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Magnitude 7.1 earthquake rips northwest from the M6.4 just 34 hours later

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POSTED ON JULY 6, 2019 BY TIEGAN HOBBS

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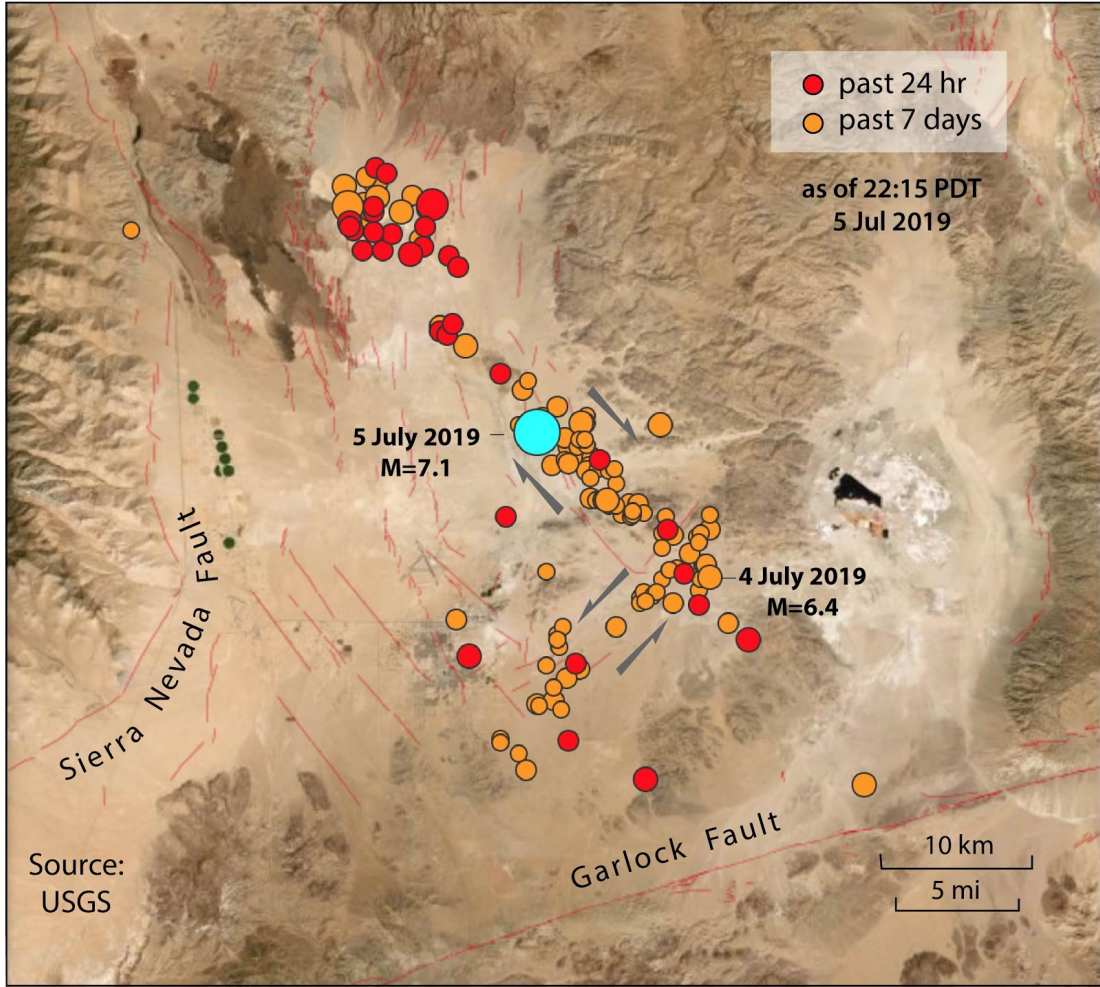
*The M 6.4 earthquake loaded the site where the M 7.1 shock nucleated. Now, the M 7.1 has extended the original rupture to the northwest, as well as to the southeast, where it kisses the major Garlock Fault.*

