Virtual Research Presentation Conference

Searching for Triggered Fault Slip from the 2019 Ridgecrest Earthquake Sequence

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Program: Spontaneous Concept

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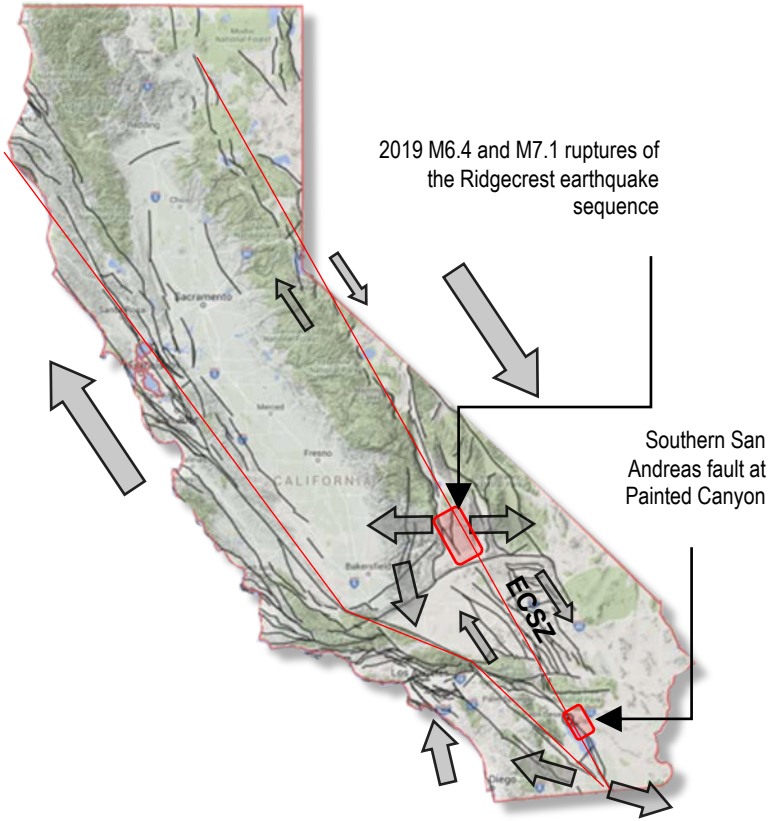
Introduction

Abstract

On July 4 and 5, 2019 the Ridgecrest earthquake occurred on a set of conjugate faults with a M6.4 foreshock followed 36 hours later by a M7.1 mainshock. An increasing number of observations indicate that large earthquakes trigger slip on near and distant faults that are not part of the main fault rupture. We carried out repeated near-surface airborne stereo photogrammetry surveys on the Southern San Andreas fault and of both ruptures of the Ridgecrest earthquake sequence. The objective is to assess whether the Ridgecrest earthquake triggered slip on near or faults in the Eastern California Shear Zone above the resolution of the past surveys. A second objective is to quantify any postseismic slip on the Ridgecrest ruptures. We found no afterslip for the two targeted ruptures of the surveys. A small amount of right-lateral compressive slip may have occurred on the southern San Andreas fault. The earthquake sequence and postseismic motions show coseismic and postseismic transtensional deformation suggesting a deeper source for postseismic deformation. East-west extension dominates south of the Garlock fault after the earthquake. The right-lateral normal Paradise fault south of Death Valley appears responsible for the Mojave Desert deformation.



