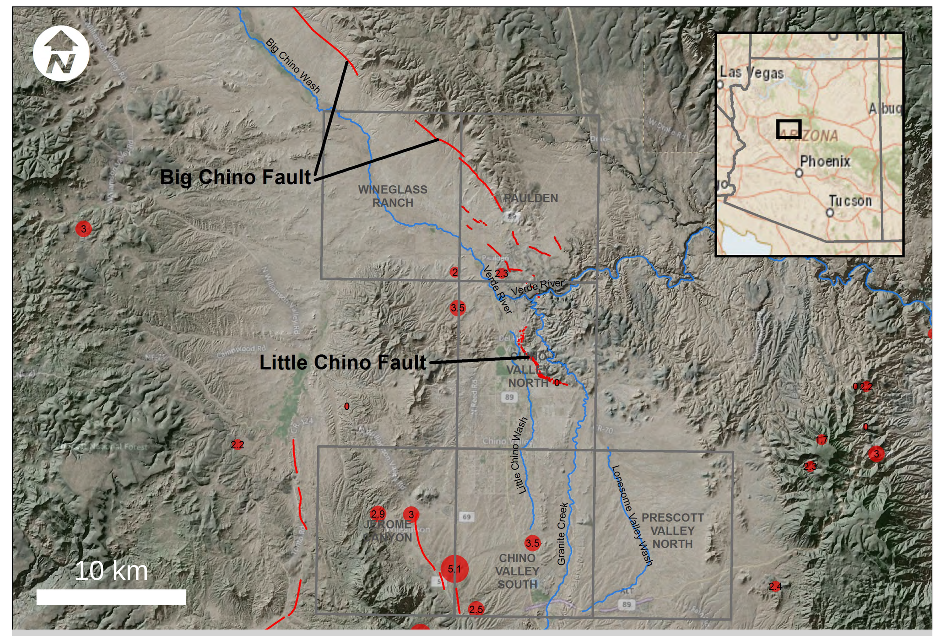
COMPLEXITIES AT THE TERMINUS OF THE BIG CHINO FAULT SYSTEM, NORTH-CENTRAL ARIZONA

Gootee, Brian F., Young, Jeri J., Pearthree, Philip A., and Ferguson, Charles A.
Arizona Geological Survey

ABSTRACT

Recent detailed geologic mapping completed north of Prescott in central Arizona identifies multiple fault scarps extending about 15 km south of the previously mapped terminus of Big Chino Fault. The strike of the fault zone changes from SE along the north side of Big Chino Valley to S along the east side of Little Chino Valley. The pattern of faulting is complex in detail, with orientations ranging from E to SW, but primary fault strikes are SE, SSE, and S. Faults cut primarily Paleozoic carbonate rocks and extensive late Miocene to Pliocene volcanic rocks, but locally, Quaternary alluvial deposits are faulted as well. Surface displacement is variable but generally down to the SW, with the possibility of substantial right-lateral displacement across 2 fault strands. Fault scarps are <10 m high and are fairly gentle, yet appear to have re-oriented local drainage networks and may have affected regional drainage patterns as well. A fortuitous roadcut through a complex fault zone in Little Chino Valley provides insights into the late Quaternary rupture history of these faults. The road cuts entirely through a 10 m-high fault scarp and alluvial ridge. A team of AZGS geologists and volunteers mapped the 80-m long exposure, where we identified 14 individual faults forming a SE-trending graben on the crest of the fault scarp. A stacked sequence of five moderately to weakly developed buried Pleistocene soils records at least 3 individual surface-faulting events with up to 3 m of cumulative vertical displacement across individual faults. A radiocarbon date of 6.5 ka was obtained from charcoal associated with deposits that filled the youngest fault-related graben, suggesting a latest Pleistocene to early Holocene age of youngest rupture. This age estimate is similar to the estimated age of the youngest event for the main Big Chino fault zone, suggesting that the Big and Little Chino fault zones, and the splays between them, may have ruptured in the most recent large earthquake. This increases the length of the fault zone from 50 km to at least 65 km, suggesting that the most recent large earthquake was at least M7.



Regional map of Big and Little Chino Fault zones and other Quaternary faults (red lines). Red dots are relative earthquake epicenters with magnitude values. Data from AZGS Earthquake Catalog.

