Tectonogeomorphic evidence for late Holocene complex rupture linking the Panamint Valley and Ash Hill faults, Eastern California Shear Zone

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Poster 070

Introduction

- The Eastern California Shear Zone (ECSZ; Fig. 1) has historical evidence for > 7.0 Mw complex multifault ruptures including the 2019 Ridgecrest sequence, 1992 Landers, and 1999 Hector Mine earthquakes.
- Panamint Valley similarly displays paleoseismic evidence for complex rupture in the ~10 km wide transfer zone between the Ash Hill and Panamint Valley faults (Fig. 2, 3).
- We investigate the geometry and kinematic relationships of late Holocene offsets in this transfer zone as a means to understand how rupture may propogate through this transfer zone.

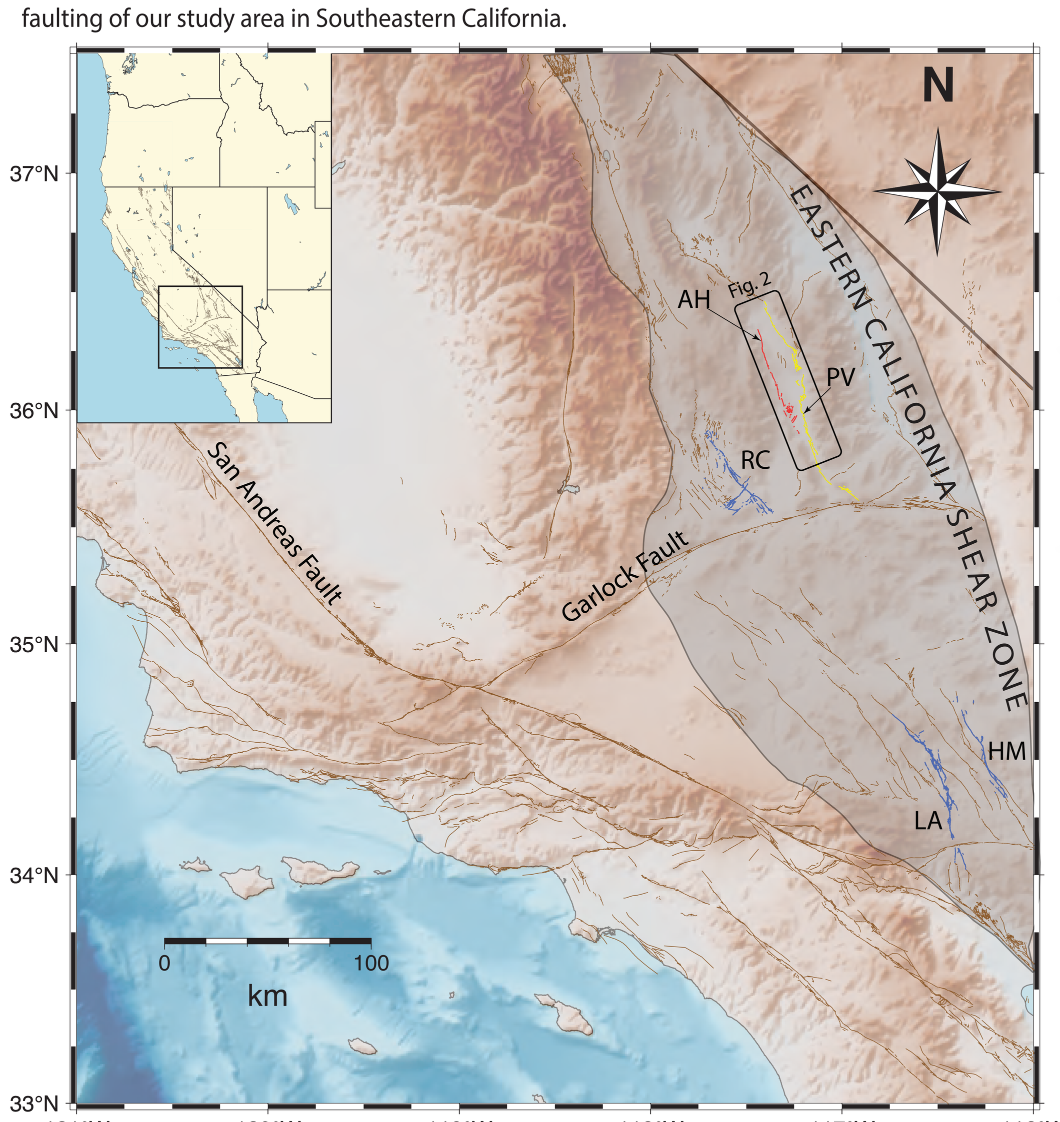
Methods

- 1:4000 scale tectonogeomorphic mapping in 25 km^2 area between the Ash Hill and Panamint Valley faults (Fig. 3)
- Relative dating alluvial fan surfaces using morphology and weathering criteria (see online supplementals).
- Measurement of horizontal and vertical offset of bars, swales and channels from field mapping and LaDiCaoz_v2 backslipped reconstructions of newly generated high resolution (5 cm) drone-based structure from motion digital surface models.

Results

- We have identified 100+ fault strands between ~.15-4.2 km in length
- Faults occur in parallel and en echelon arrays with ~15-250 m spacing
- We classified seven generations of fan units ranging from Qf4 to Qf7y, with three distinct ruptures between Qal and Qf7y, Qf7y and Qf7o, and Qf6y and Qf6o (see online supplementals for full description of surfaces).
- Lateral offsets of geomorphic features range between .5-2.5 m and vertical offsets range between .02-.60 m

Figure 1 (below): Regional faults of Southern California are shown in brown with the Eastern California Shear Zone (ECSZ) highlighted in grey. In this study, we analyze complex and multi-fault rupturing between the Ash Hill (AH; red) and Panamint Valley (PV; yellow) faults. The ECSZ has several historical examples of > 7.0Mw earthquakes including the 2019 Ridgecrest sequence (RC), the 1992 Mw 7.3 Landers (LA), and the 1999 Mw 7.1 Hector Mine (HM) earthquakes (all shown in blue). An inset shows the regional location and faulting of our study area in Southeastern California.