Problem Description

a) The goal is to improve understanding of the physical mechanisms of tectonic processes and fault slip, to understand long range interactions between faults and to ultimately improve earthquake hazard assessment

b) This work fuses multiple types of data allowing for dense near-fault high-resolution measurements and precise long-term regional measurements, which helps separate deep and shallow processes

c) NASA's Earth Surface and Interior program asks: "What is the nature of deformation at plate boundaries and what are the implications for earthquakes?" and these high resolution topographic measurements are directly relevant to NASA's Surface Topography and Vegetation Targeted Observable

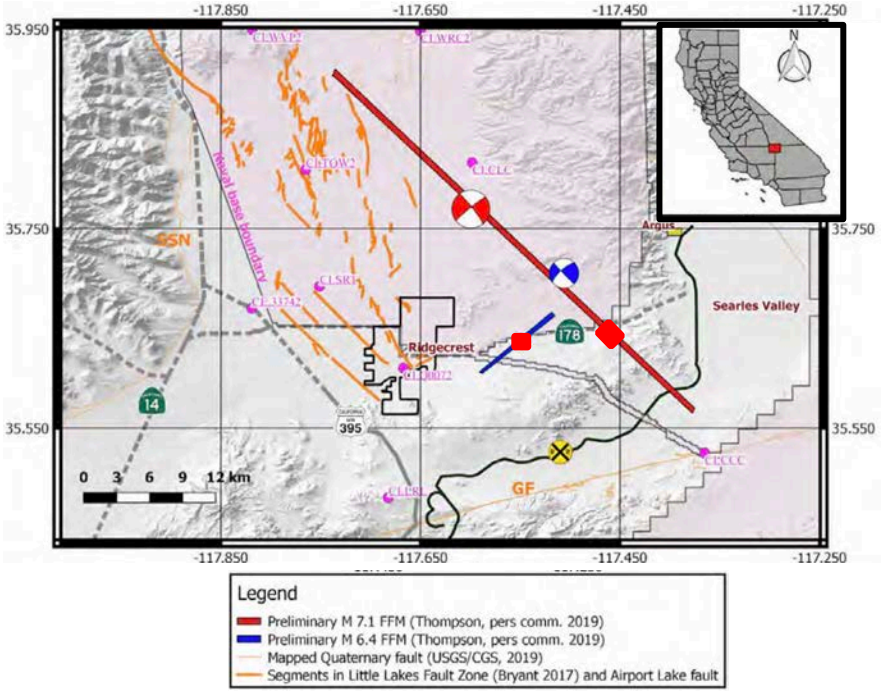
Methodology

a) Experiment description

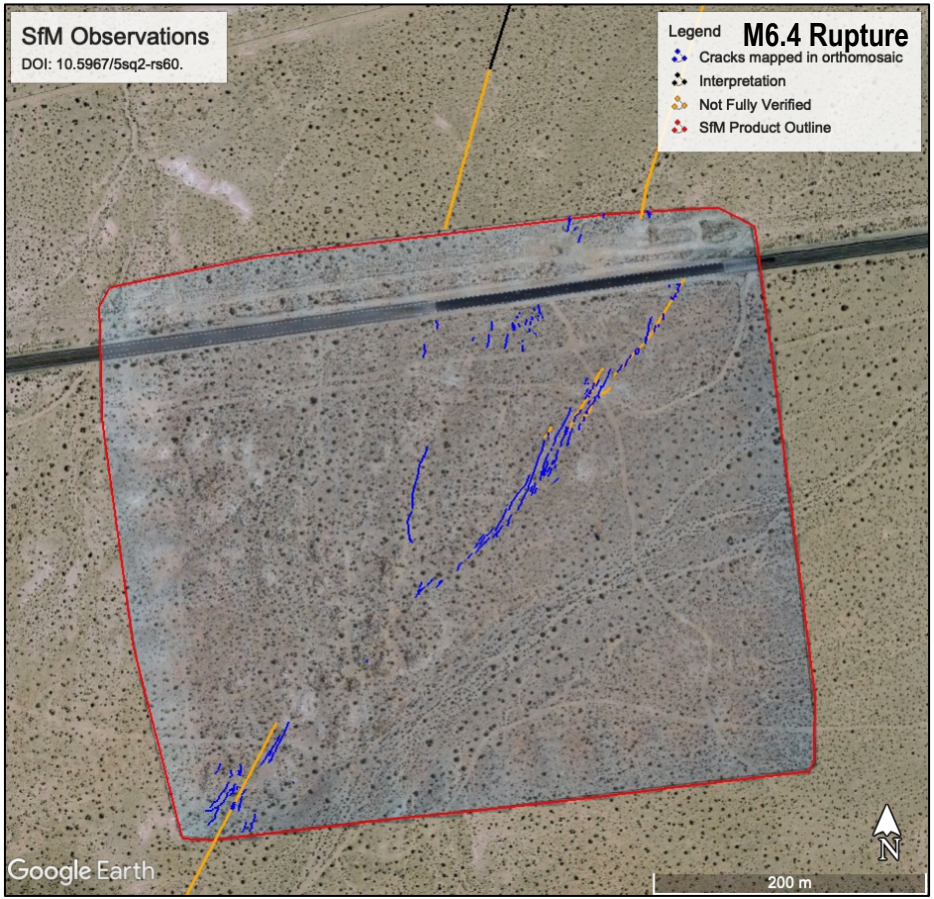
- We repeated stereophotogrammetry measurements using small UAS (drones) to image targeted sections of the M6.4 and M7.1 2019 Ridgecrest ruptures and Painted Canyon on the Southern San Andreas fault
- We determined regional long-term velocities, coseismic displacements, and postseismic motions surrounding the Ridgecrest rupture and Eastern California Shear Zone (ECSZ) from a continuous network of Global Navigation Satellite System (GNSS) stations