**Citation:** Ross S. Stein, Tiegan Hobbs, Chris Rollins, Geoffrey Ely, Volkan Sevilgen, and Shinji Toda, (2019), Magnitude 7.1 earthquake rips northwest from the M6.4 just 34 hours later, Temblor, <http://doi.org/10.32858/temblor.037>

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Rupture of a Previously Unknown Fault

The town of Ridgecrest was not done shaking after a [magnitude 6.4 earthquake](#) on the morning of July 4. An M=7.1 shock ruptured for at least 35 km (20 mi) from the 4 July 2019 epicenter, towards the northwest, and perhaps also for 25 km to the southeast. It is astonishing that there is no continuous mapped fault at the ground surface, despite the near absence of vegetation that can otherwise hide faults. Numerous other faults have been [mapped in this region](#), trending predominantly in a north-south direction, somewhat different than this earthquake. The aftershock alignment, however, is very straight in a northwest-southeast trend, suggesting that beneath the surface must lie a continuous fault. We strongly suspect that the rupture is right-lateral (whichever side you are on, the other moves to the right). The trend is parallel to the San Andreas Fault, but has a strike (or compass orientation) more westerly than most of the nearby surrounding faults.

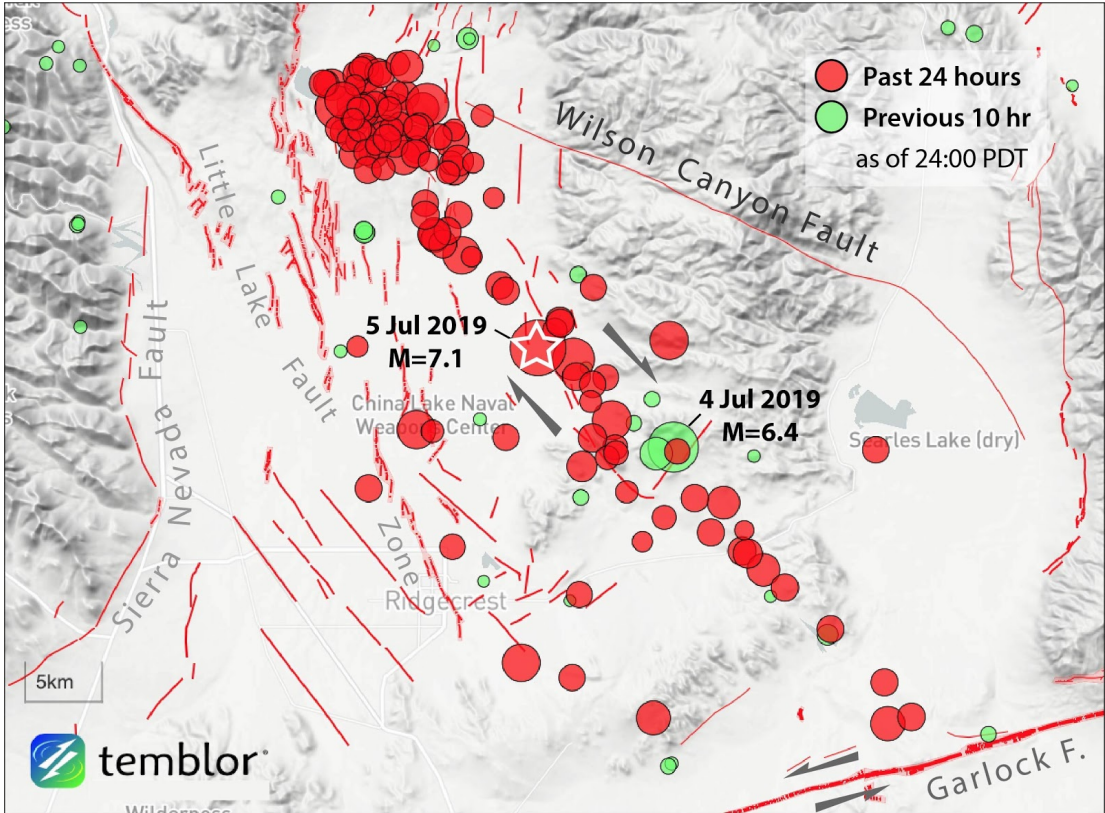


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Without knowing about this fault, there was no reason to suspect that such a large earthquake could occur to the north of the July 4 rupture. Fortunately, this is a remote location, with even fewer people living to the northwest of the mainshock than the south.