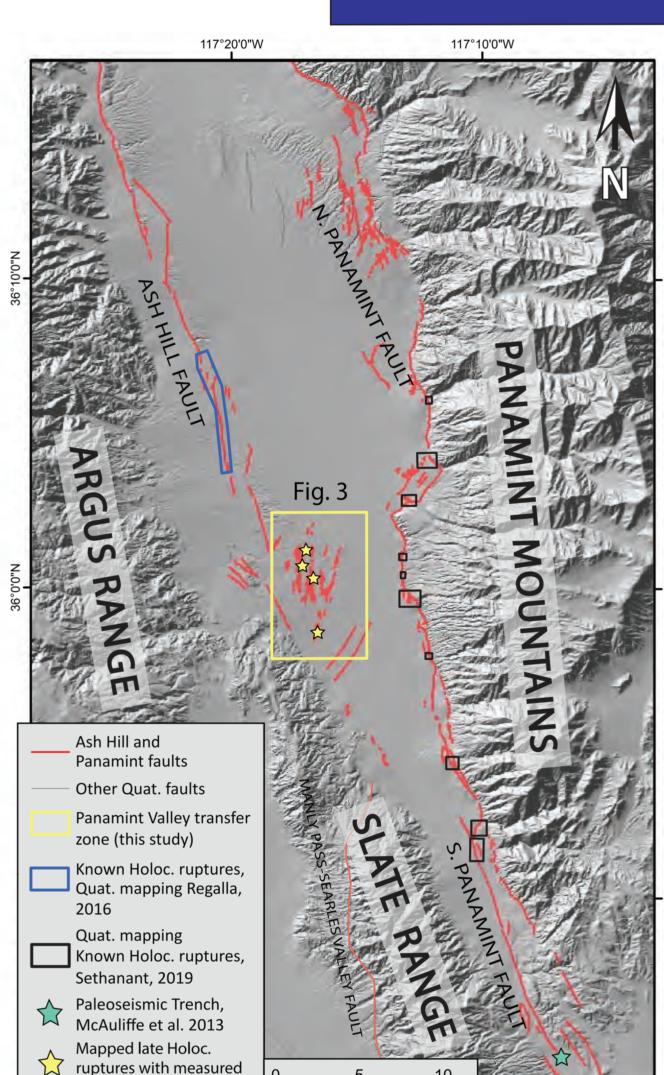


Figure 2 (right): A 10m DEM of Panamint Valley shows locations of Ash Hill, Panamint Valley and Manly Pass-Searles Valley fault systems, complex rupturing in the transfer zone (Fig. 3), as well as relevant previous mapping and trench locations. Our new rupture mapping has identified locations (denoted with yellow stars) where the youngest alluvial fan deposits in the transfer zone are offset by the most recent event (MRE), penultimate and antepenultimate events, and where offsets have been backslipped with LaDiCaoz_v2.

Late Holocene scarps in Panamint Valley display **complex surface rupture**.

Newly mapped ruptures suggest this 10 km wide region acts as a zone for **complex strain transfer** during earthquakes.

For a full description of the study, methods and supplementals, please visit:

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Implications

- Fault scaling relationships dictate that the lengths and offsets of newly mapped ruptures cannot rupture independently of a larger fault zone.
- Newly mapped ruptures must rupture in conjuction with the proximal Ash Hill, Panamint Valley, or Manly Pass-Searles Valley faults.
- Alluvial units that bracket ruptures in the transfer zone have similar morphologies to alluvial units that bracket earthquakes on the Ash Hill and Panamint Valley faults (1-3).
- From our newly mapped ruptures and measured offsets, we propose that this transfer zone has acted as a region for complex strain transfer over multiple earthquake cycles.

Future Work

- We will find absolute dates of offset surfaces to bracket the timing of late Holocene ruptures in the transfer zone.
- We will use measured offsets to quantify fault kinematics in the transfer zone, and compare ruptures to measured offsets from the Ash Hill and Panamint Valley fault zones.

Citations

1. McAuliffe, L.J., Dolan, J.F., Kirby, E., Rollins, C., Haravitch, B., Alm, S., & Rittenour, T.M. (2013). Paleoseismology of the southern Panamint Valley fault: Implications for regional earthquake occurrence and seismic hazard in southern California. Journal of Geophys. Research: Solid Earth, 118(9), 5126–5146. https://doi.org/10.1002/jgrb.50359
2. Regalla, C., Pangrcic, H., Kirby, E., & McDonald, E. (2016). Late Holocene rupture history of the Ash Hill fault, Eastern California Shear Zone. Poster Presentation at 2016 SCEC Annual Meeting.
3. Sethanant, I. (2019) Late Holocene Earthquake History Recorded in Alluvial Fan Sequences, Panamint Valley, Eastern California.

