

# Earthquake catalog shows complex rupturing during 2019 Ridgecrest sequence

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The 2019 Ridgecrest earthquake sequence, which startled nearby California residents over the 4 July holiday with magnitude 6.4 and magnitude 7.1 earthquakes, included 34,091 earthquakes overall, detailed in a high-resolution catalog created for the sequence.

The [catalog](#), developed by David Shelly at the U.S. Geological Survey in Golden, Colorado, was published in the Data Mine column in *Seismological Research Letters*. The paper is part of a larger Data Mine series aimed at rapidly sharing data from the Ridgecrest sequence among researchers.

"Because of the complexity in this sequence, I think there are still a lot of unanswered questions about what the important aspects of the triggering and evolution of this sequence were, so having this catalog can help people make more progress on answering those questions," said Shelly.

Shelly used a technique called template matching, which scanned through seismic signals to find those matching the "fingerprint" of 13,525 known and cataloged earthquakes, as well as precise relative relocation techniques to detect 34,091 earthquakes associated with the event. Most of the earthquakes were magnitude 2.0 or smaller.

The catalog covers the [time period](#) spanning the the foreshock sequence leading up to the 4 July 2019 magnitude 6.4 [earthquake](#) through the first 10 days of aftershocks following the magnitude 7.1 earthquake on 5 July.

By precisely locating the earthquakes, Shelly was able to discern several crosscutting [fault](#) structures in the region, with mostly perpendicular southwest- and northwest strikes. The foreshocks of the magnitude 6.4 event aligned on a northwest-striking fault that appears to have ruptured further in the aftershocks of that earthquake, along with a southwest-striking fault where a surface rupture was observed by teams who went out to the site.

Shelly said the magnitude 7.1 earthquake appears to have started at the northwestern edge of the magnitude 6.4 rupture, extending to the northwest and southeast and possibly extending that rupture to the northwest and southeast. The [magnitude](#) 7.1 event was highly complex, with several southwest-striking alignments and multi-fault branching and high rates of aftershocks, especially at the northwestern end of the rupture.

The Ridgecrest earthquakes took place along "a series of immature faults, in the process of developing," Shelly said, noting that this could explain in part why the earthquake sequence was so complex. Compared to the mature San Andreas Fault Zone to the west, which accommodates about half of the relative plate motion as the Pacific and North American tectonic plates collide, the Ridgecrest faults are broadly part of the Eastern California Shear Zone, where multiple faults accommodate up to 25 percent of this tectonic strain.

Shelly noted that the catalog benefitted from the long-established, densely instrumented, real-time seismic network that covers the region. "When there's a big earthquake in an area that's not well-covered, people rush out to try to at least cover the aftershocks with great fidelity," he explained. "Here, having this permanent network makes it so you can evaluate the entire earthquake sequence, starting with the foreshock data, to learn more about the earthquake physics and processes."

**More information:** David R. Shelly, A High-Resolution Seismic Catalog for the Initial 2019 Ridgecrest Earthquake Sequence: Foreshocks, Aftershocks, and Faulting Complexity, *Seismological Research Letters* (2020). [DOI: 10.1785/0220190309](https://doi.org/10.1785/0220190309)

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