While much of the seismicity in the last 48 hours has fallen along two nearly linear faults, aftershocks of this magnitude 7.1 earthquake have formed a cluster to the northwest of the main rupture fault. This cluster, near Little Lake, CA, is approximately 15 km (9 miles) south of the Coso Geothermal Area. That geothermal region is home to abundant seismicity [Hauksson & Unruh, 2007] which is often clustered in swarms at its periphery. All events in this swarm, as of midnight local time on July 5th, are shallower than 10 km depth, consistent with previous swarms in this area.



*This Temblor app map with another 2 hours of events gives a different impression of the M 7.1 aftershocks than the initial USGS map, suggesting that the rupture does not simply extend to the northwest. Based on these aftershocks it appears ‘bilateral’, meaning that the fault unzipped both to the northwest and southwest, for a total length of up to 55 km. This would be more consistent with its magnitude, as a strike-slip M 7.1 typically has a length of about 50 km. If this is correct, then parts of the Garlock Fault might also be brought closer to failure.*

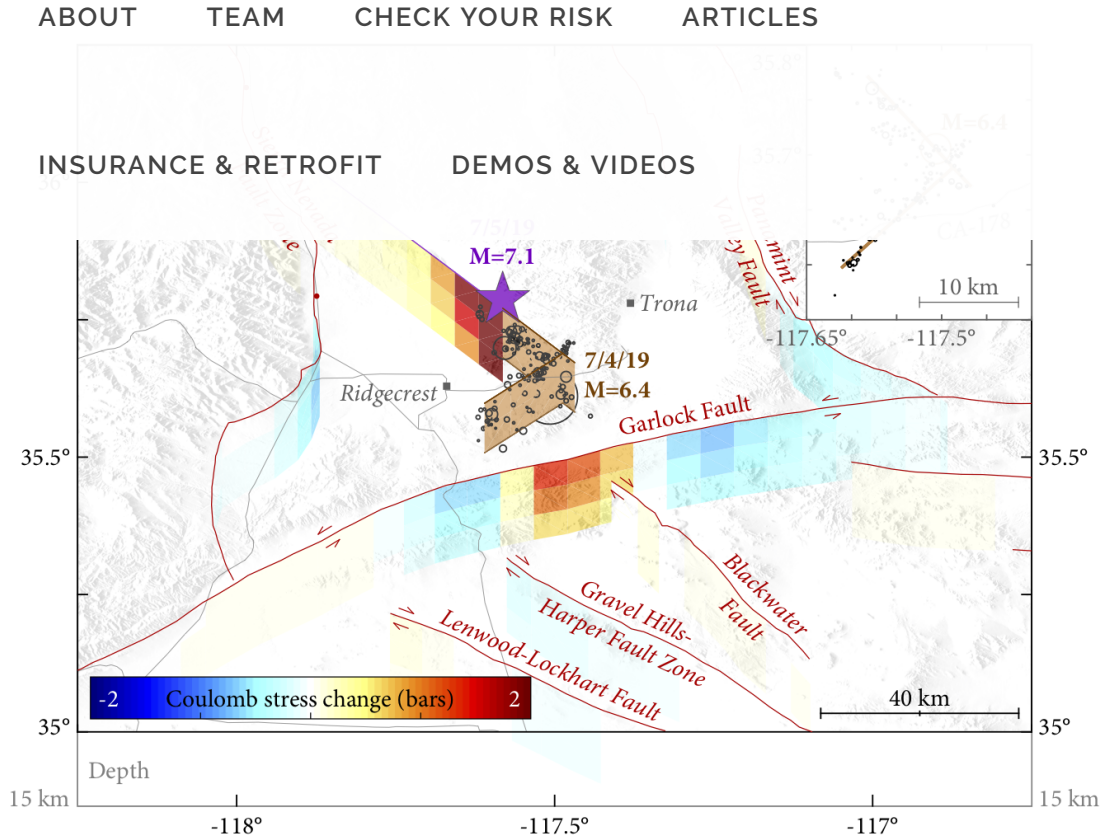
Chain Reaction

In retrospect, the M 6.4 quake on July 4 can now be regarded as a foreshock of the M 7.1. While generally uncommon, there are many recent examples of occurrences similar to this. The 14 April 2016 M 6.0 Kumamoto shock was followed 28 hours later by a M 7.0 quake on 15 April 2016 that ruptured two major faults that were brought closer to failure by the first event. The 3 November 2002 M 7.9 Denali earthquake on the Denali Fault was preceded by a M 6.7 shock on the Fault on 23 October 2002, 11 days beforehand.

The epicenter of the M 7.1 was Loaded by the M 6.4 Earthquake

Preliminary Coulomb stress transfer calculations reveal that the epicenter of the M 7.1 shock was brought 2 bars closer to failure by the M 6.4 shock. In other words, the 4 July event stoked the fire for the 5 July magnitude 7.1 earthquake. This large stress





Coulomb stress changes on nearby faults, as a result of the 4 July 2019 M=6.4 earthquake near Ridgecrest. The approximate location of the 5 July M=7.1 earthquake is indicated by the purple star, near the northwesterly extension of the fault that ruptured on the 4th of July. Stress in the region of the M=7.1 event was increased by roughly 2 bars following the M=6.4 earthquake.