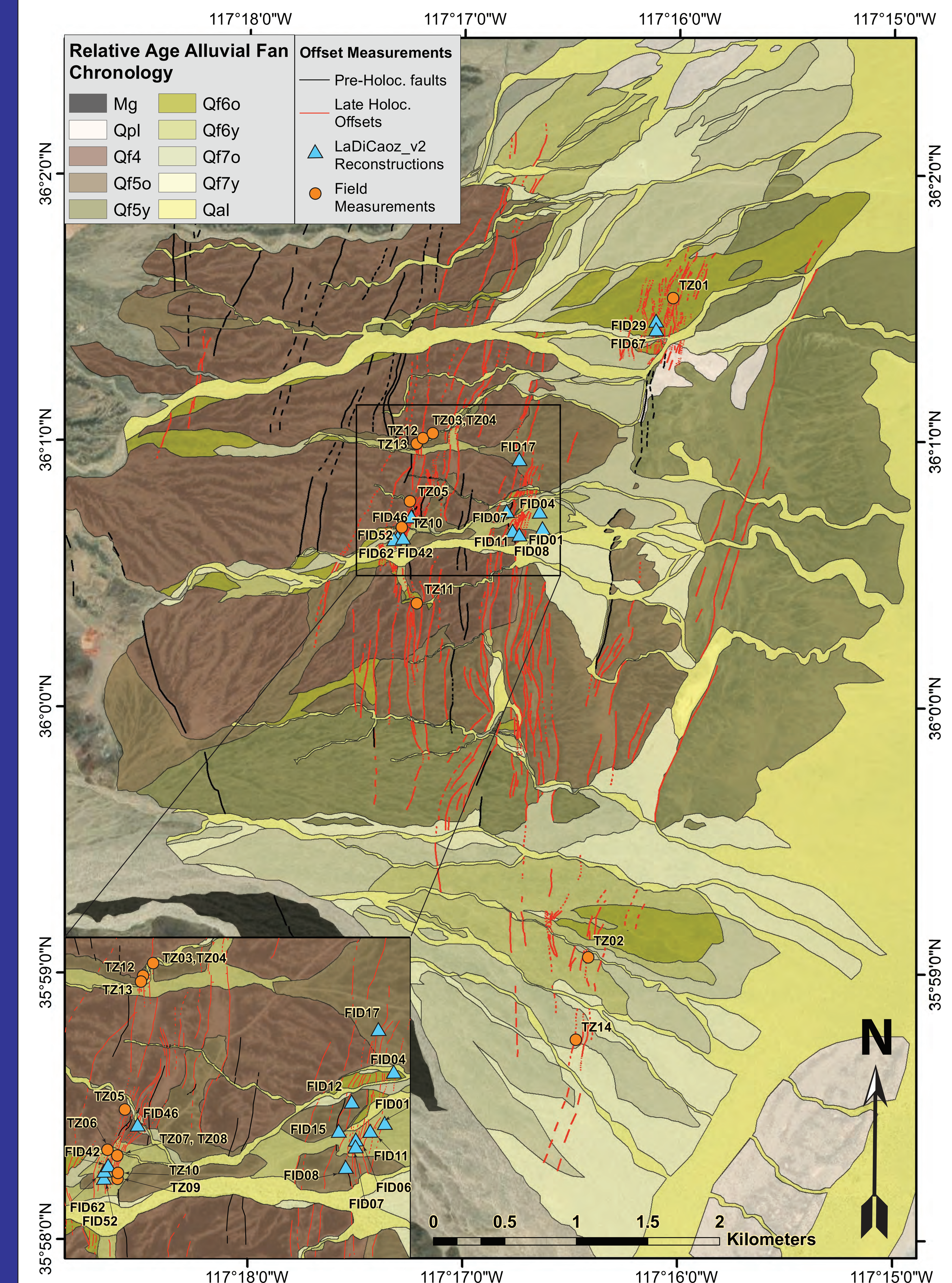

Figure 3: Our newly mapped late Holocene ruptures offset seven generations of fans in the transfer zone, spanning Qf4 to Qf7y, from oldest to youngest, the latter immediately predating Qal. Also shown are Miocene gravels (Mg) and Quaternary playa deposits (Qpl). Modifiers of old and young are used to further subdivide fan groups that are offset by different ruptures. Measured offsets are denoted by an orange circle and the prefix "TZ" if they are a field measurement, and a blue triangle with the prefix "FID" if it was backslipped using LaDiCaoz.