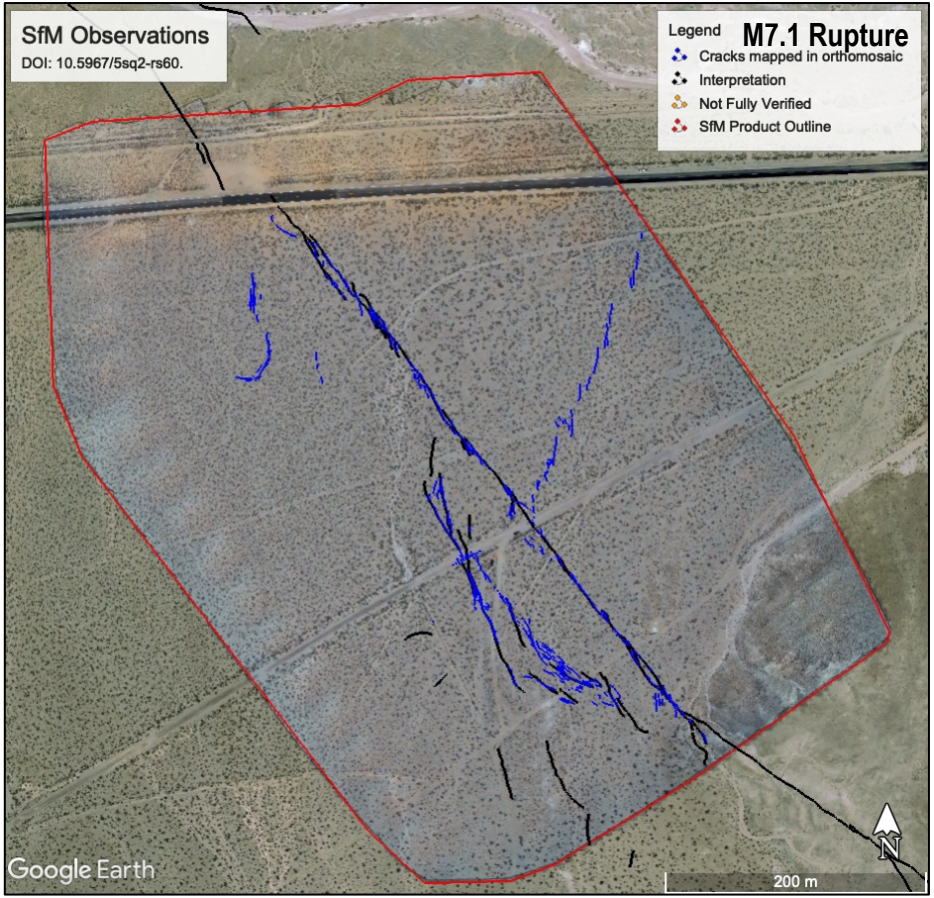
b) Advancement

- Combining high resolution near fault measurements with regional deformation measurements is used to assess style of deformation and shallow versus deeper source
- Regional measurements identify regions off different tectonic deformation



