NEVADA SEISMOLOGICAL LABORATORY

Whats happening at Parker Butte?

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Lyon County LEPC Meeting

January 15, 2024

University of Nevada, Reno

In conclusion:

Earthquakes are happening!

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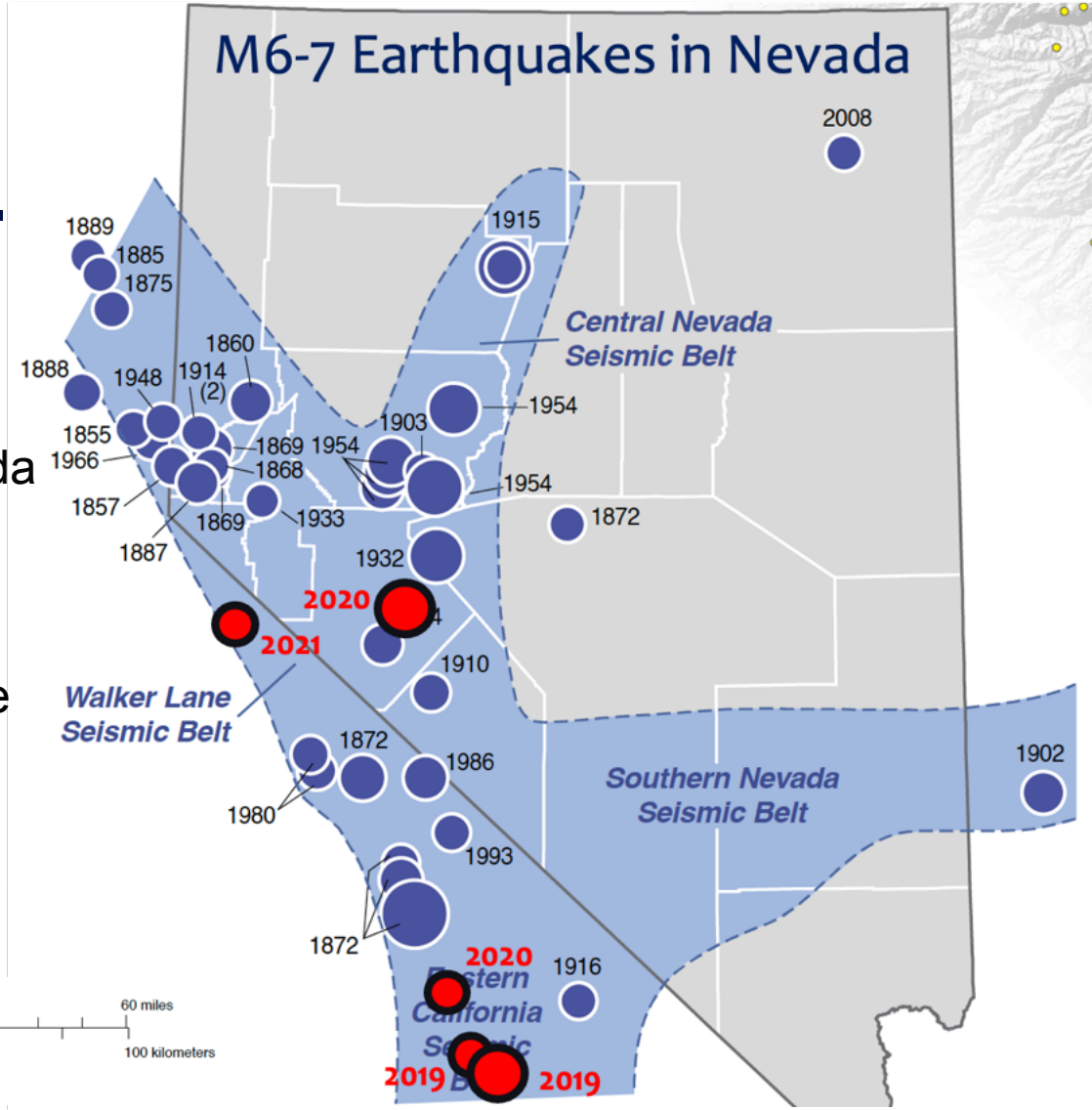
Nevada has earthquakes.

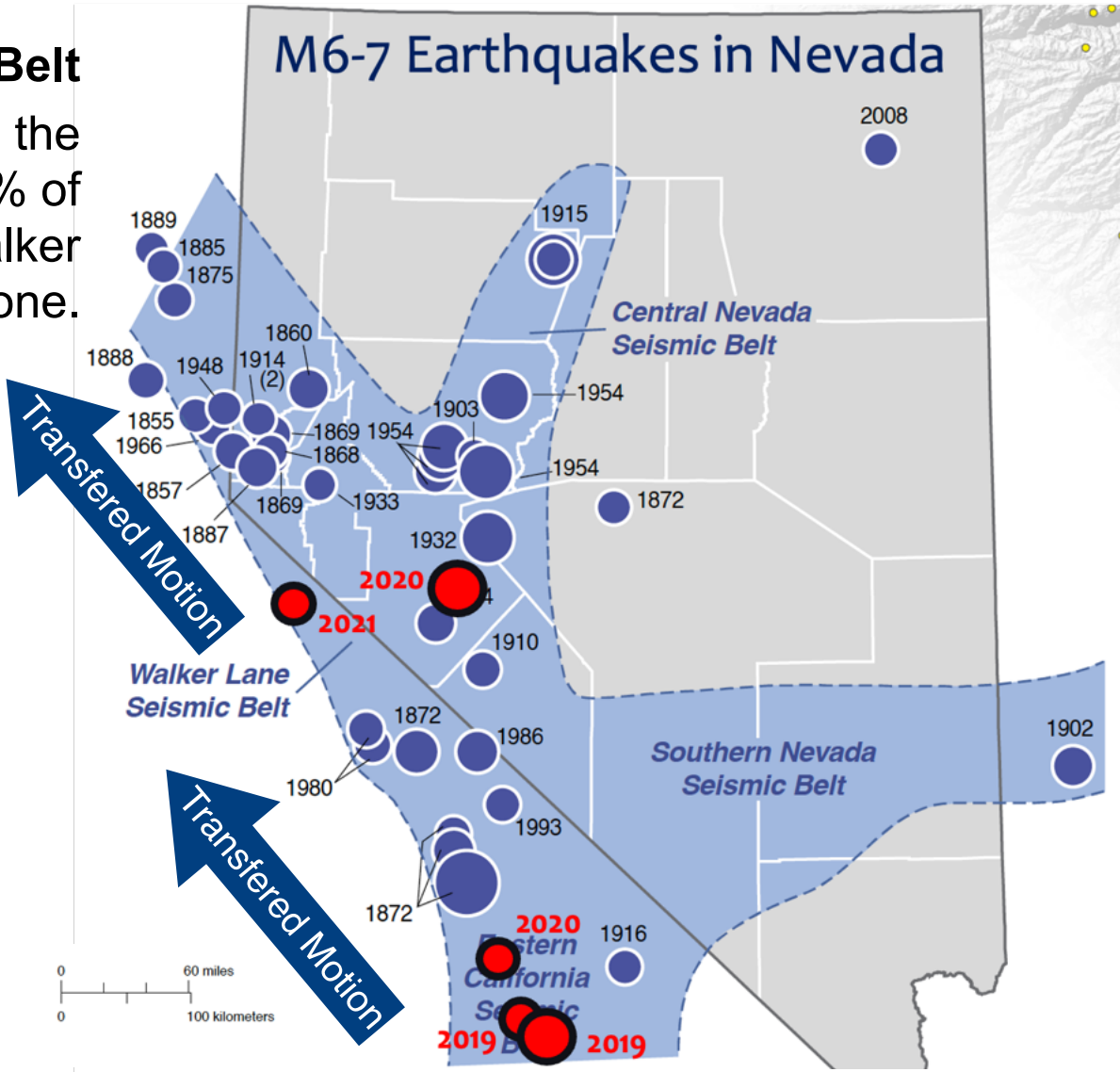
- Nevada has 3rd most M5+ in the US (magnitude that causes damage)
- One M5 or greater per year (on average)
- The largest historical earthquake in Nevada was the 1954 M7.3 Fairview Peak earthquake, followed 4 minutes later by a M6.7 earthquake in Dixie Valley.
- Recent damaging-sized earthquakes have luckily not hit urban centers:
  - 2020 M6.5 Monte Cristo (Tonopah, NV)
  - 2021 M6.0 Antelope Valley (Walker, NV)



Map modified from dePolo + dePolo 1999

Walker Lane Seismic Belt

Pacific plate is moving relative to the North American plate. ~20-25% of motion is accommodated in the Walker Lane Shear Zone.



