Determining fault slip rates using structure-from-motion photogrammetry

Isaac Bauer, Dr. Eric Kirby, Sydney Maguire, Kirsty McKenzie
Department of Earth, Marine, and Environmental Sciences
THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

Background and Motivation

- The Eastern California Shear Zone (ECSZ) accommodates motion between the Pacific and North American plates [1], with shear distributed among numerous N/NW-striking right-lateral faults [2] (Figure 1).
- The Garlock fault is an **active fault** with poorly understood seismic potential.
- The modern trace has had **earthquakes in the recent past** (thousands of years), with numerous faults adjacent to the Garlock whose **slip history is unknown**.
- In this work, I evaluate the **amount of slip on one such fault using ancient sedimentary deposits** to understand regional seismic hazard.

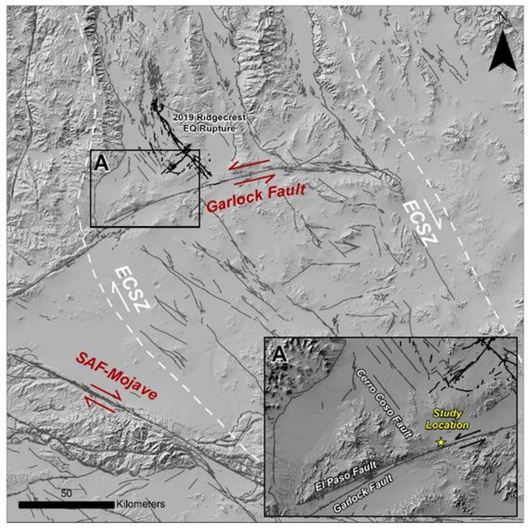


Figure 1: Eastern California Shear Zone terminating against Garlock fault.

Research question: What is the record of ancient earthquakes along a strand of the Garlock fault, in eastern California?

Methods

1) Collected photogrammetric and GPS data during field trip (summer 2023) to construct topographic model (Figure 3).

2) Digitized sedimentary packages and tectonic structures within the model.

3) Measured dip of growth strata by extracting geometries from the 3D orthomosaic.

4) Quantified strike/dip and rotation of strata deformed during faulting.

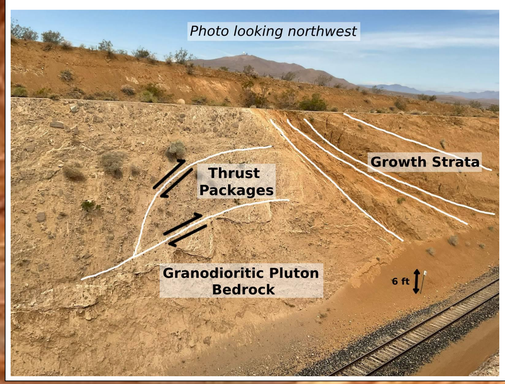
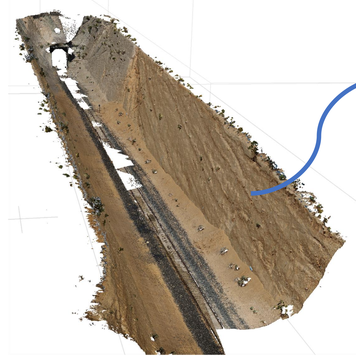


Figure 2: Railroad cut of Garlock fault. Site of summer, 2023 field work.

Results

Strata are progressively tilted and rotated (older units dip more steeply).



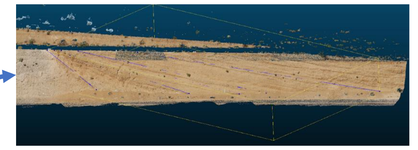


Figure 3: 3D topographic model of fault exposure. Six alluvial fan units are measured.

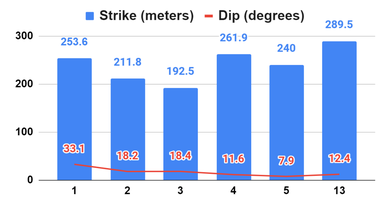


Figure 4: Strike and dip.

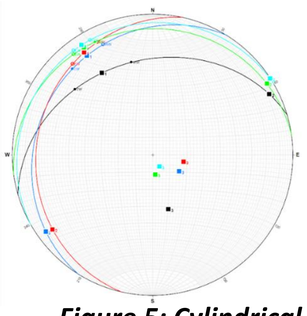


Figure 5: Cylindrical plane of best fit.

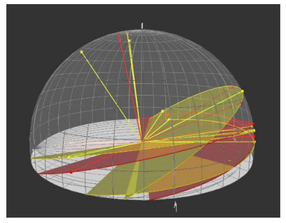


Figure 6: 3D stereonet projection.

Future Work

- By measuring the rotation of these sedimentary units deformed during faulting, the historic rate and strength of faulting along a strand of the Garlock fault is observed.
- **Next steps:** In combination with a burial age of the strata (currently being analyzed) from the cosmogenic isotopes 26Al and 10Be [3], bounds will be placed on the rates of deformation.

References

[1] Meade, B. J., & Hager, B. H. (2005). Block models of crustal motion in Southern California constrained by GPS measurements. Journal of Geophysical Research, 110(B3). https://doi.org/10.1029/2004jb003209

[2] Andrew, J. E., Walker, J. D., & Monastero, F. C. (2015). Evolution of the central garlock fault zone, California: A major sinistral fault embedded in a dextral plate margin. Geological Society of America Bulletin, 127(1-2), 227–249. https://doi.org/10.1130/b31027.1

[3] Bierman, P. R., Bender, A. M., Christ, A. J., Corbett, L. B., Halsted, C. T., Portenga, E. W., & Schmidt, A. H. (2021). Dating by cosmogenic nuclides. In Encyclopedia of Geology (pp. 101-115). Academic Press Oxford