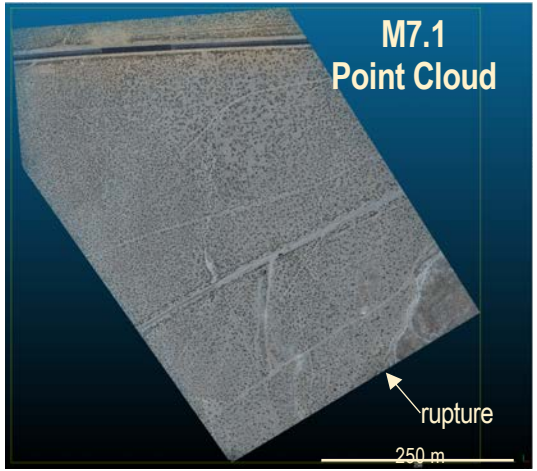
Coseismic fractures

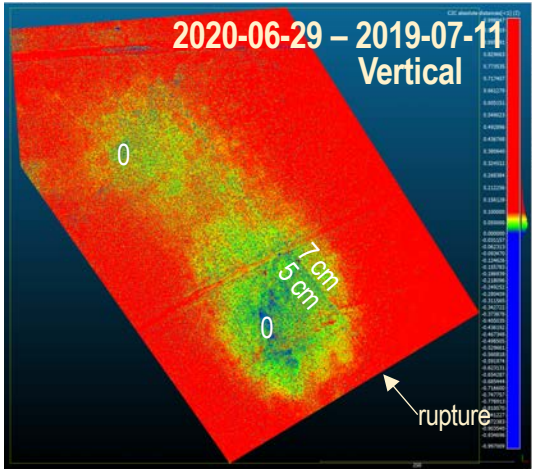


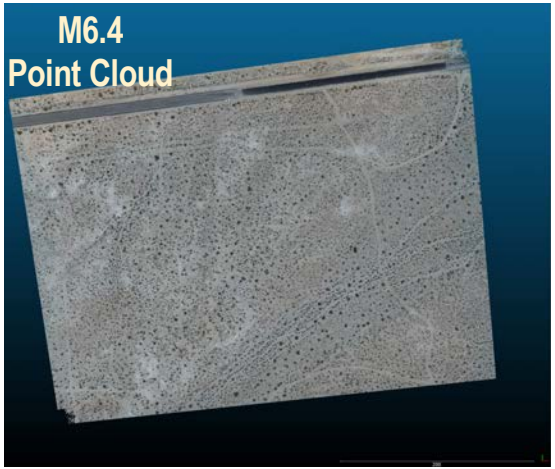


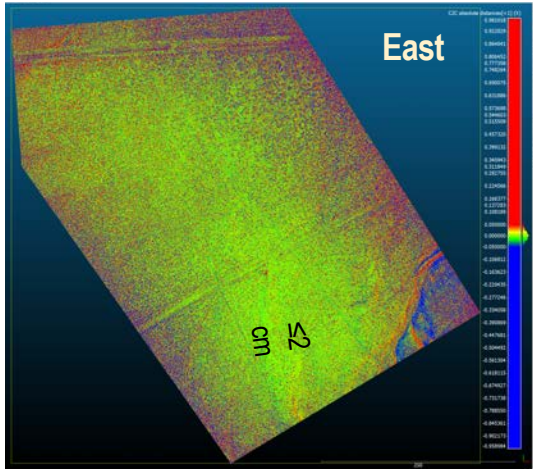