Map modified from dePolo + dePolo 1999

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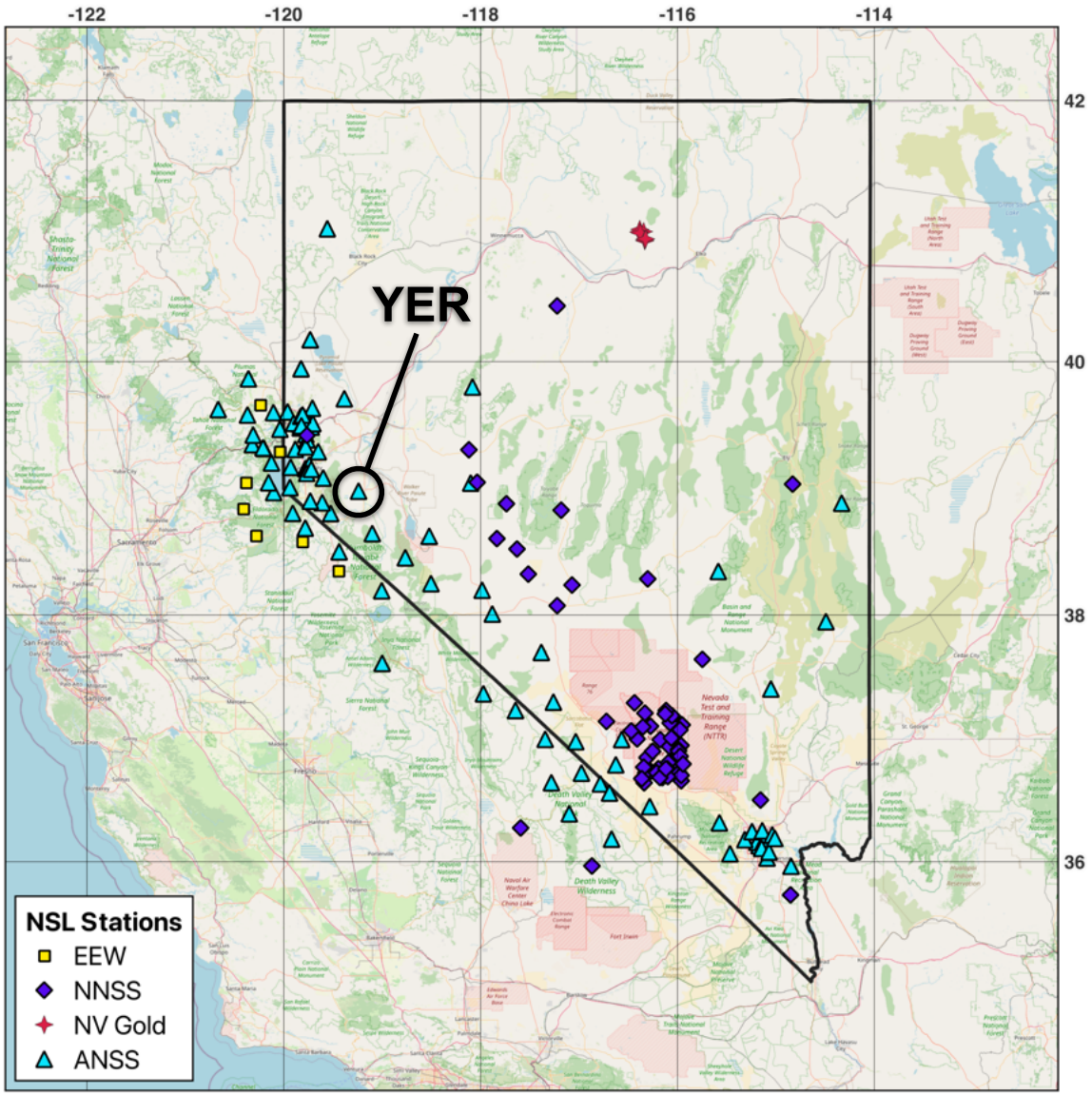
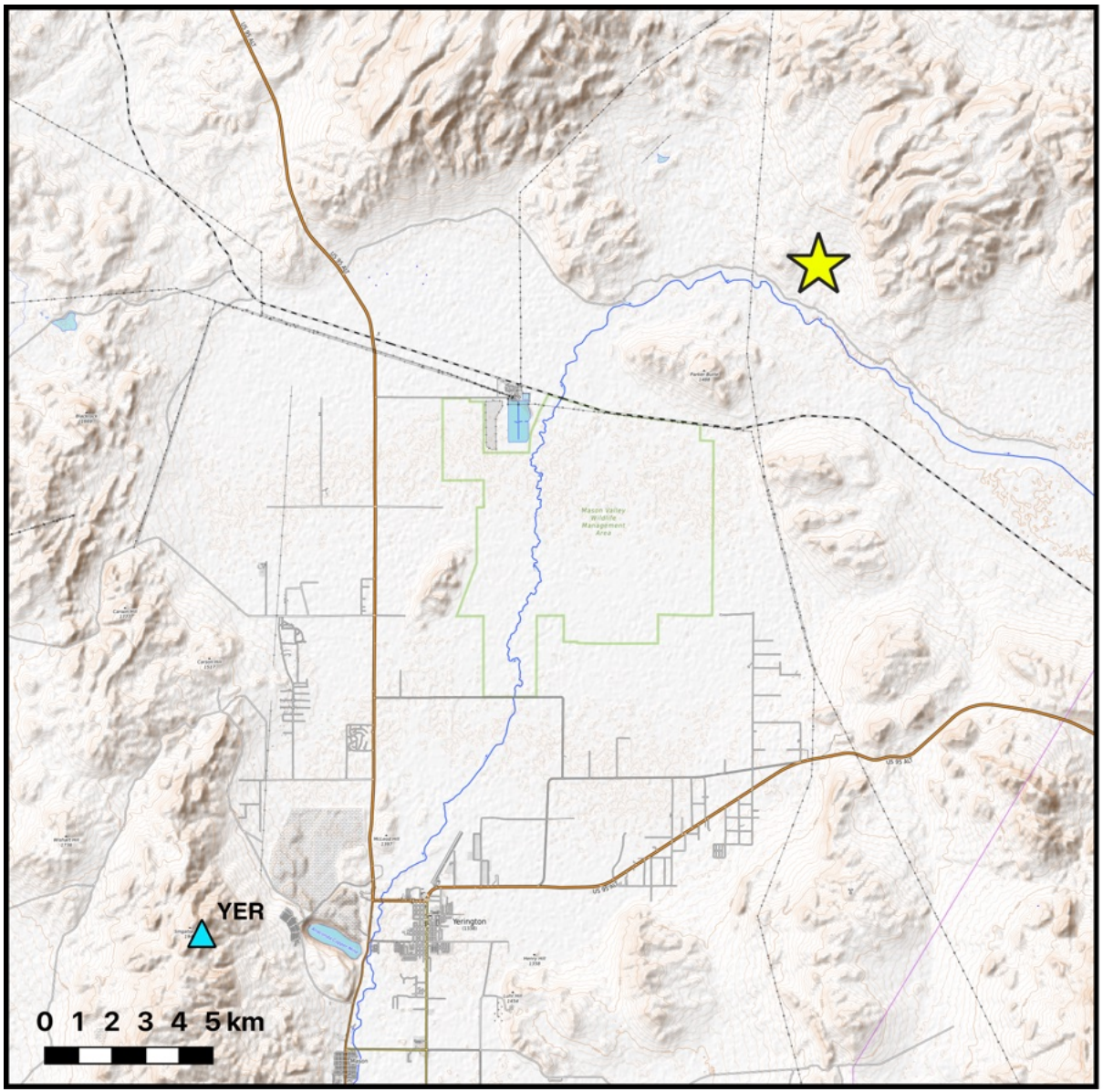


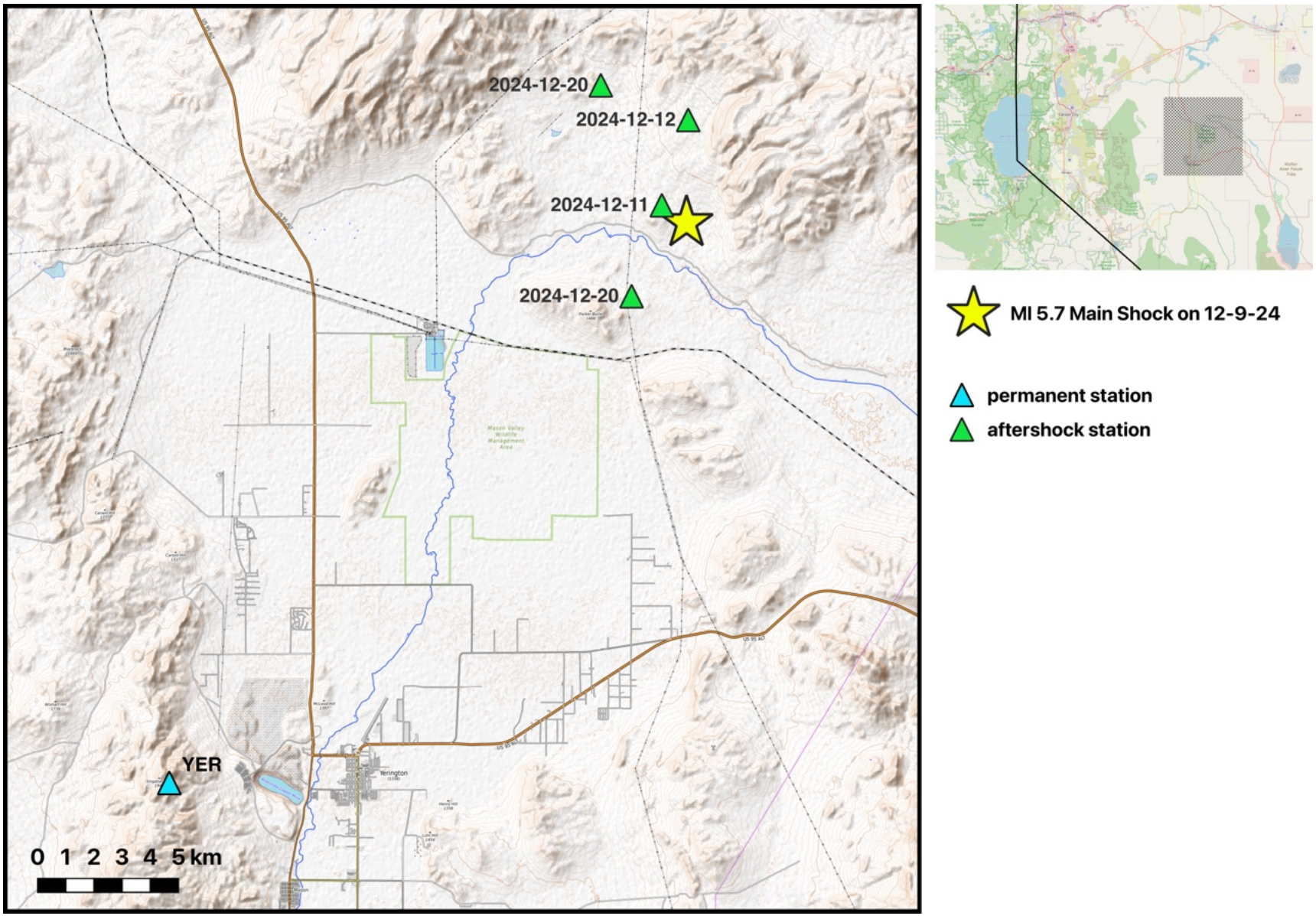
What does the NSL do?

