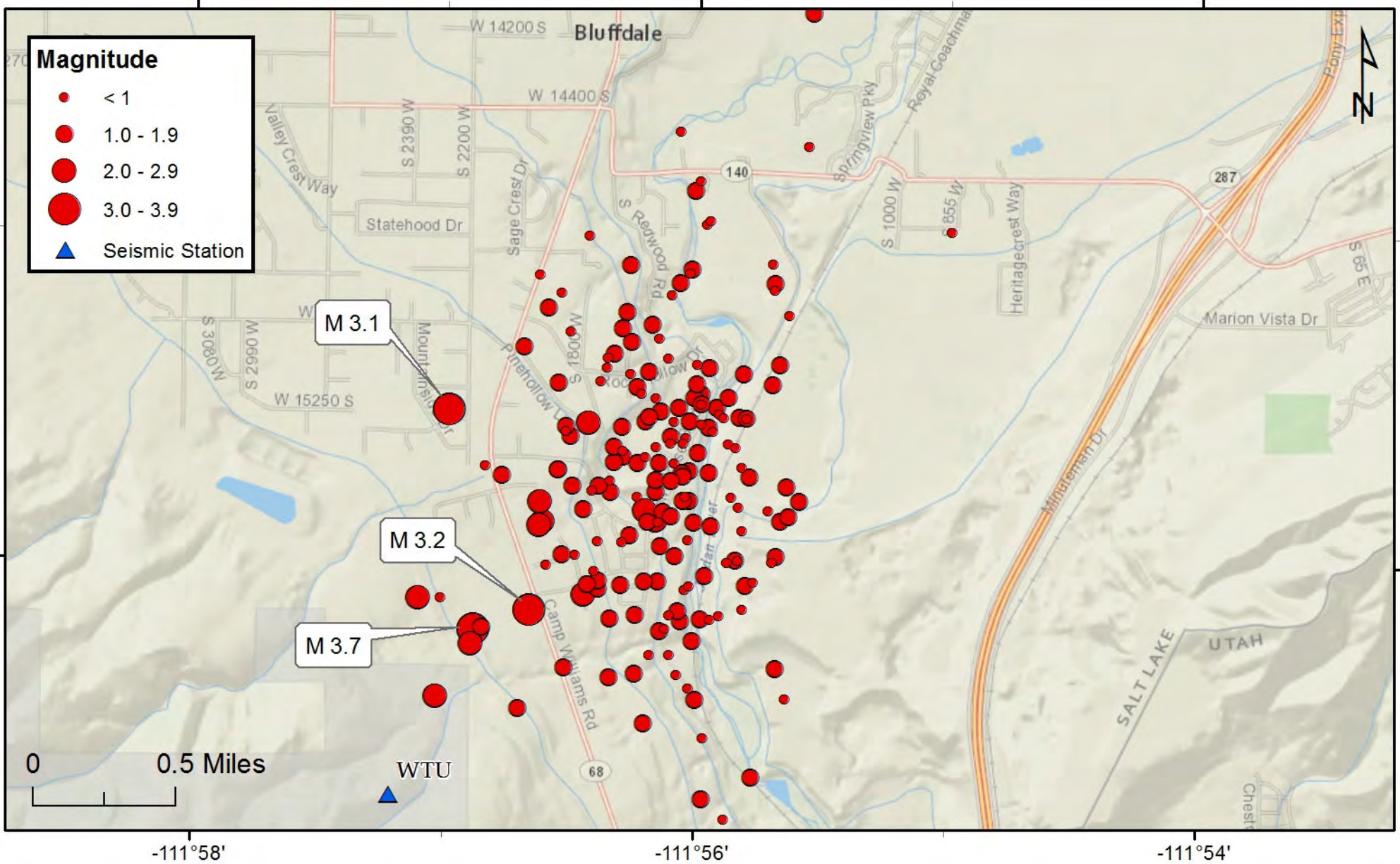
Foreshocks: 13; largest was M 3.2

Aftershocks: 177; largest was M 3.1



# Recent Seismicity near Bluffdale, Utah

February 13 - April 20, 2019



# Bluffdale Earthquake Sequence

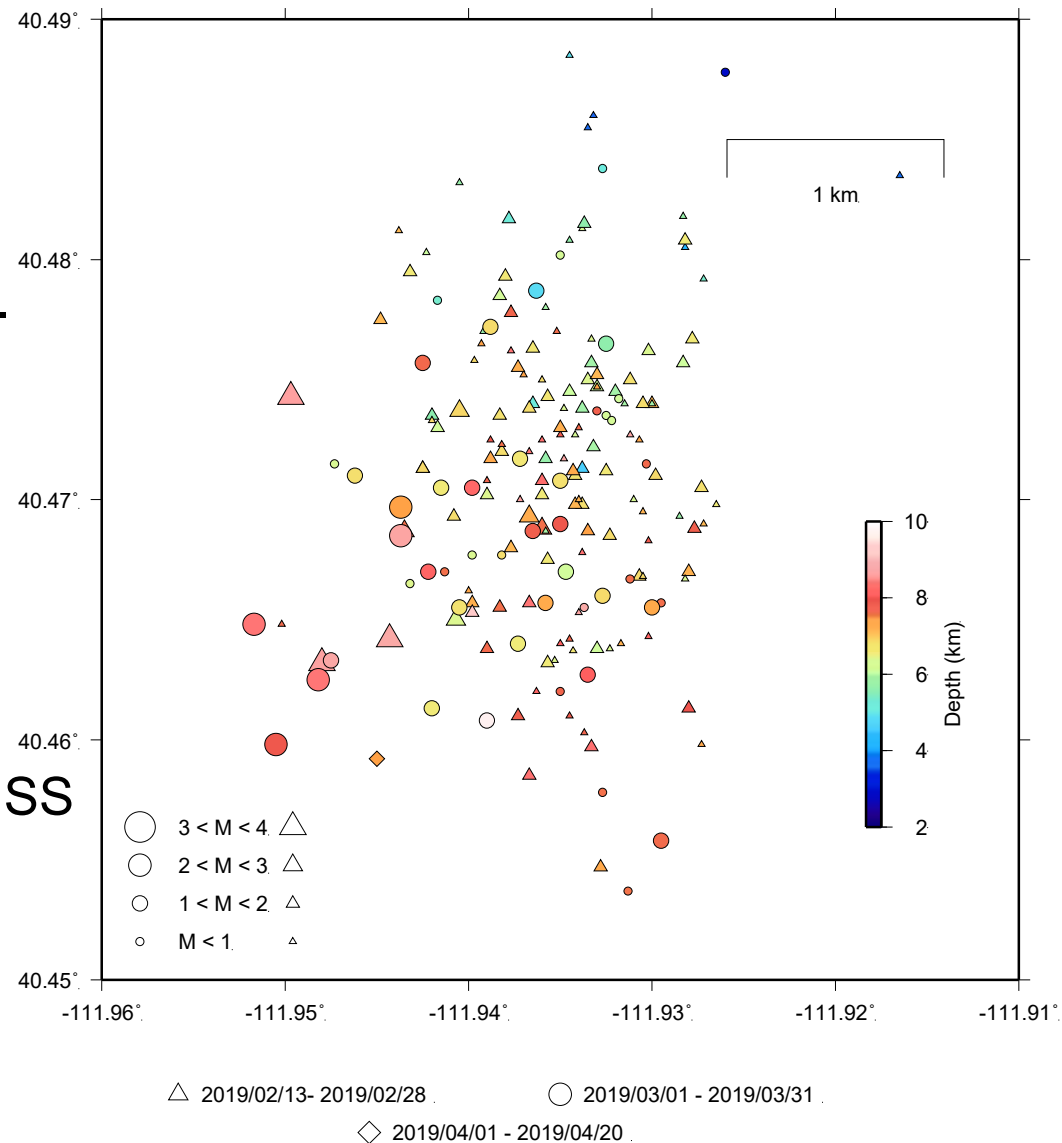
## Relocation

- Improved locations from UUSS catalog
- Subsurface viewed at higher resolution.
- GrowClust

## GrowClust

A software package that computes relative event relocations.

- Relies on catalog locations from the UUSS
- *Correlation Coefficients (cc)*
- *Differential Times (dt)*