Donnellan et al, 2020

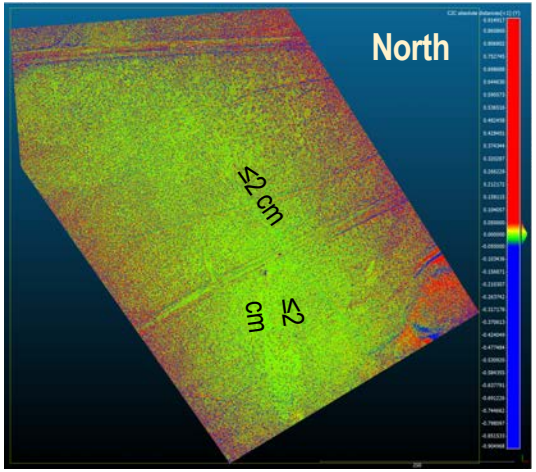
Local Postseismic Motions

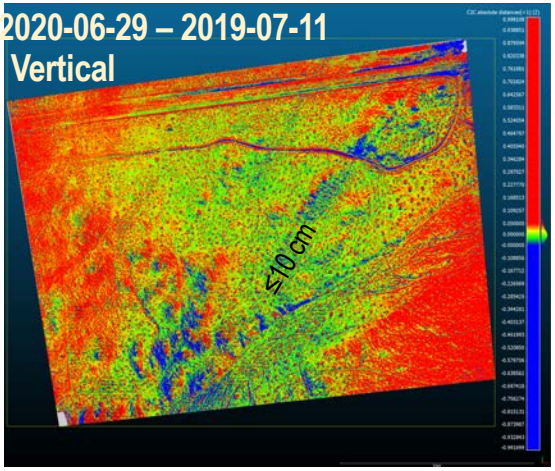