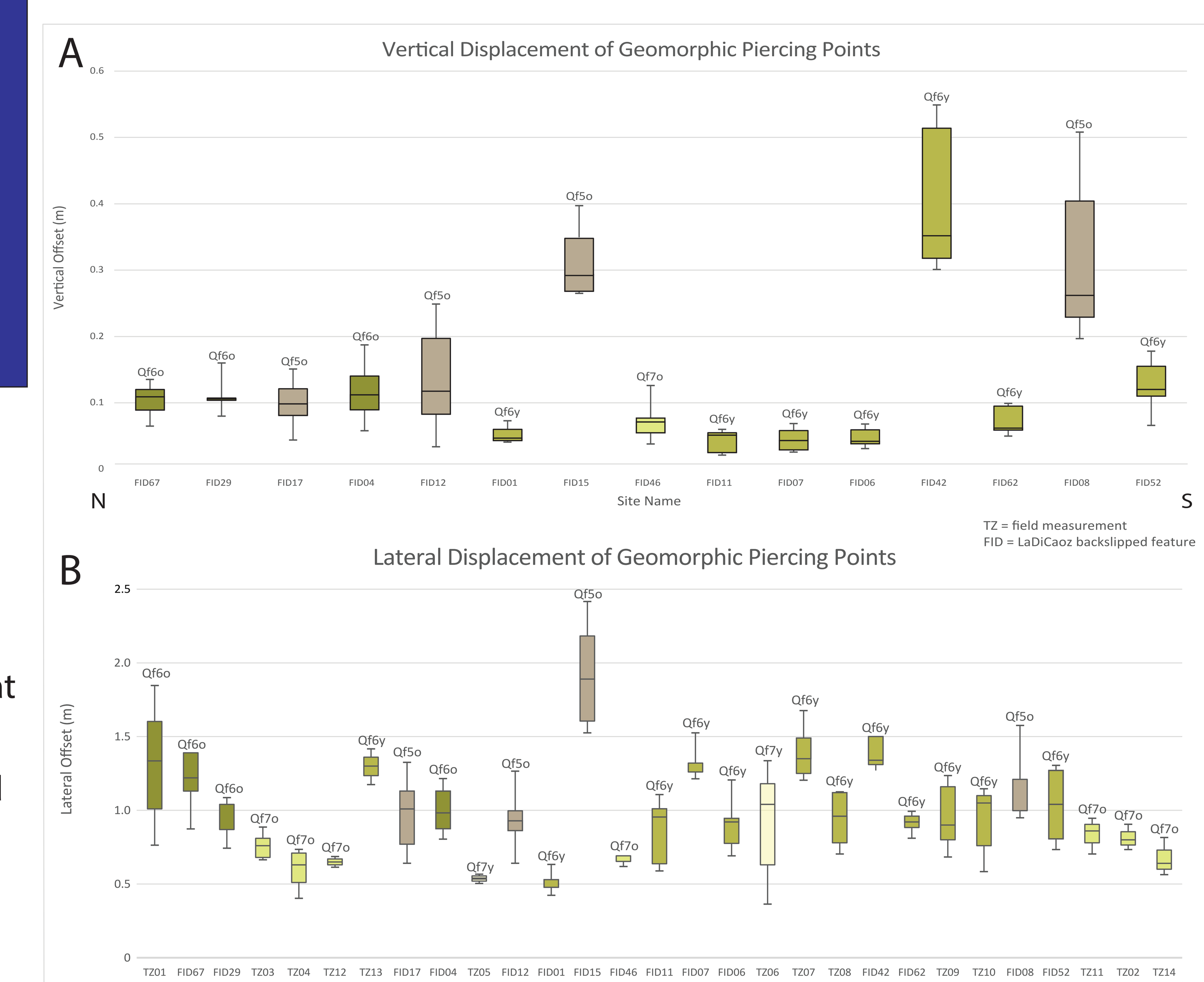

Figure 4: Offsets measured in the field and backslipped in LaDiCaoz are divided by A) vertical displacement and B) lateral displacement. Field measurements have the prefix "TZ" and LaDiCaoz backslipped sites have the prefix "FID". Each measurement is color coded and labeled with the respective unit it offsets as seen in Figure 3. Offsets are arranged left to right from north to south. No field measurements were taken for vertical offset, due to the nature of degradation and alteration of the scarp face making field interpretation difficult using the current methods.

Acknowledgments

Funding for this project provided by the Duebendorfer-Barnes Structure Endowment.