2021 SOURCES: Surficial fractures from the 2019 Ridgecrest mainshock mapped from high-resolution aerial imagery

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Abstract
The surface deformation field of an earthquake contains information about rupture propagation and fault geometry. The 2019 Ridgecrest Earthquake sequence caused a surface rupture that was documented by 5 cm resolution aerial imagery collected by the National Center for Airborne Laser Mapping. We mapped a section of the mainshock from this imagery where the earthquake ruptured through lake bed sediments in the China Lake Naval Air Weapons Station. This map highlights the principal rupture trace but also reveals secondary fracturing, offset channels, liquefaction features, and broad zones of distributed deformation that extend up to kilometers away from the primary faults. These maps may be incorporated into probabilistic displacement hazard assessments for the region.

Background
- The 2019 Ridgecrest Earthquake sequence started on July 4th with a Mw 6.4 foreshock, followed by a Mw 7.1 ~30 hours later.
- The sequence ruptured several faults in the Eastern California Shear Zone.
- The sequence produced ample surficial deformation, including primary and secondary deformation features from cm-to km scale.

Data & Methodology
- Mapping was performed under QGIS (quantum geographic information systems) software. We distinguished fractures based on lineaments of disturbed soil, or as linear open fissures and scarps evident from shadows and collapsed material.
- We used 5cm per pixel imagery collected by the National Center for Airborne Laser Mapping about a month after the event (Hudnut et al., 2020).
- Different sections of the sequence were split into different groups with this map being focused on the middle mainshock section (Figure 1).
- Editing and superimposed images were made with Adobe Illustrator.

Results
- Our maps include sections of widely distributed deformation that were previously unmapped and highlight small fractures below the resolution of other datasets (Fig 6).

Summary/Conclusion
- Our high-resolution maps reveal secondary fracturing, liquefaction, and distributed deformation zones that extend away from the primary deformation strands.
- The map highlights the complexity of the surface rupture at sub decimeter resolution.
- These data may be used for probabilistic displacement hazard assessment or serve as a machine learning dataset in the future.

Fig 1: Index image of the Ridgecrest earthquake sequence with this poster focusing on the middle mainshock profile located near the Salt Wells Fault zone.

Fig 2: Images from the surface rupture of the Ridgecrest earthquakes. Photos by Mike Oskin.

Fig 3: Different fault strands that exhibit both dense, narrow deformation zones (left) and wide deformation zones that extend meters away from the fault (right).

Fig 4: Comparative image of microfractures before mapping was performed.

Fig 5: A fault strand orientated from the NE to SW direction. Evidence of dense and narrow microfractures followed by a section of possible liquefaction coseismic features.

Fig 6: Left: Surficial fractures mapped from lidar data. Right: Surficial fractures mapped from aerial imagery. Note the lidar data includes a mismapped shoreline (East).

Fig 7: Evidence of distribution deformation extending meters away from the main fault strand that is orientated in the SE direction.

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