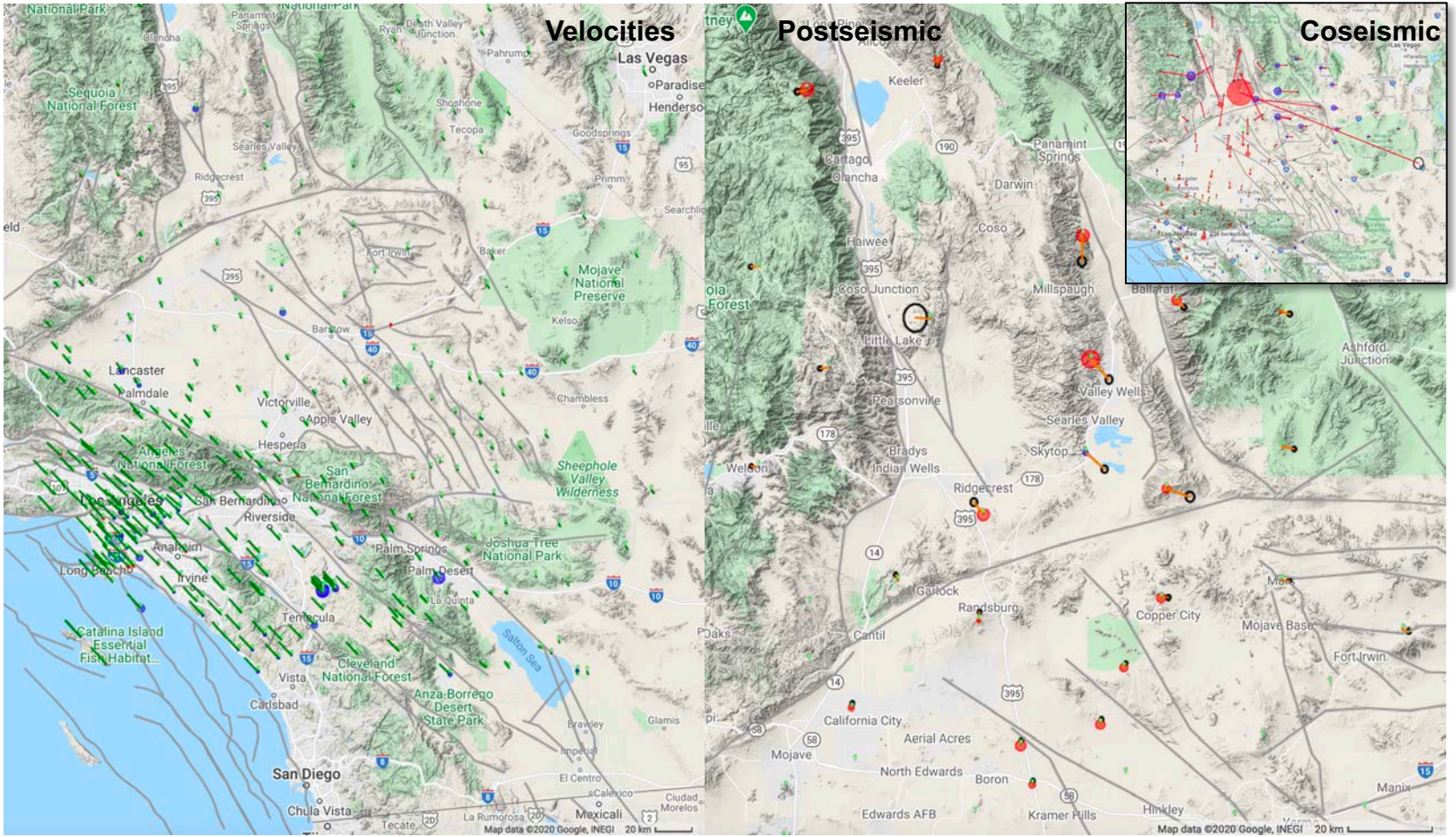




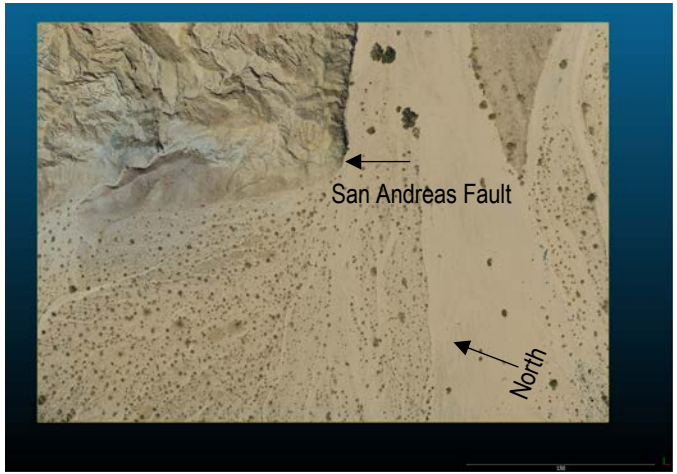


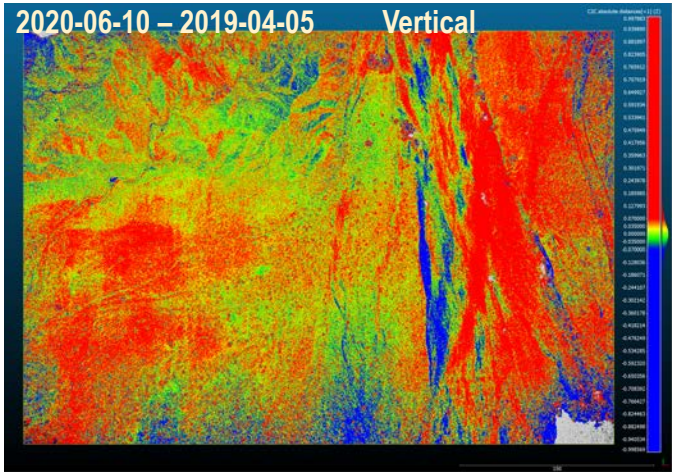


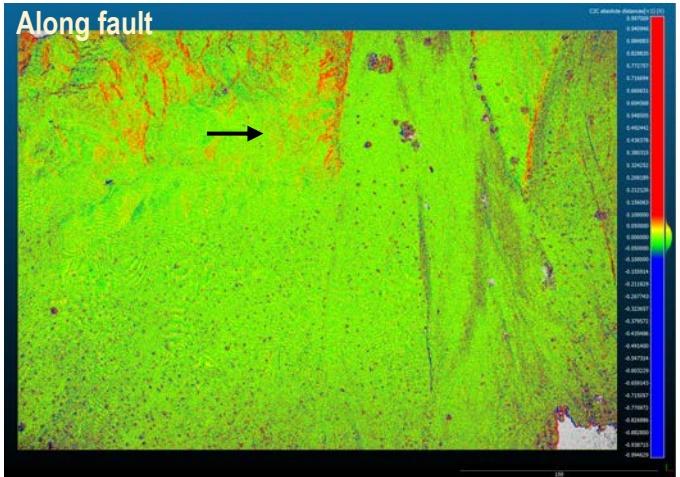
Regional Deformation