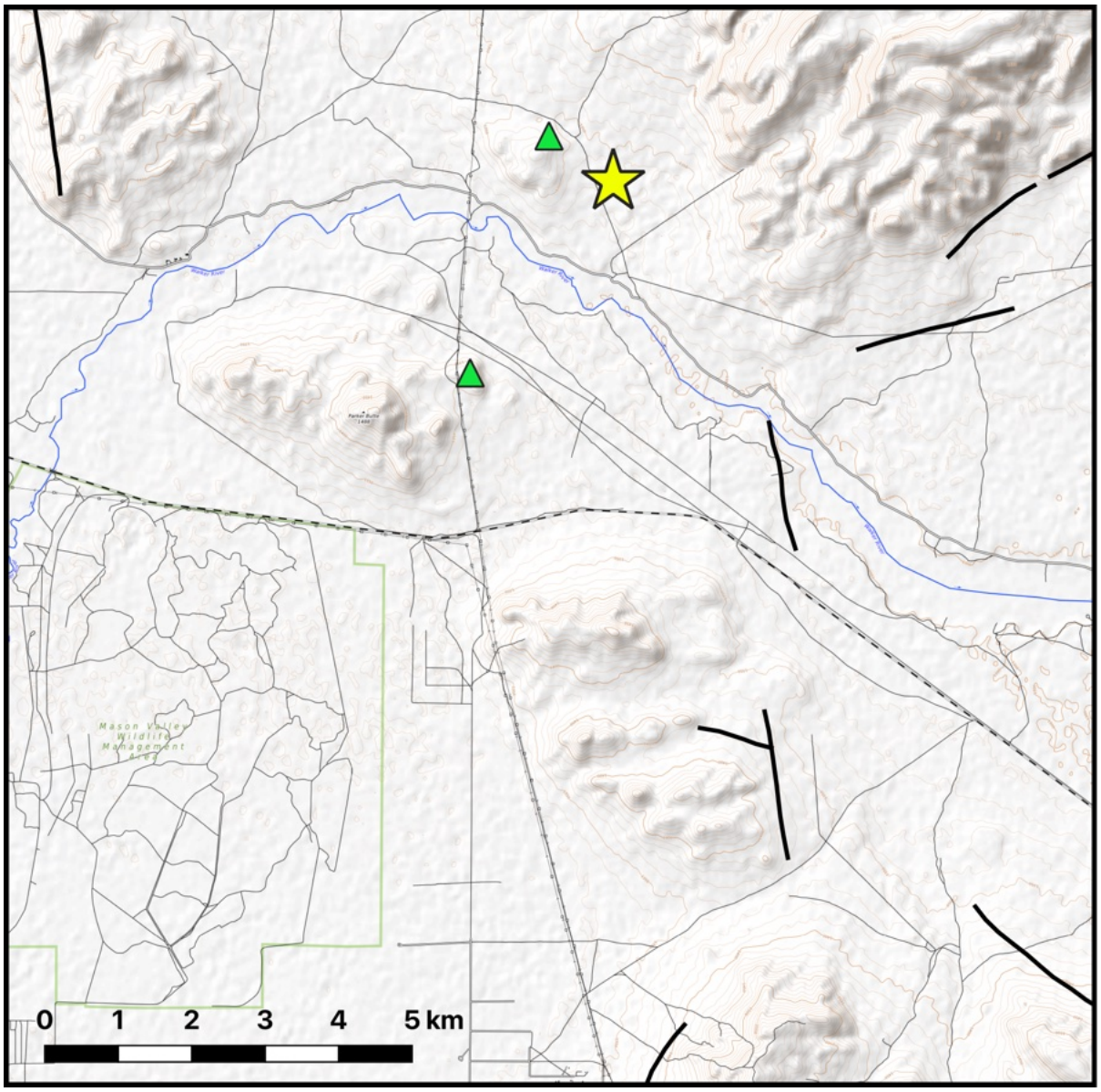
- ~114 USGS supported stations and ~72 NNSS supported stations
- Responsible for:
  - Locations
  - Magnitudes
  - Moment tensors
  - Focal mechanisms
- Reporting in real-time (10 minutes) to the USGS for all **M** > 2.5 earthquakes in Urban Areas and all **M** > 3 statewide.

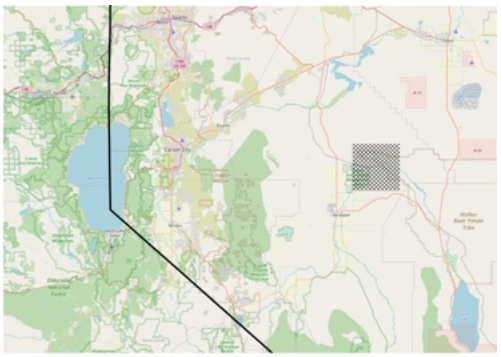


MI 5.7 Main Shock on 12-9-24

permanent station


2024-12-20
2024-12-12
2024-12-11
2024-12-20
YER
0 1 2 3 4 5 km
MI 5.7 Main Shock on 12-9-24
permanent station
aftershock station





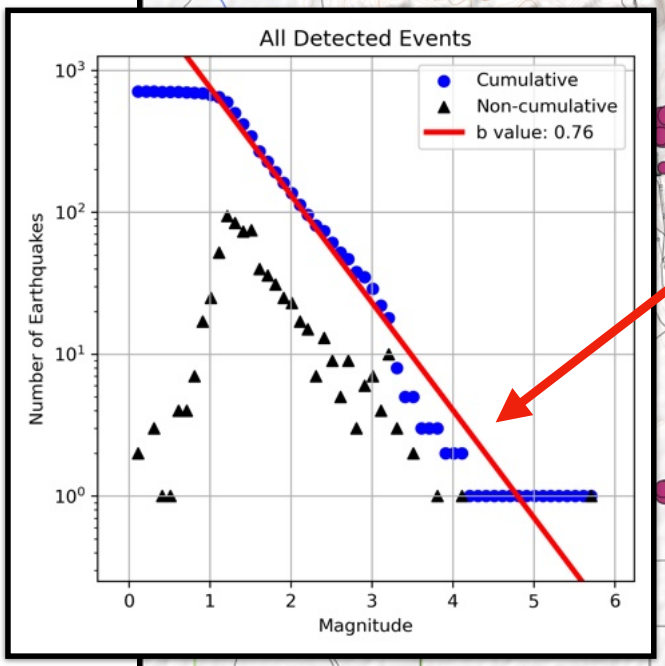
Ml 5.7 Main Shock on 12-9-24

aftershock station

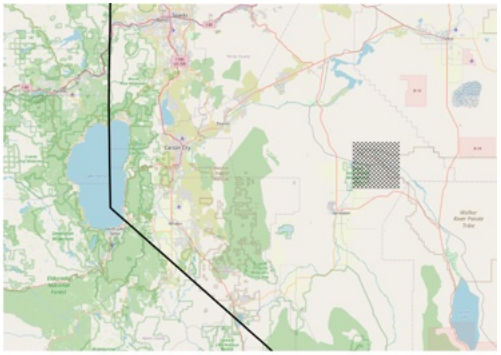
Quaternary faults

From 12-5-24 to 1-3-24 we located and cataloged 560 earthquakes

Color coded by depth



“Typical” distribution of earthquake magnitudes (no such thing as typical)



Ml 5.7 Main Shock on 12-9-24

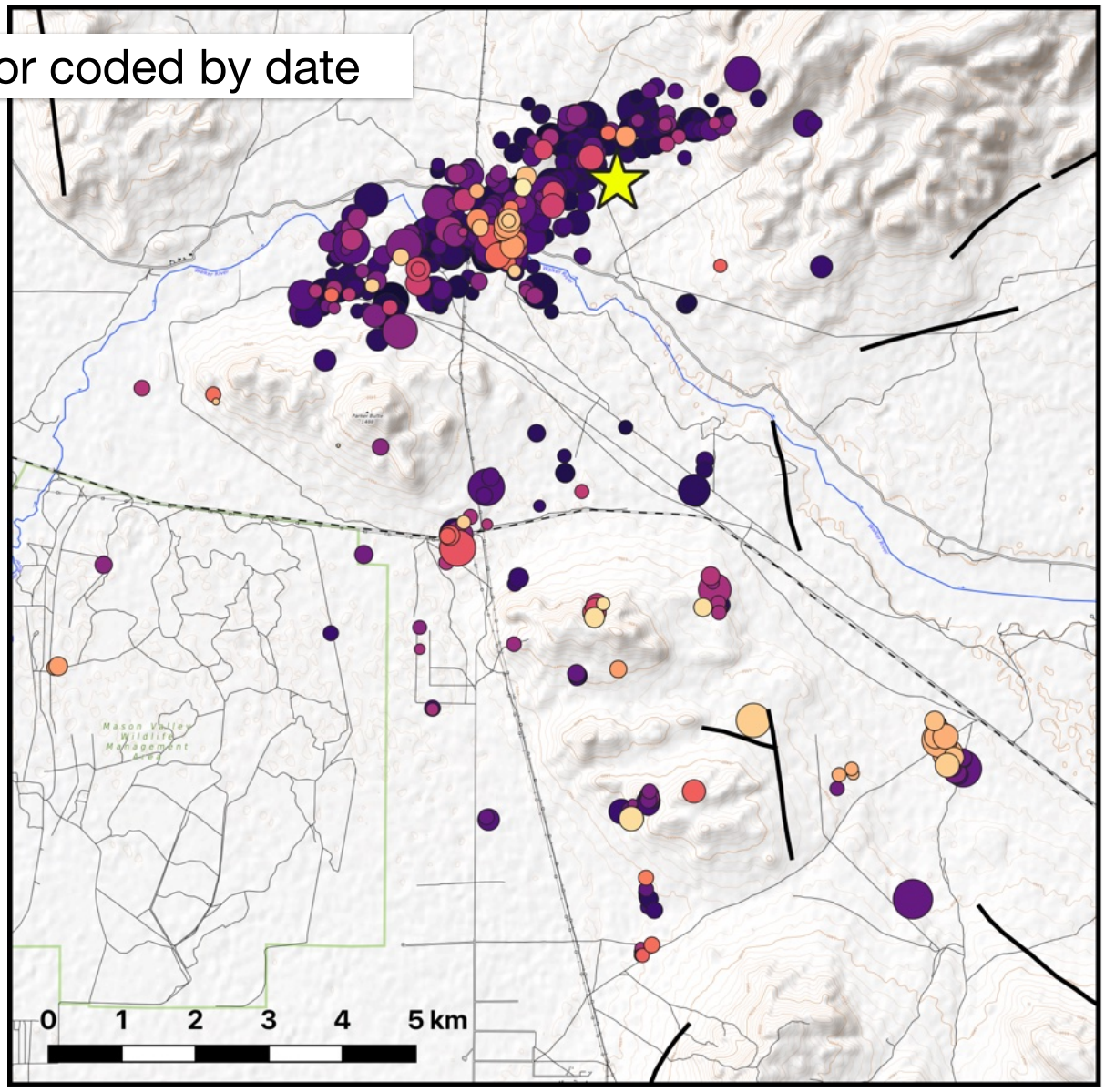
magnitude (Ml)
- 1
- 2
- 3
- 4

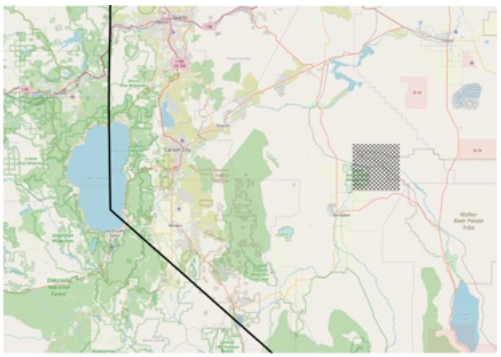
depth (km)
- 1.0 - 3.0
- 3.0 - 6.0
- 6.0 - 9.0
- 9.0 - 12.0
- 12.0 - 14.0

Quaternary faults

0 1 2 3 4 5 km

Color coded by date





MI 5.7 Main Shock on 12-9-24

magnitude (MI)