Event 1: 2019/02/15 12:02:50.77 40.4642 -111.9443 8.76 3.18 -9.99 58 1.0 0.4

Event 2: 2019/02/23 09:31:10.54 40.4743 -111.9497 8.55 3.10 -9.99 39 2.0 0.5

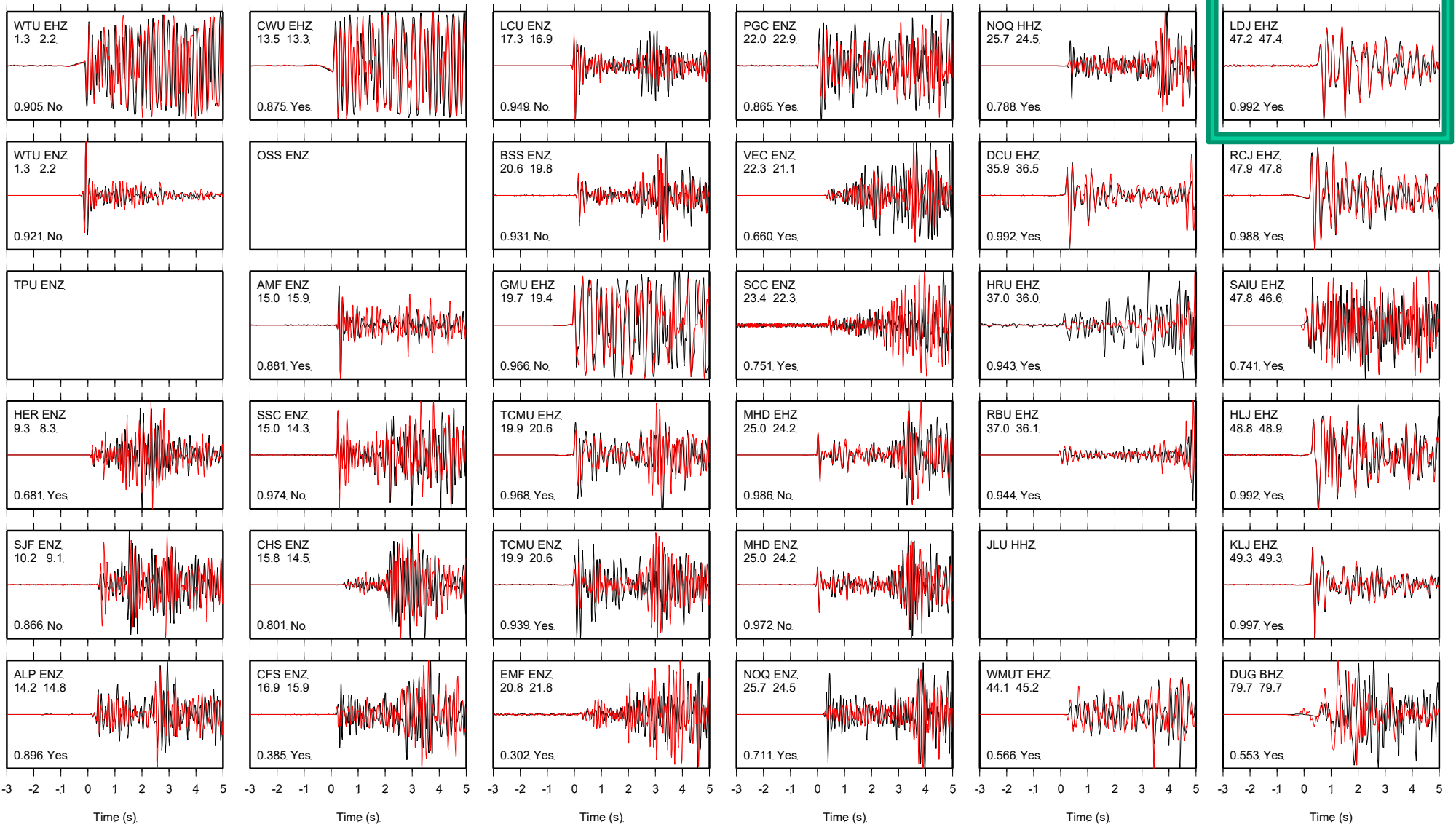
Correlation Program: xcorr\_all\_gp.