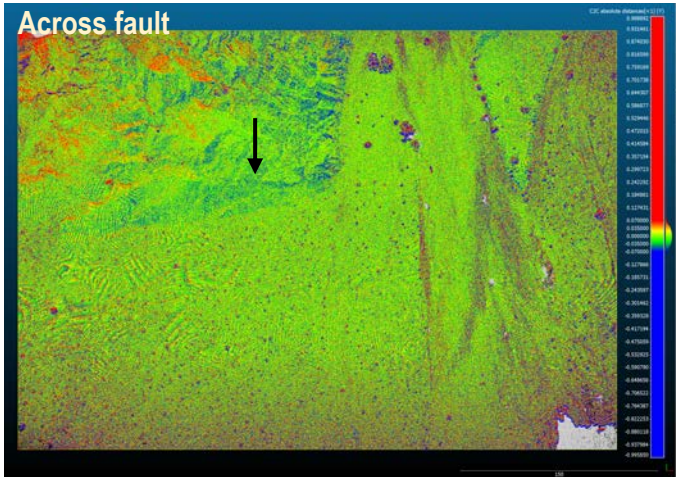


Painted Canyon









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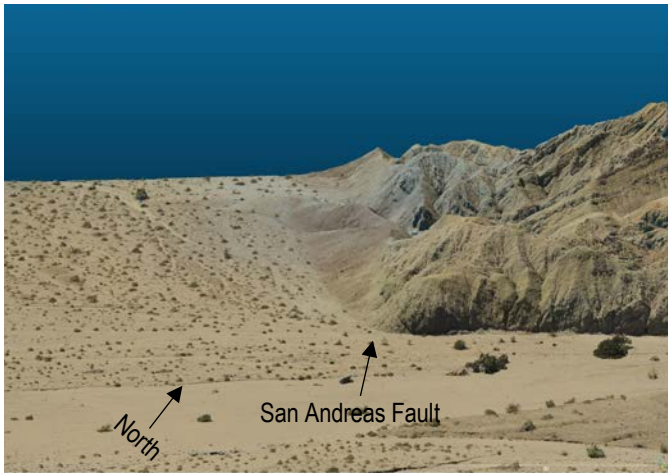