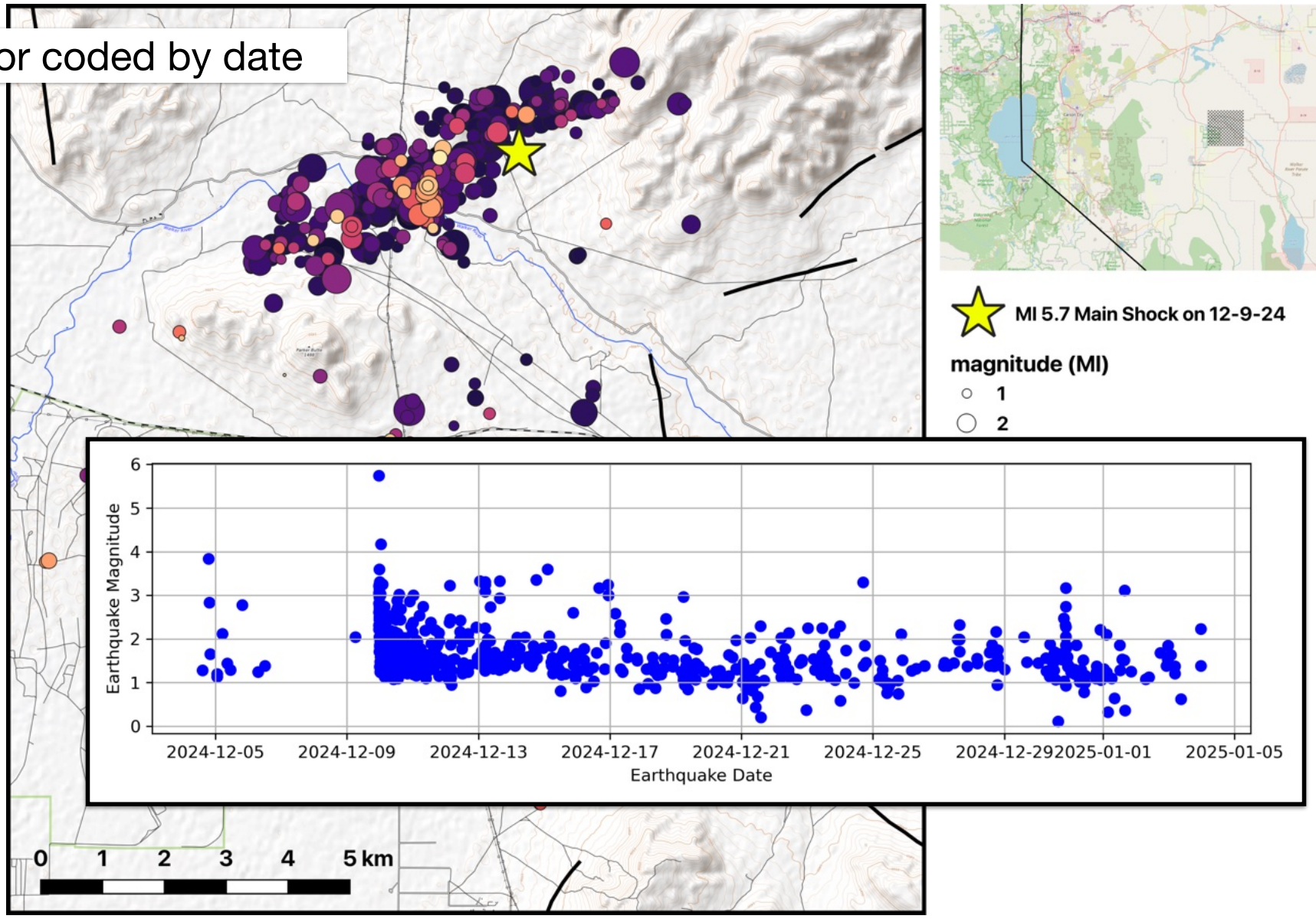
1
2
3
4

earthquake date

12/6/24
12/13/24
12/20/24
12/27/24
1/3/25

Quaternary faults

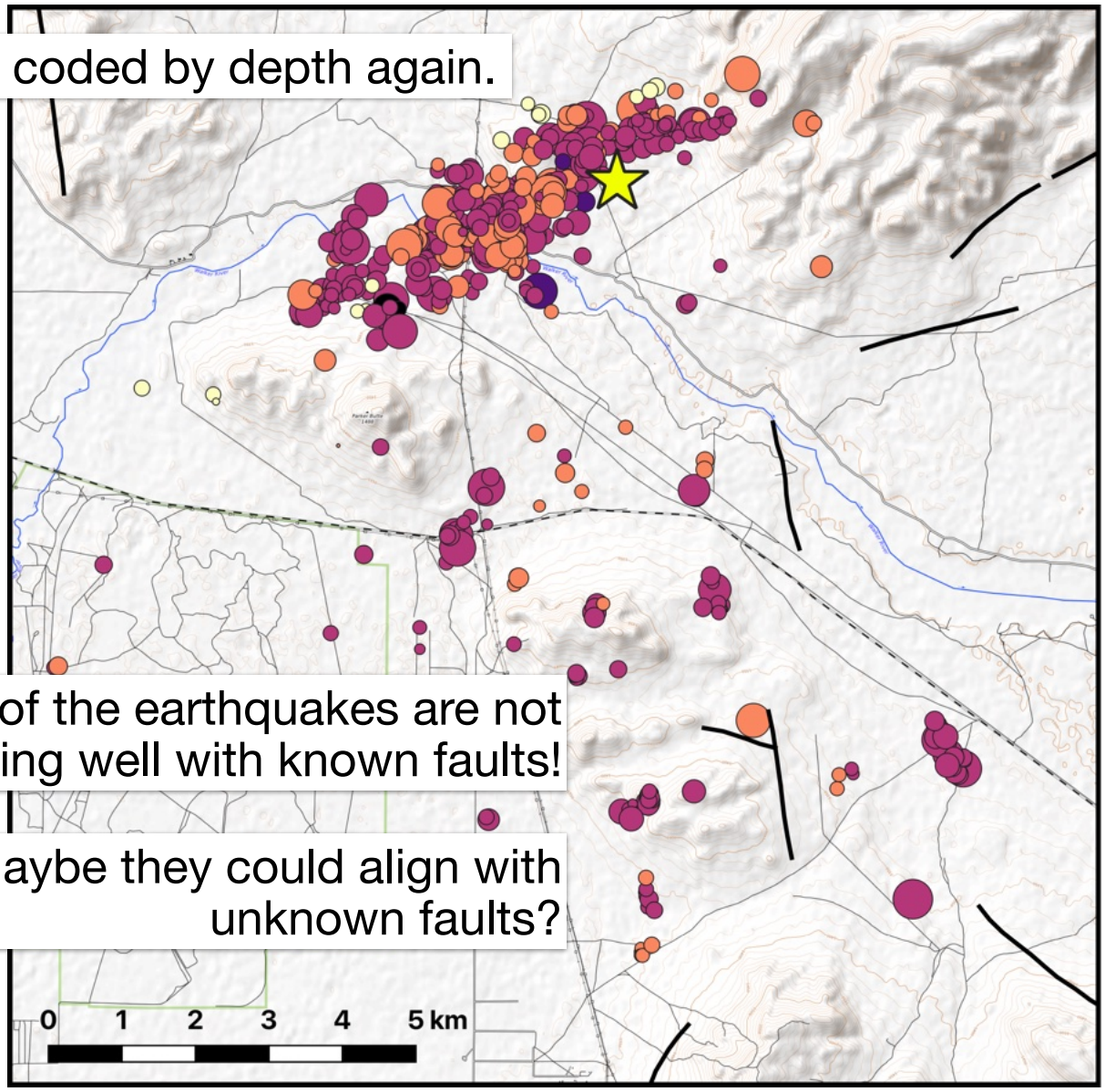
Color coded by date

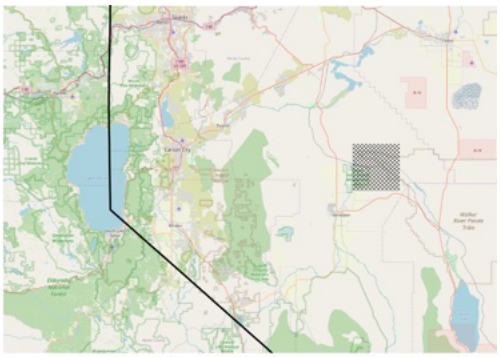


Color coded by depth again.

Most of the earthquakes are not aligning well with known faults!

Maybe they could align with unknown faults?





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4

depth (km)