tflag=t1

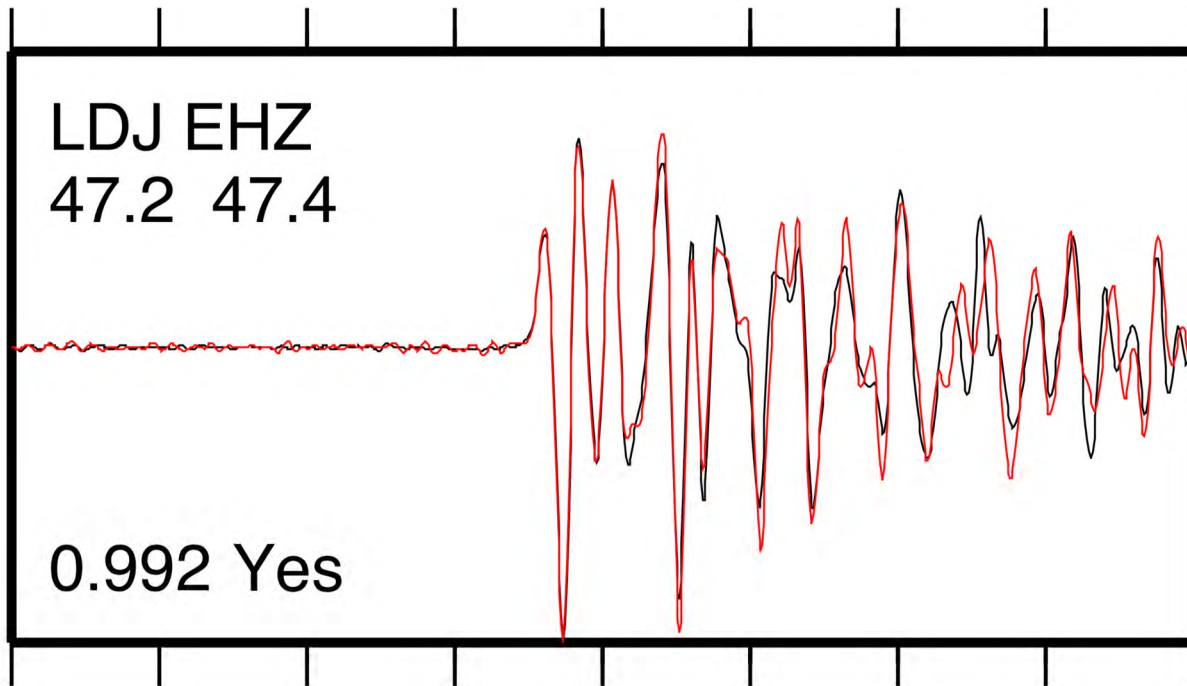
Frequency Band: 1.0 10.0 4

Time Window: -1.0 1.0

Taper: Bartlett







For 191 earthquakes:

- Event Pairs : 18,145
- CC's and DT's : 934,343

# Initial Results

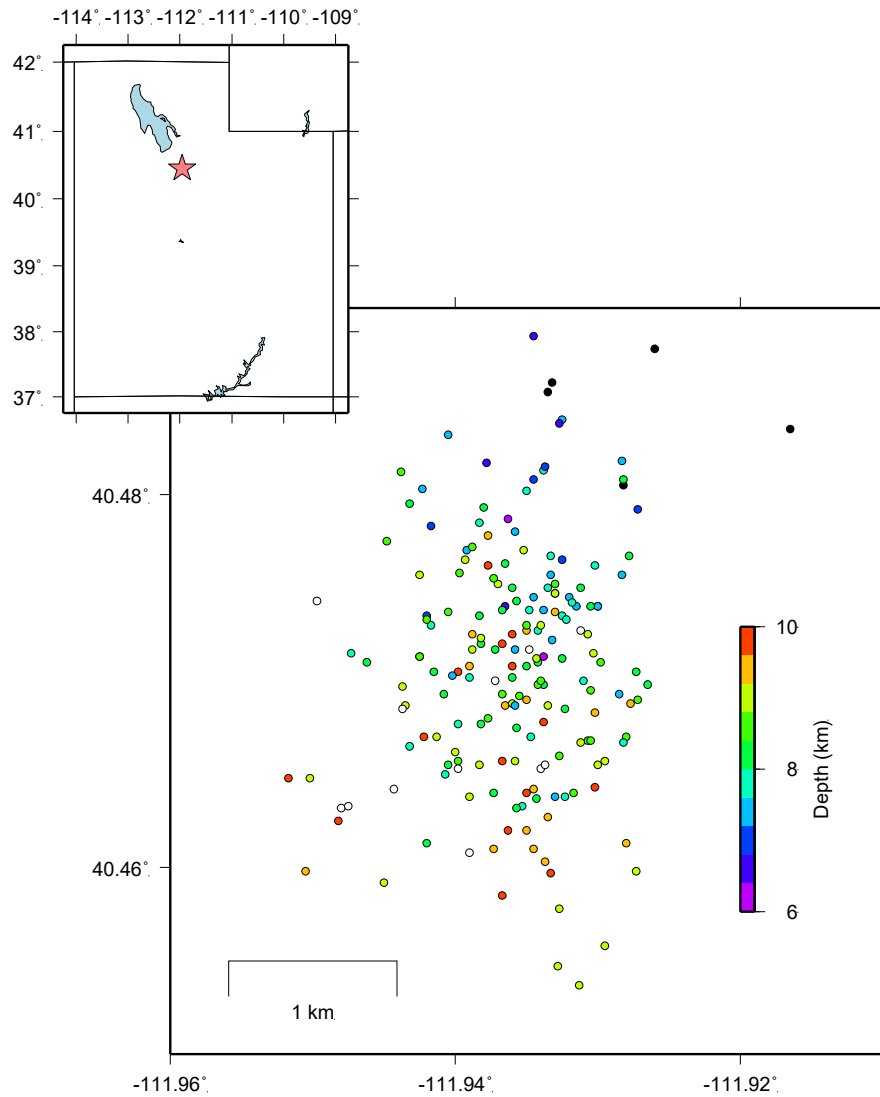


Figure 1: UUSS Catalogue Locations

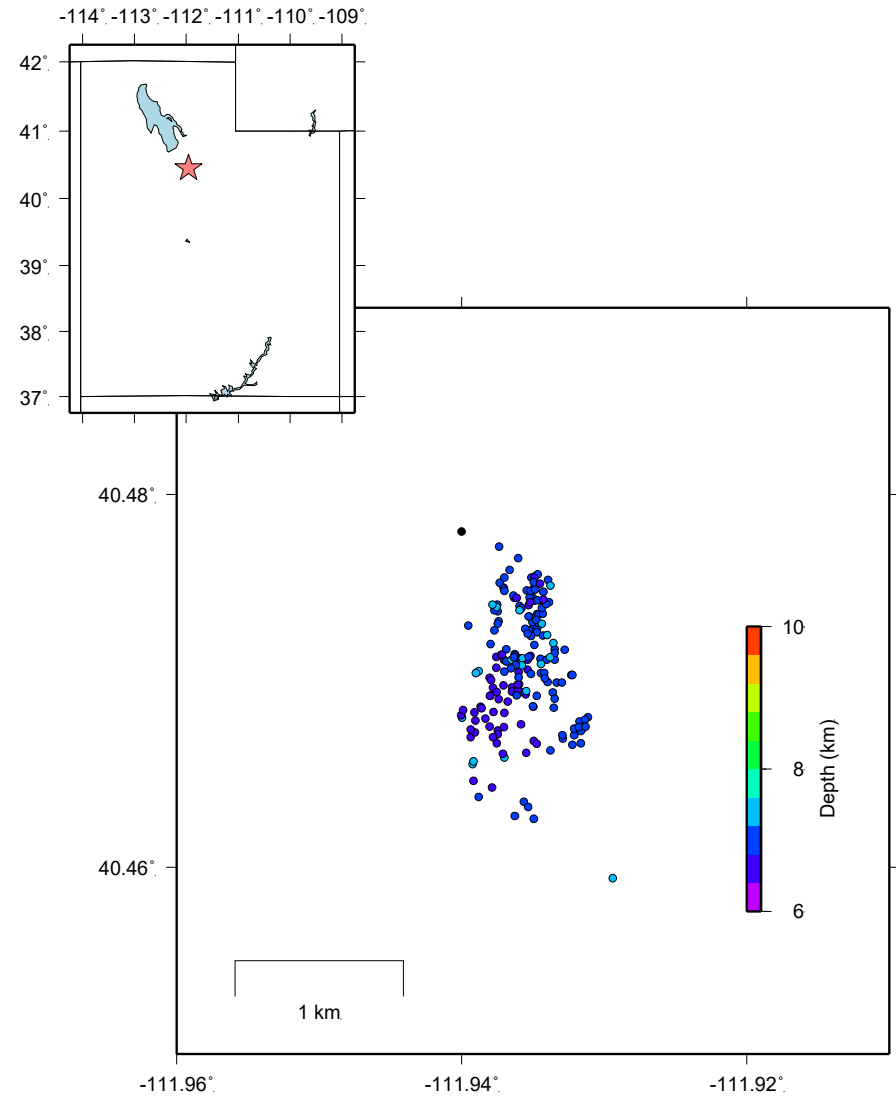


Figure 2: GrowClust relocated epicenters

# Moving Forward

## Detections

- Template matching
- Detecting more earthquakes
- Relocation of the detections

## UUSS

- Streamline the workflow
- Application to other sequences
- Application to UUSS catalog