### Aftershocks Propagating Towards the Garlock Fault


Seismicity between the M=7.1 at 8:19pm and midnight (local) has continued to the northwest and southeast. At the time of writing, 12:10am (local) the closest aftershock is within a few kilometers of the nearby Garlock Fault, which runs east-west between the Eastern California Shear Zone and the San Andreas Fault. Changes in stress on this major fault can have major implications for the nearby city of Los Angeles, and so will be closely monitored in the coming days. At this time, the [USGS has forecasted](#) that in the next week there is only a 9% chance of an aftershock which is equal to or larger than this M=7.1 event.

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### References

Hauksson, E., & Unruh, J. (2007). Regional tectonics of the Coso geothermal area along the intracontinental plate boundary in central eastern California: Three-dimensional Vp and Vp/Vs models, spatial-temporal seismicity patterns, and seismogenic deformation. *Journal of Geophysical Research: Solid Earth*, 112(B6).

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WayneK

• 13 days ago

What I'm surprised about is that no one has even mentioned anything about moving directly to the volcanic area off of HWY 395. Tons of cinder cones in that area (zoom in to the new quake area in the northwest). Not a previous quake. Could magma be on move? Just coincidence?

1 ^ | v • Reply • Share ›




Ross Stein

Mod → WayneK • 8 days ago

Good point! We discuss this in our most recent article, published on 7/19/2019.

^ | v • Reply • Share ›




Ross Stein

Mod → WayneK • 12 days ago

Hopefully, we will soon learn if there has been a change in the geologic deformation over the area with the hottest groundwater since the seismicity.

^ | v • Reply • Share ›

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Frank M. Pelteson

• 12 days ago


I wouldn't be surprised that the Naval Weapons Center Inyokern and the Edwards Air Force Flight Test Center nearby would have to solve a bunch of problems with the test track and other test equipment. No mention of this important set of problems was made.

^ | v • Reply • Share ›

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Herrnhut

— Thank you for such an insightful article. May the LORD Jesus bless all the USGS staff with providence and health when

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Ross Stein

— It is very difficult to be certain if these are late aftershocks, since we don't know what the seismicity was before the 1872

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Morgan Page

— These results are different from what we find when we look at P-wave peak ground

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cgoldfinger

— This map of the San Andreas is now out of date. The ashore at Point Delgada is

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