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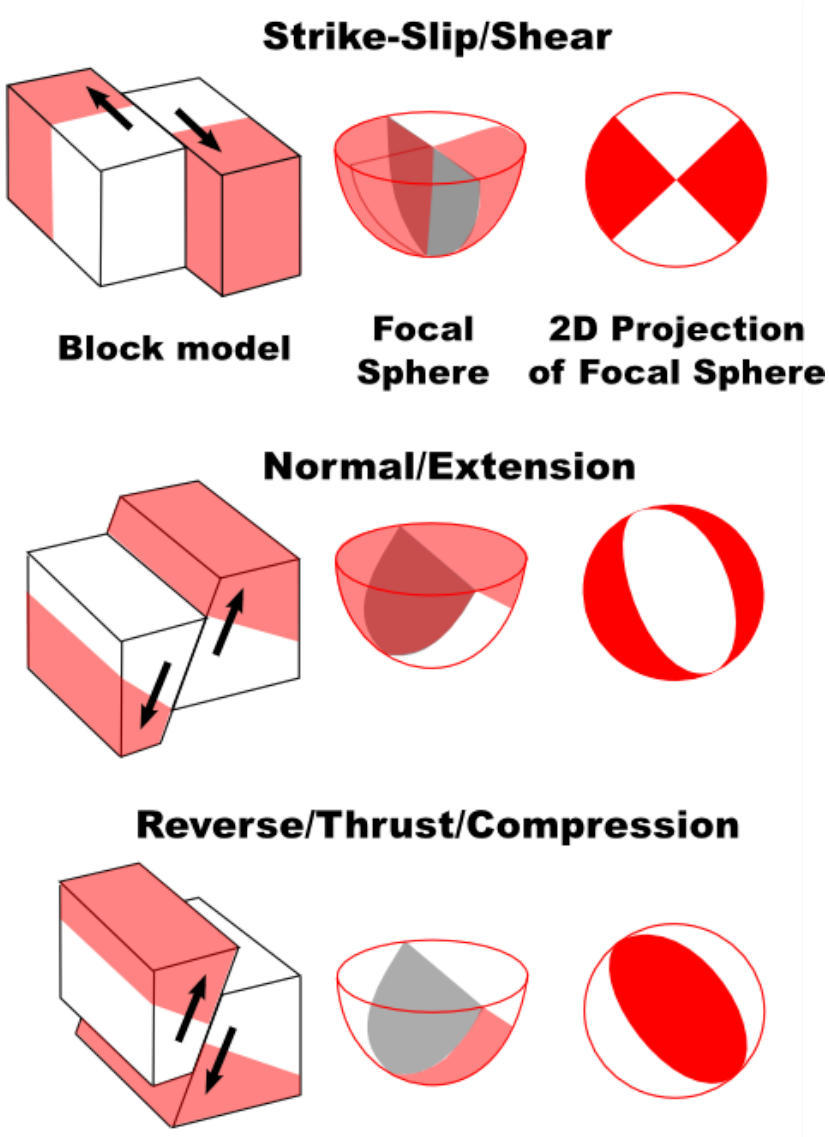
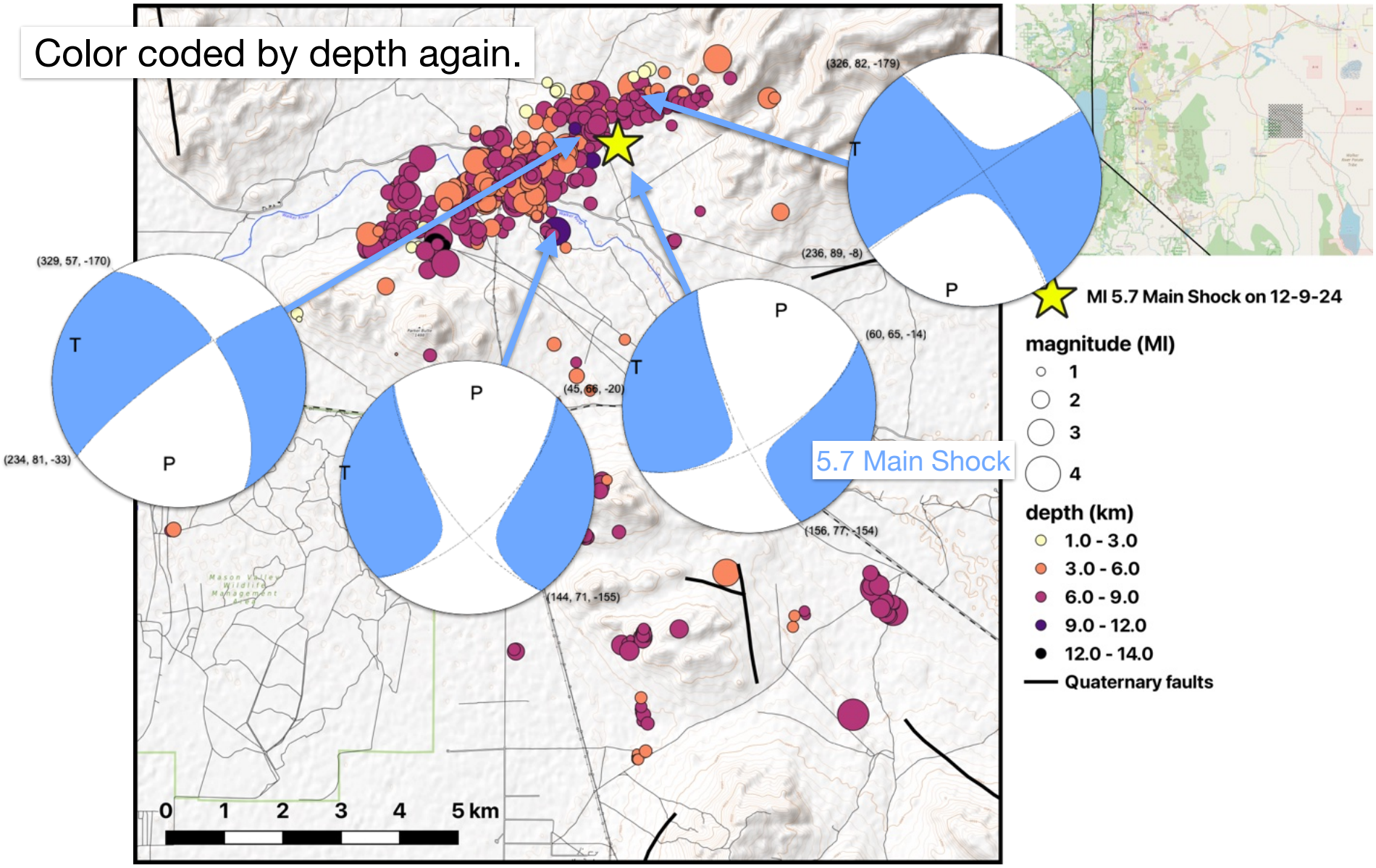
3.0 - 6.0
6.0 - 9.0
9.0 - 12.0
12.0 - 14.0

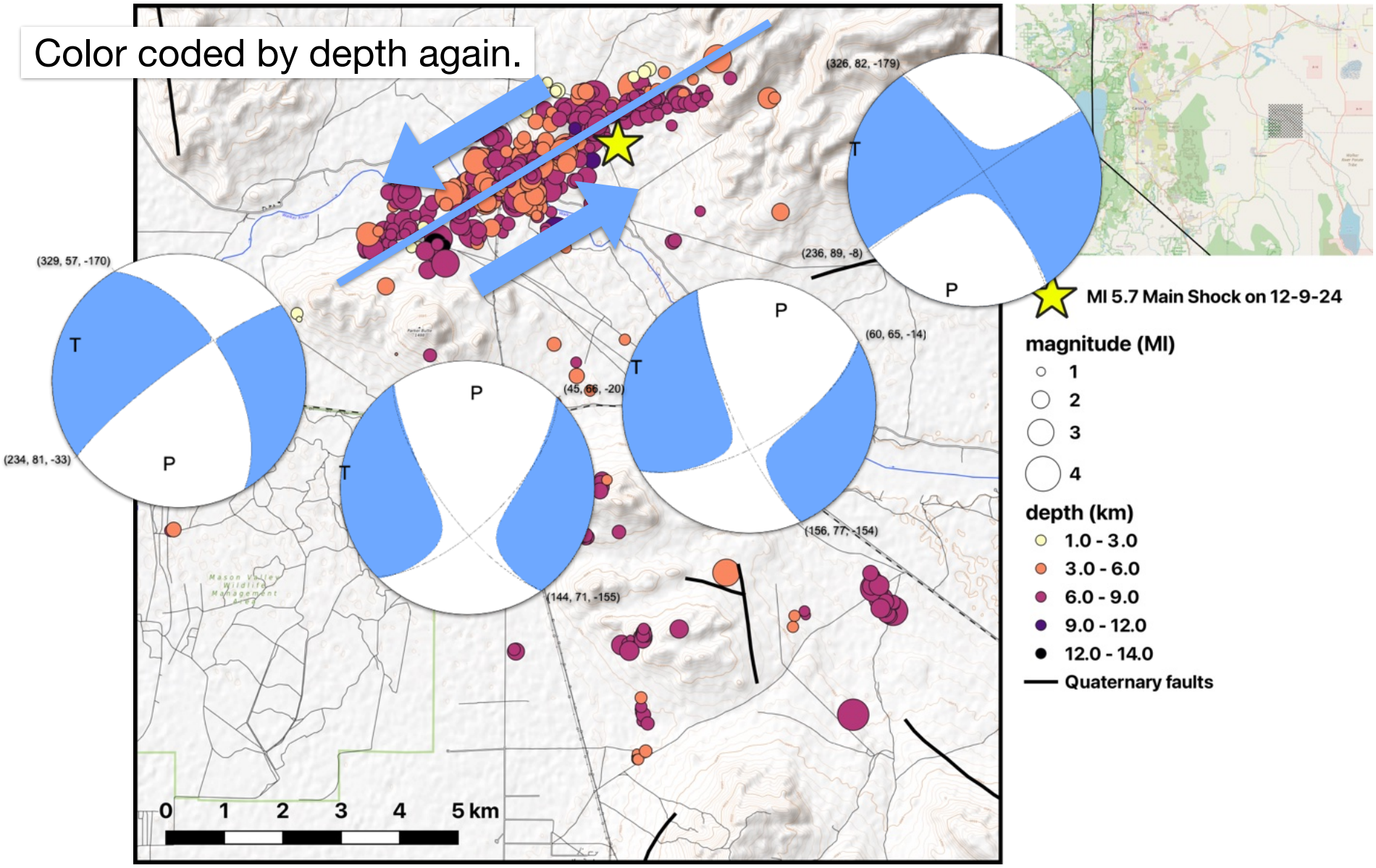
Quaternary faults

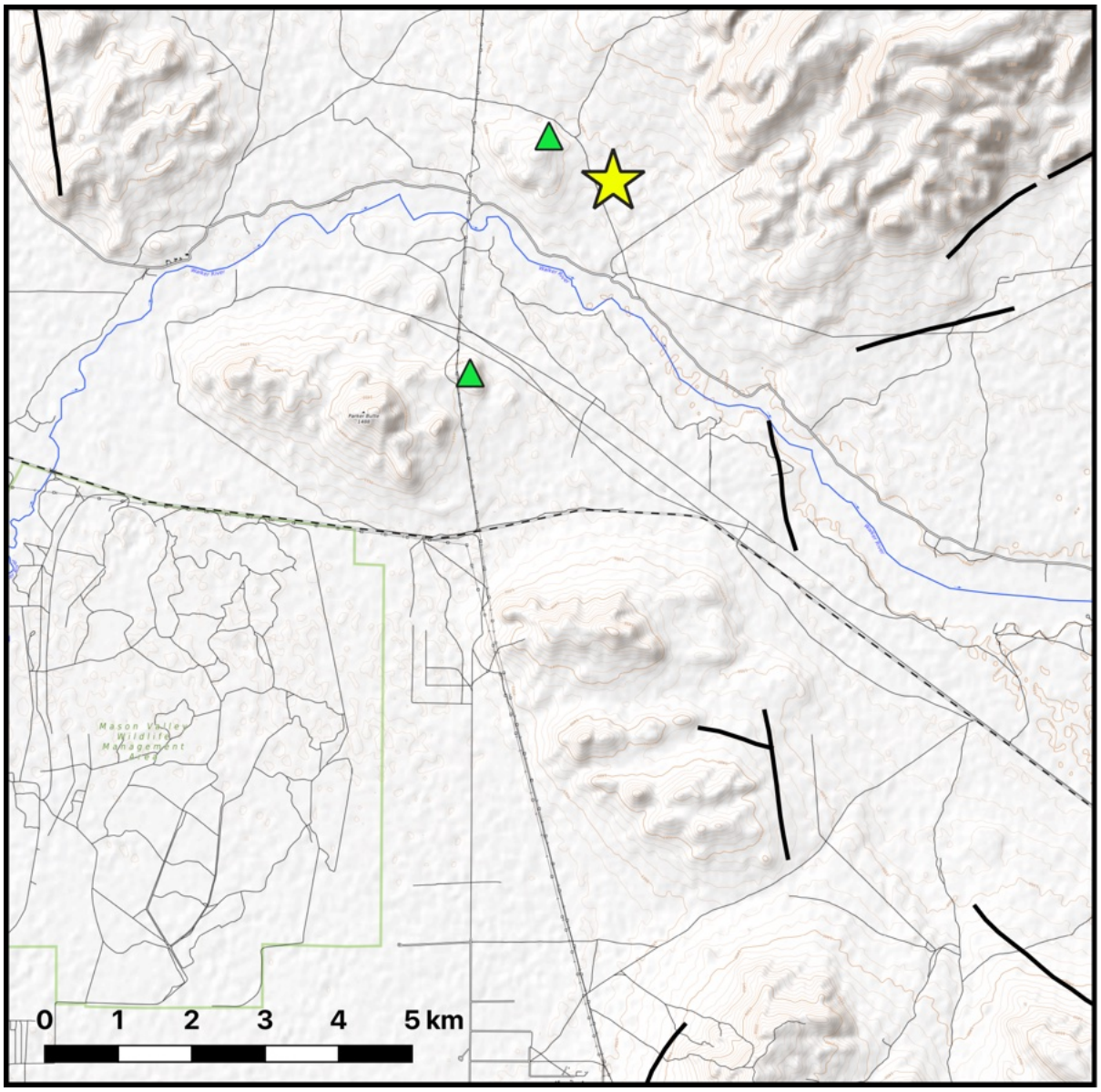
Moment tensor solutions can help us learn about what kind of fault the earthquakes are occurring on.

