Damage to Pinnacles Spires as surveyed on July 12 2019
Ridgecrest earthquake sequence

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- Damage to Fragile Geologic Features (FGFs) can help constrain ground motions and hazard curves. Estimates depend on age, fragility, damage and ground motions.

- Several tufa spires (FGFs) in the Trona Pinnacles National Monument were damaged from shaking during the Ridgecrest Sequence.

- Tufa spires are more fragile and more prone to weathering and degradation than other FGFs. Their study can nonetheless help us refine techniques for the use of other FGFs.

- On July 12, we documented the damage / intact state of a large number of Pinnacles’ tufa spires.

- A subset of damaged pinnacles were imaged using unmanned aerial vehicles (UAVs); area surveyed by Lidar.

- The pinnacles have been heavily photographed with images readily available to provide the pre-damage state of the pinnacles.
Before and after pics – Spire 01

Photo: J. Brune

Photo: C. Goulet
Spire 01

66°NE (T) 35°37'10"N, 117°22'21"W ±19.7ft ▲ 1759ft

Photo: C. Goulet
Spire 01

Rolls shown with dashed lines
3D point cloud image – UAV survey

Detached rock volume ~ 9.5 m³
A few examples of what appears as very fresh damage – 26 IMG_8985
A few example of what appears as very fresh damage

Fresh impact marks in trail
Before and after pics – Spire 02

Fresh damage?
Before and after pics – Spire 02
Pic angles do not match perfectly

Photo: J. Brune
Before and after pics - 04

Photo: J. Brune
Next steps:
- Catalog pictures and spires
- Collect pre-event pictures
- Add to SCEC PBR/FGF archive as new state
- Analyze UAV and Lidar images from SCEC NSF RAPID recon
- Reverse-engineering ground motions

Thank you!
41 m to the West, within fault zone

At the fault trace

1.8 km to the East, next to cracks