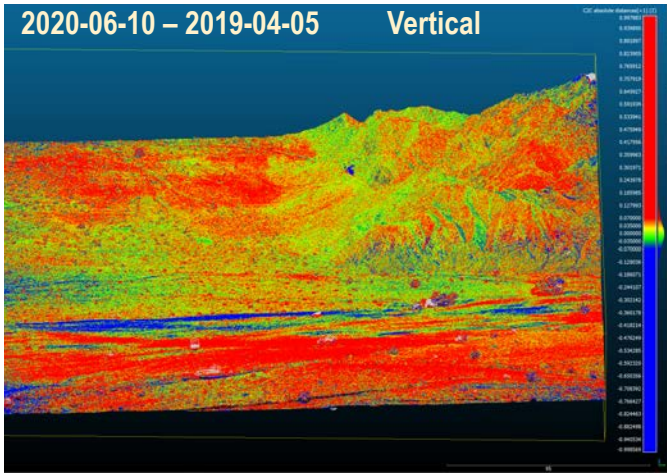

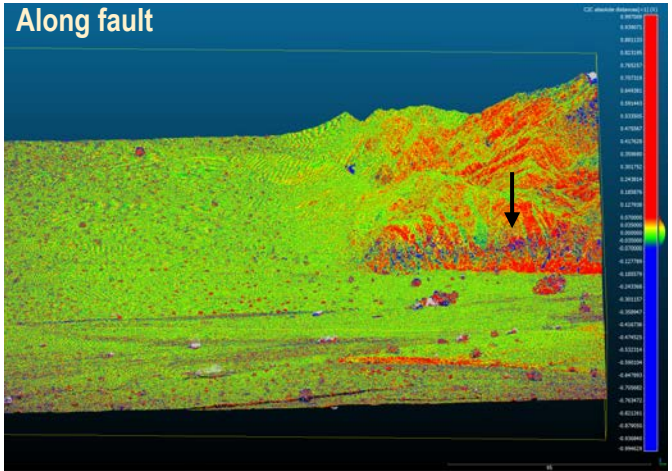

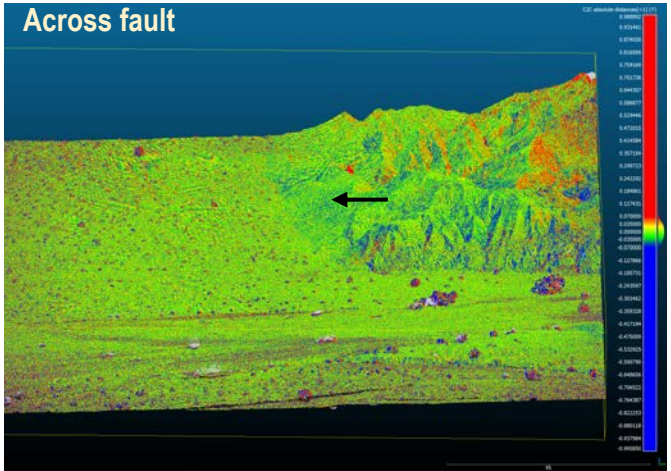

Results

a) Accomplishments (Goals were met)

- We did not resurvey the Blackwater fault or Landers rupture due to Covid-19 delays. However, our results show that the Paradise fault further east is responsible for ECSZ deformation
- We see regional postseismic deformation but not local afterslip, which means deeper processes occurred following the Ridgecrest rupture sequence
- There may be some minor compression and right-shear on the southern San Andreas fault

b) Significance

- A distinct change in deformation north and south of the Garlock fault suggests it acts as a barrier between tectonic regions
- East-west extension is the dominant postseismic mechanism in the Mojave Desert rather than right-lateral shear
- Left-lateral triggered slip on the Garlock fault could transfer the extension to the Paradise fault south of Death Valley

c) Next steps

- Model the crustal deformation
- Assess weather local vertical motions are experiment noise or shallow process, possibly from fluid motions

References

1. Donnellan, Andrea, et al. "Targeted High-Resolution Structure from Motion Observations over the M w 6.4 and 7.1 Ruptures of the Ridgecrest Earthquake Sequence." Seismological Research Letters (2020).
2. Heflin, Michael, et al. "Automated estimation and tools to extract positions, velocities, breaks, and seasonal terms from daily GNSS measurements: illuminating nonlinear Salton Trough deformation." Earth and Space Science 7.7 (2020): e2019EA000644.