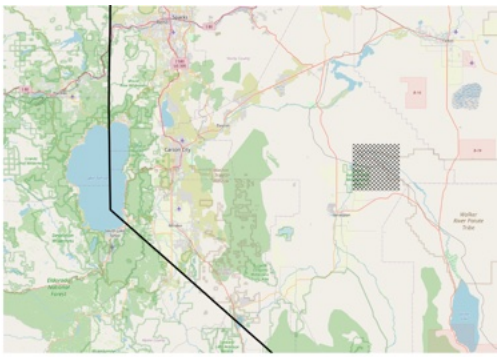



Color coded by depth again.
(326, 82, -179)
T
P
(329, 57, -170)
T
P
(234, 81, -33)
(236, 89, -8)
P
T
(60, 65, -14)
P
T
(45, 66, -20)
5.7 Main Shock
(156, 77, -154)
(144, 71, -155)
0 1 2 3 4 5 km
MI 5.7 Main Shock on 12-9-24
magnitude (MI)
1
2
3
4
depth (km)
1.0 - 3.0
3.0 - 6.0
6.0 - 9.0
9.0 - 12.0
12.0 - 14.0
Quaternary faults

Color coded by depth again.



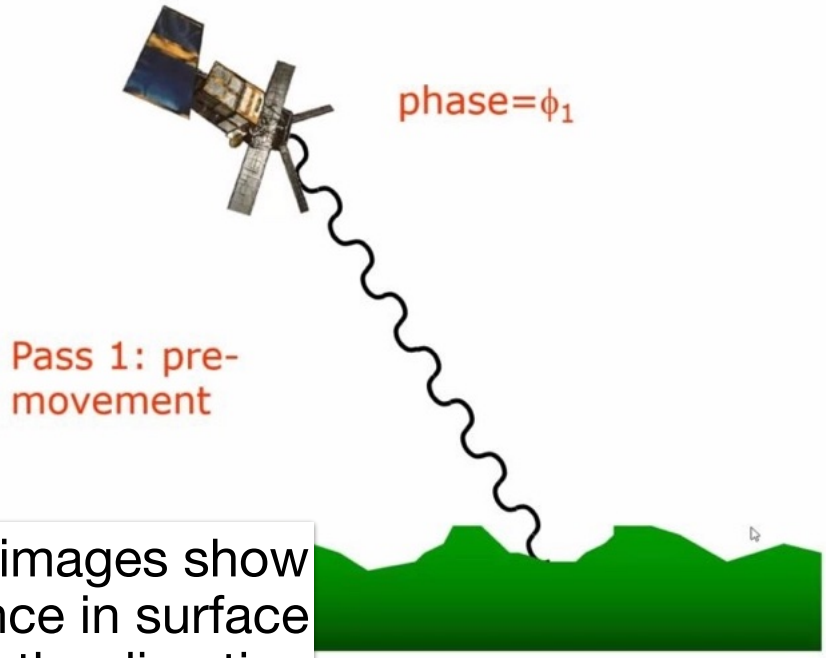


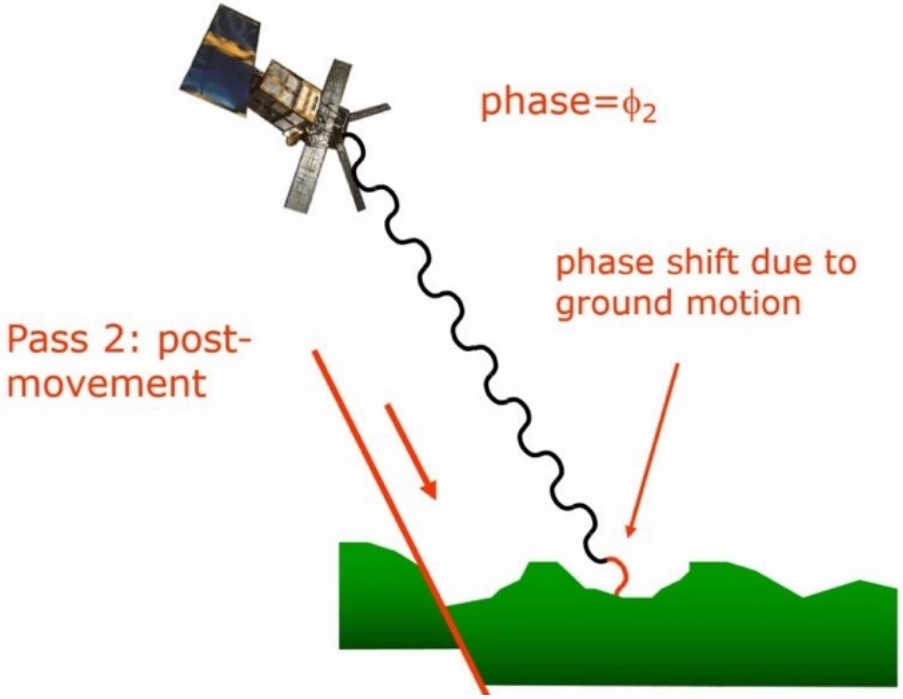


MI 5.7 Main Shock on 12-9-24

aftershock station

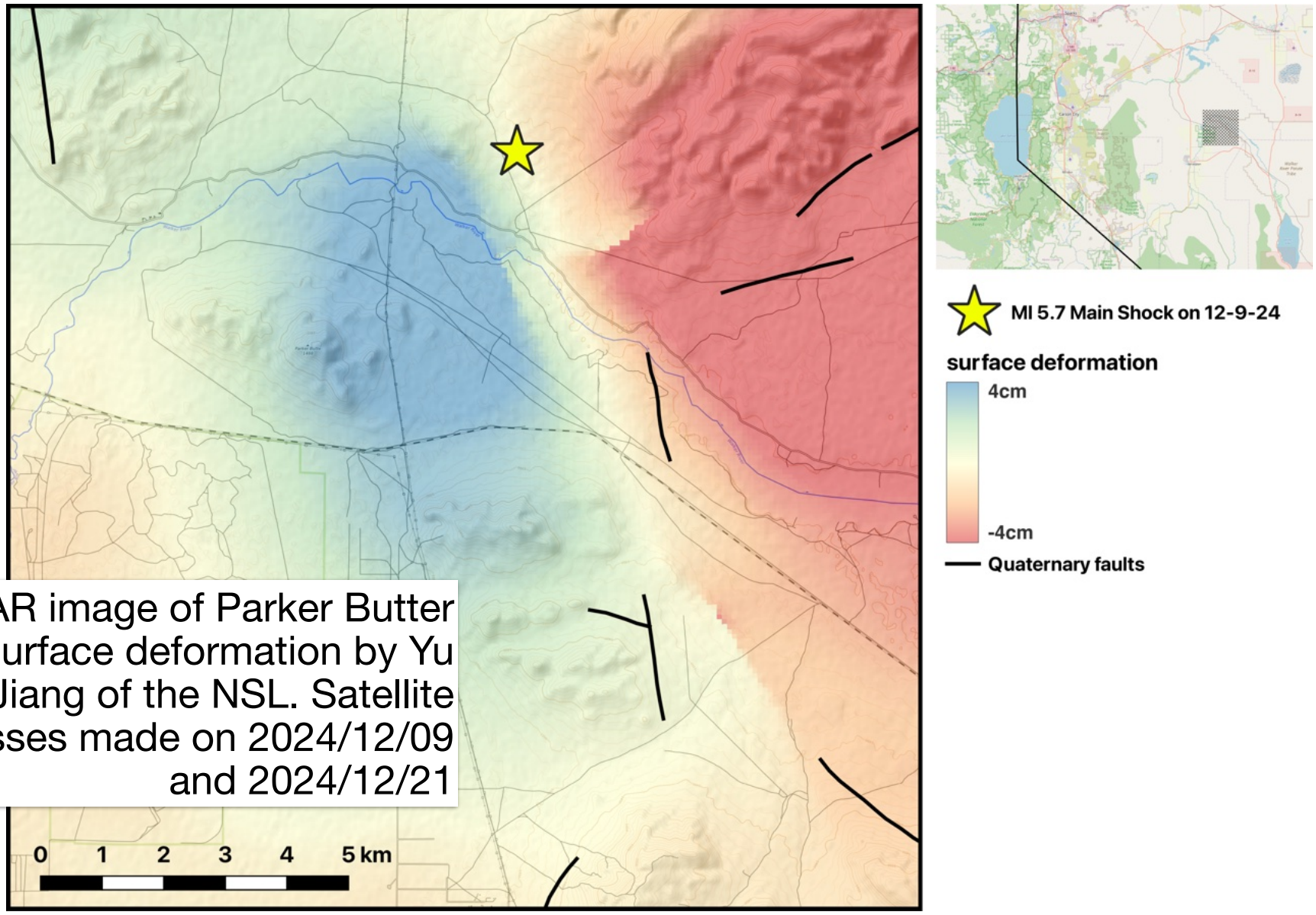
Quaternary faults



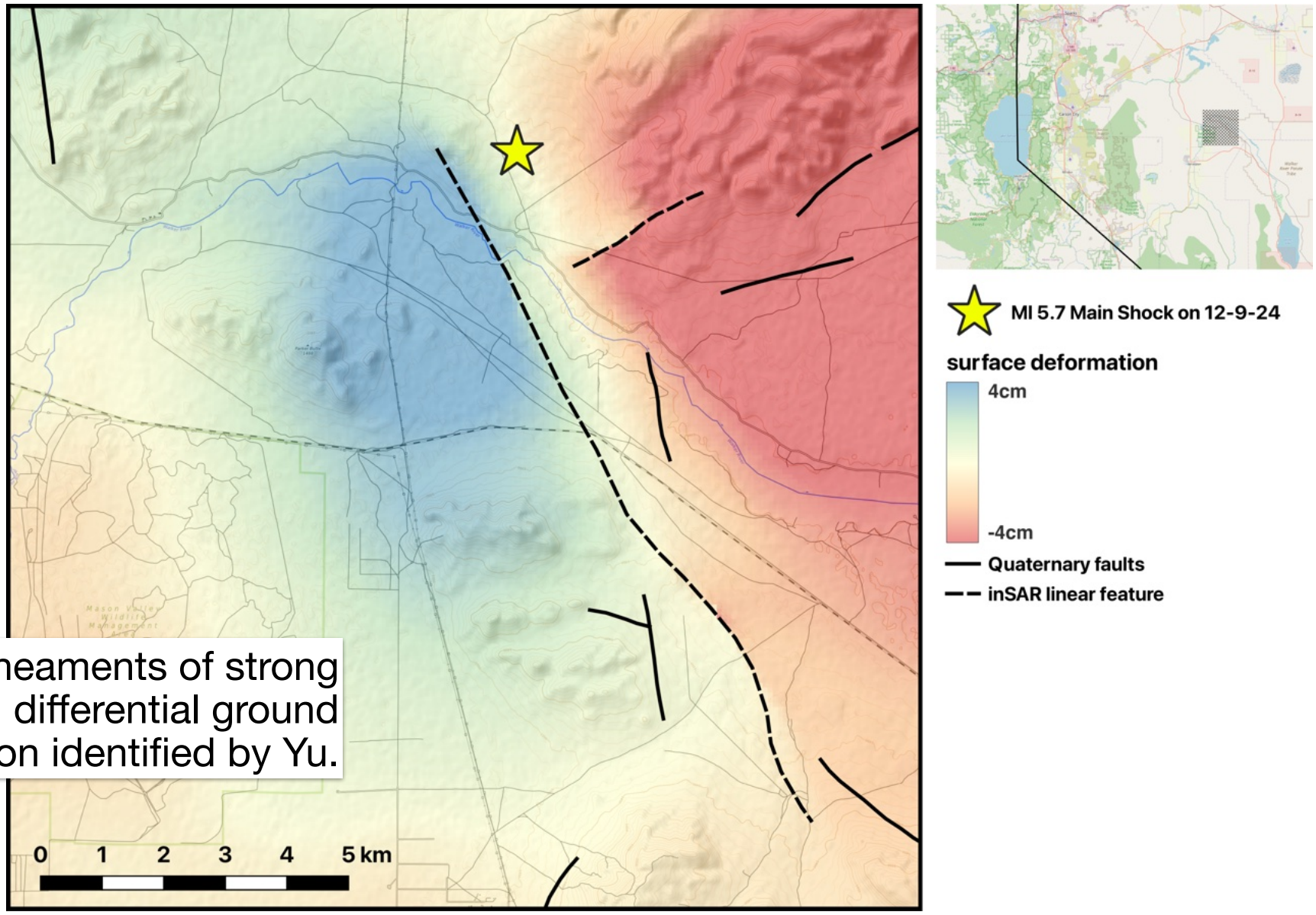


inSAR images show difference in surface elevation in the direction of satellite between two dates of satellite flyover.

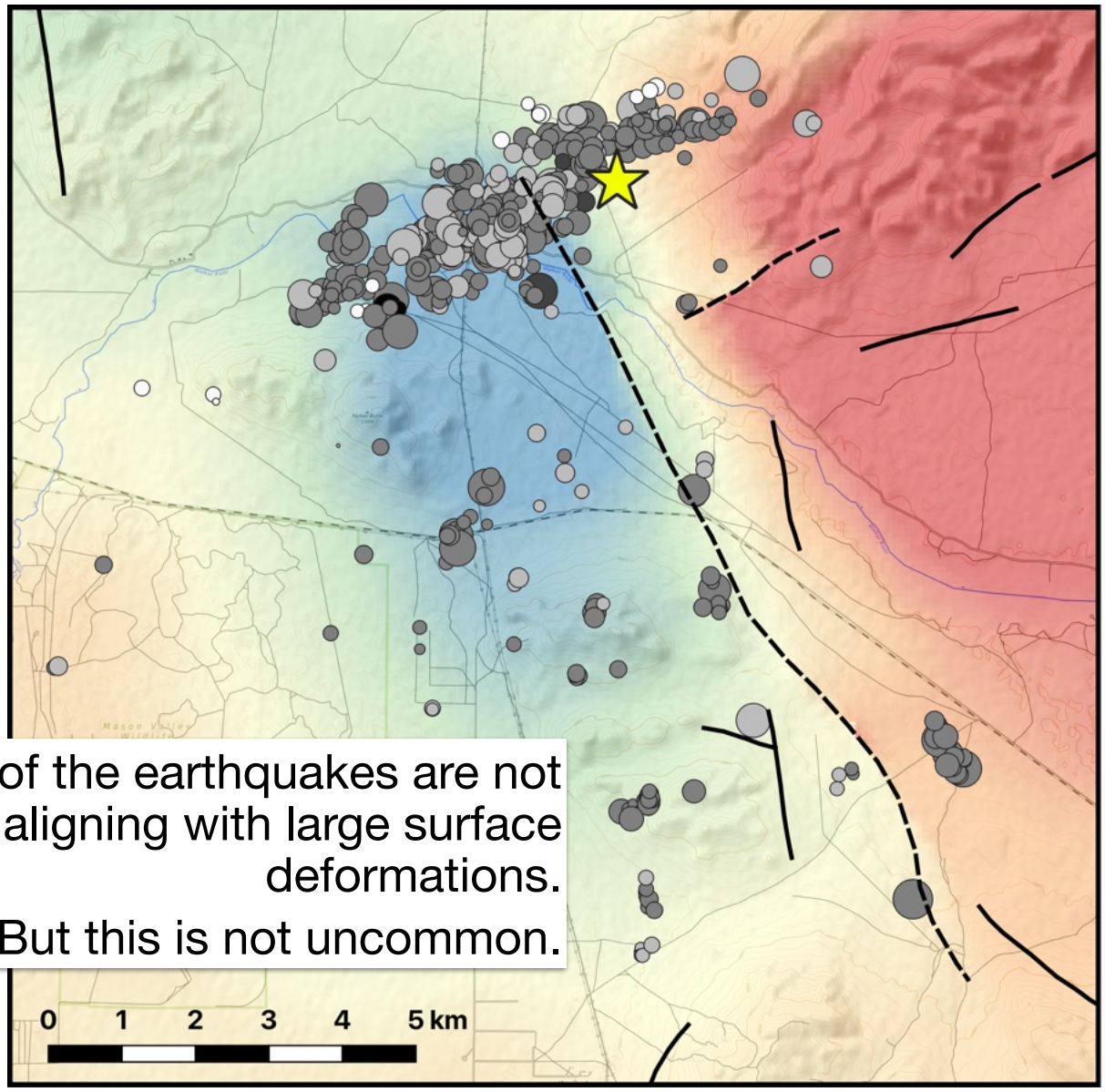
Figure Credit: Gareth Funning

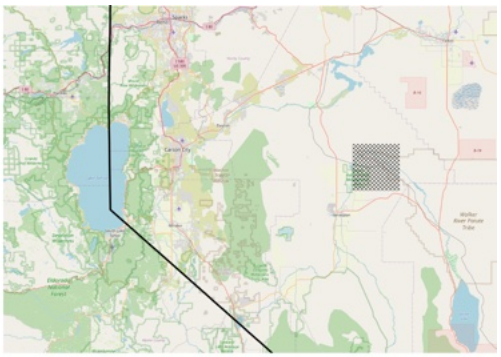


inSAR image of Parker Butter surface deformation by Yu Jiang of the NSL. Satellite passes made on 2024/12/09 and 2024/12/21



Lineaments of strong differential ground motion identified by Yu.





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1

2

3

4

depth (km)

1.0 - 3.0

3.0 - 6.0

6.0 - 9.0

9.0 - 12.0

12.0 - 14.0

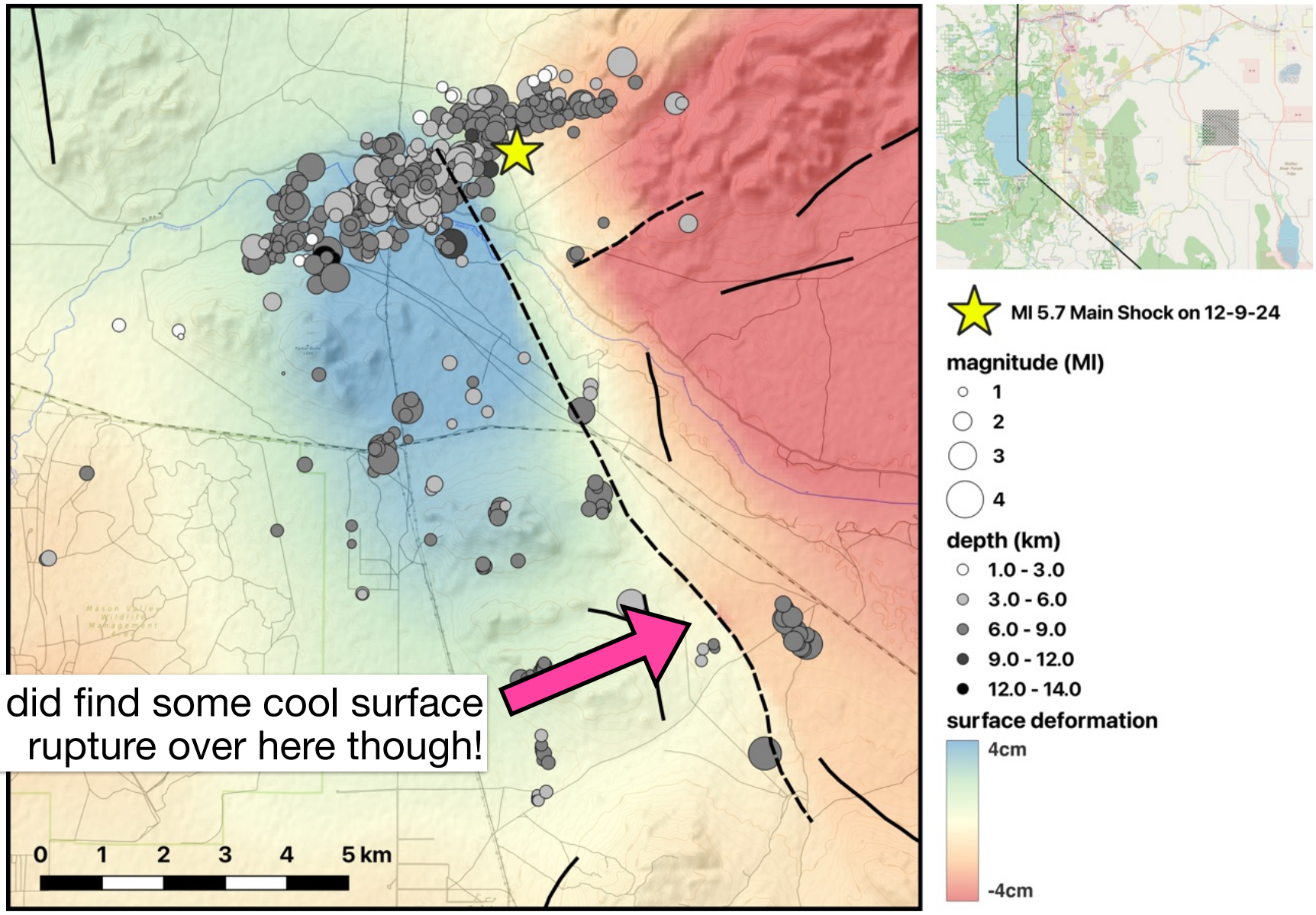
surface deformation

4cm

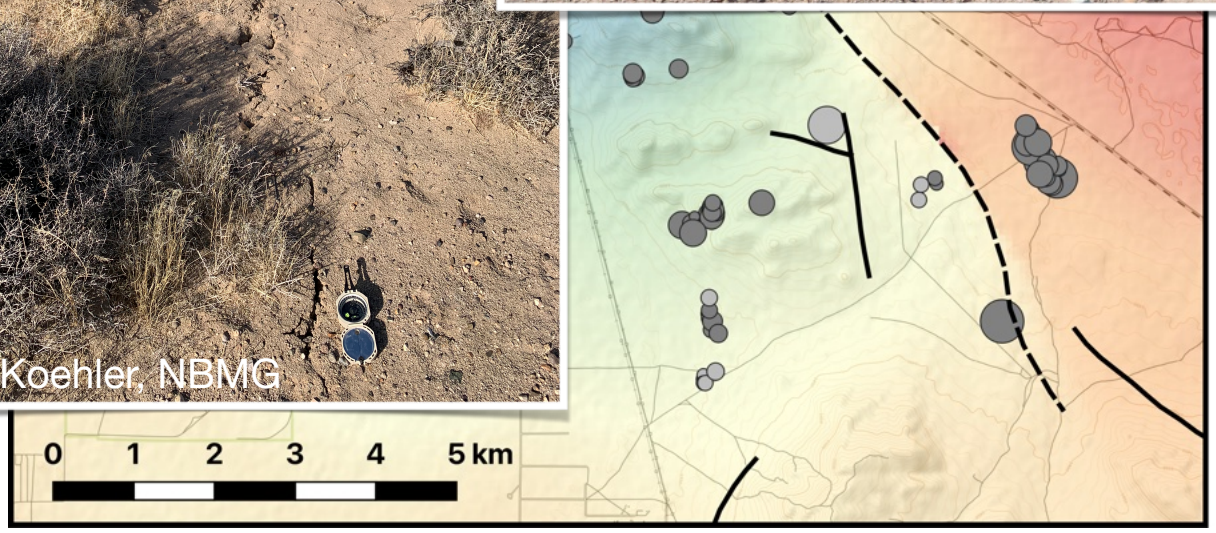
-4cm

Most of the earthquakes are not aligning with large surface deformations.

But this is not uncommon.


We did find some cool surface rupture over here though!
0 1 2 3 4 5 km
Ml 5.7 Main Shock on 12-9-24
magnitude (Ml)
1
2
3
4
depth (km)
1.0 - 3.0
3.0 - 6.0
6.0 - 9.0
9.0 - 12.0
12.0 - 14.0
surface deformation
4cm
-4cm

Surface rupture on southern lineament

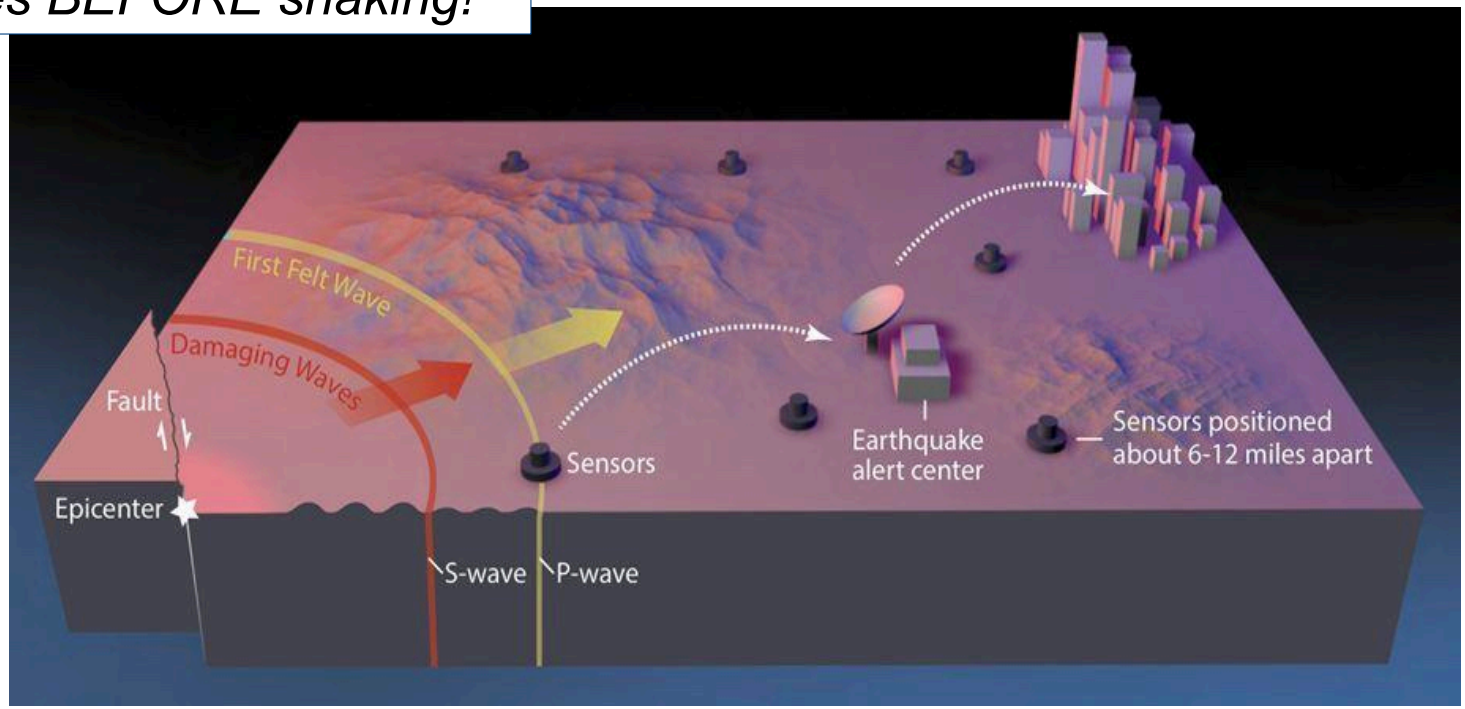


And other cool features showing liquefaction caused by the ground shaking.

There was some blocky collapse along the river banks. We found blocky collapses at other buttes as well

ShakeAlert: an Earthquake Early Warning System

ShakeAlert rapidly detects, locates, and estimates size of a large earthquake, sends alerts to likely shaking zone *seconds to minutes BEFORE shaking!*



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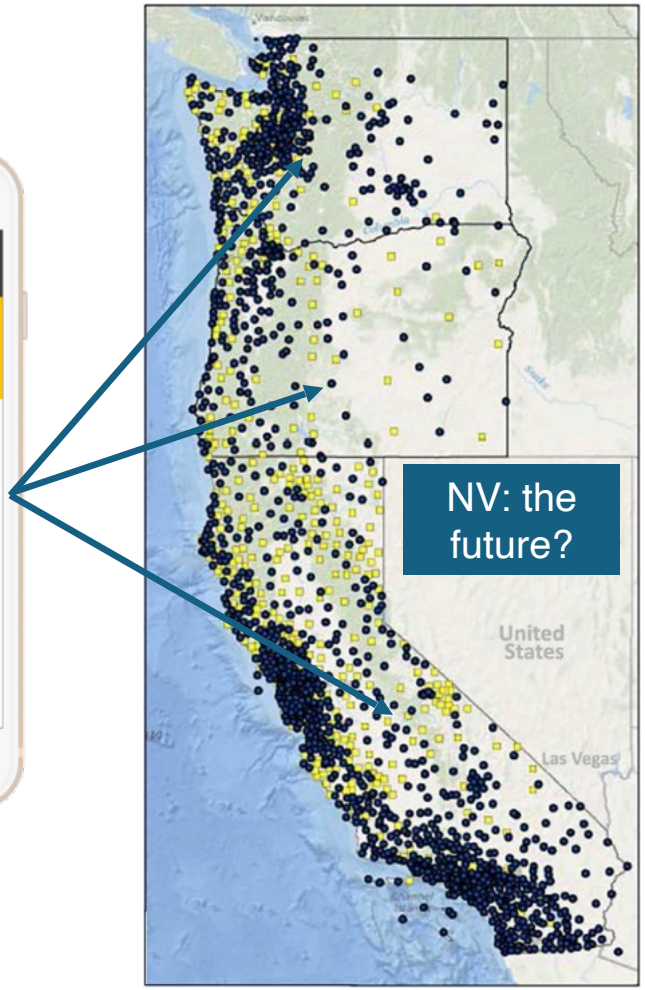
ShakeAlert: an Earthquake Early Warning System

- The USGS's ShakeAlert is the gold standard in EEW, providing earthquake warnings to cell phone users running any platform and integrating with emergency response systems.
- ShakeAlert is currently available in California, Oregon, and Washington and it maybe coming soon to Alaska.
- The NSL network provides essential data to the California system

The USGS aims to expand ShakeAlert to Nevada; this will require Federal appropriations guided by a technical implementation plan



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Impact on the State of Nevada

ShakeAlert would have a broad impact across Nevada and benefits a diverse group of stakeholders

- **Community support makes it an easy sell to our senators!**

Catherine Cortez Masto (D)

Jacky Rosen (D)

You can help us bring Earthquake Early Warning to Nevada.

- Sign a Letter of Support
- Contact our Members of Congress:

Senator Catherine Cortez Masto

Senator Jacky Rosen

Representative Mark E. Amodei

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In conclusion:

Earthquakes are happening!

And so far, we haven't seen much damage from this sequence.

We are still recording aftershocks, and will likely continue to for a while (months to years).

Questions?

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