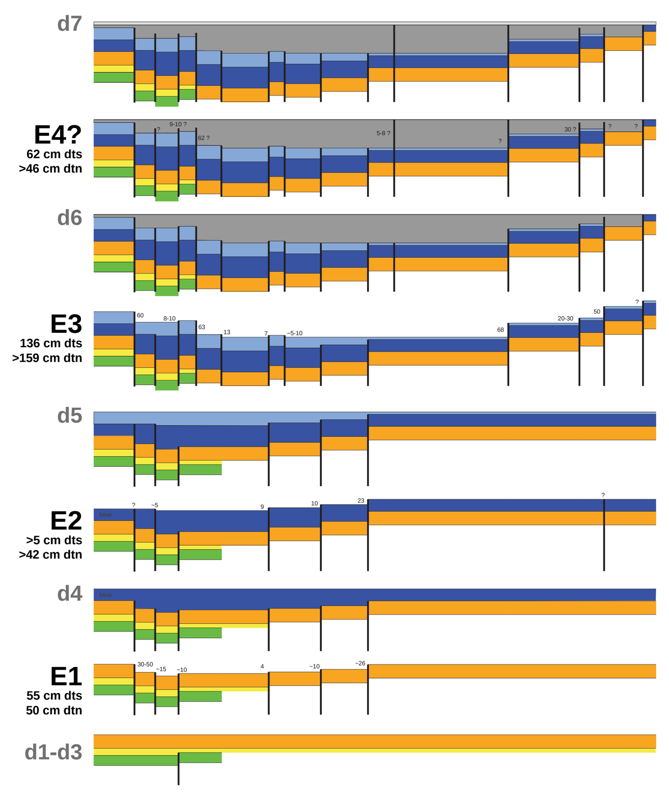
STRATEGY & GOALS

1. Conduct detailed mapping of the Little Chino Fault and eastern Big Chino Fault zone.
2. Utilize the existing roadcut across the Little Chino Fault zone, ~80 meters in length.
3. Conduct paleoseismic analysis with a uniform metric grid, tags for layering and faults, and georeferenced points for surveying and detailed mapping at 1:50 scale.
4. Conduct a total station land survey.
5. Merge surficial geology and micro-topography with the results of roadcut map.
5. Sample for radiocarbon and OSL dating.
6. Determine an age for the most rupture event, and potentially older events and rupture frequency.

RESULTS

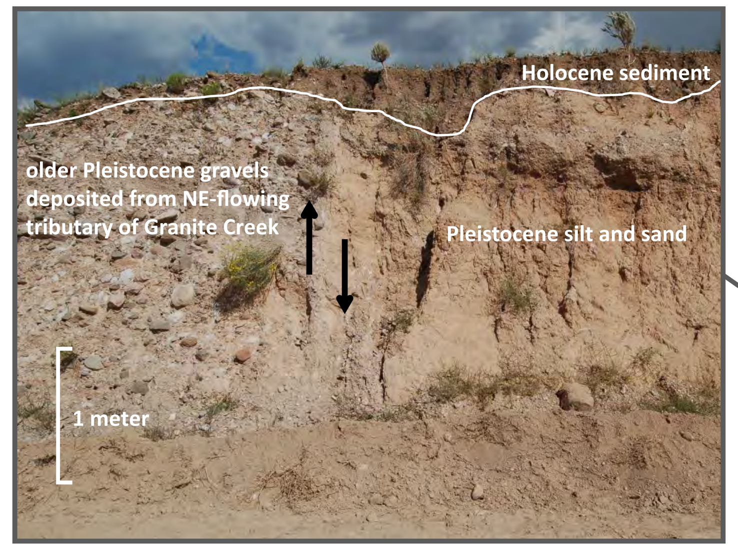
1. At least 5 depositional sequences formed in a graben at the base of a several-meter high fault scarp.
2. At least 3 seismic events recorded, up to five. Ages of minimum and maximum recorded events are currently unknown.
3. Up to 3 meters of cumulative vertical displacement across 14 faults.
4. Youngest soil is at least 6,500 years old.
5. Detailed topographic surveying in the vicinity of the roadcut did not reveal any clear topographic relationship to the faults observed in the roadcut.

EVENT ANALYSIS



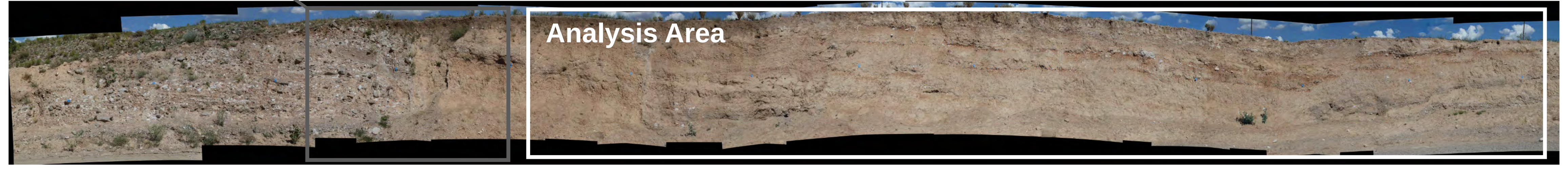
CONCLUSIONS, UNRESOLVED PROBLEMS AND ONGOING WORK

1. Paleoseismic analysis of the 80-meter long roadcut across the Little Chino Fault revealed more complex structures and deposits along the fault zone.
2. The most recent rupture event is at least 6,500 years old, but remains unknown. Further OSL dates are needed to resolve the minimum rupture event and maximum age of deposits exposed. Furthermore, the fact that the graben is topographically relieved may suggest that more recent ruptures are located basinward near the present-day wash. The complexity of faults, graben-deposits and geomorphology of the fault zone raises more questions about the activity and geologic history of the area.
3. To address faulting complexity in a subdued geomorphic landscape, airborne LiDAR would be a valuable tool for further seismic analysis. In addition, ground-based LiDAR is needed to calibrate detailed mapping of the roadcut walls. Additional OSL samples are needed to resolve existing problems with the age of the paleosols.



A major fault juxtaposing Pleistocene alluvial gravels against silt and sand. Holocene deposits do not appear to be offset; however, they fill in an eroded trough into fine-grained deposits. This fault represents an older strand with at least 3 meters of vertical offset, down to southeast, which could not be correlated to younger layers down-dip. This fault also marks the divide between two major tributaries to the Verde River.

PALEOSEISMIC ANALYSIS - Little Chino Fault Zone



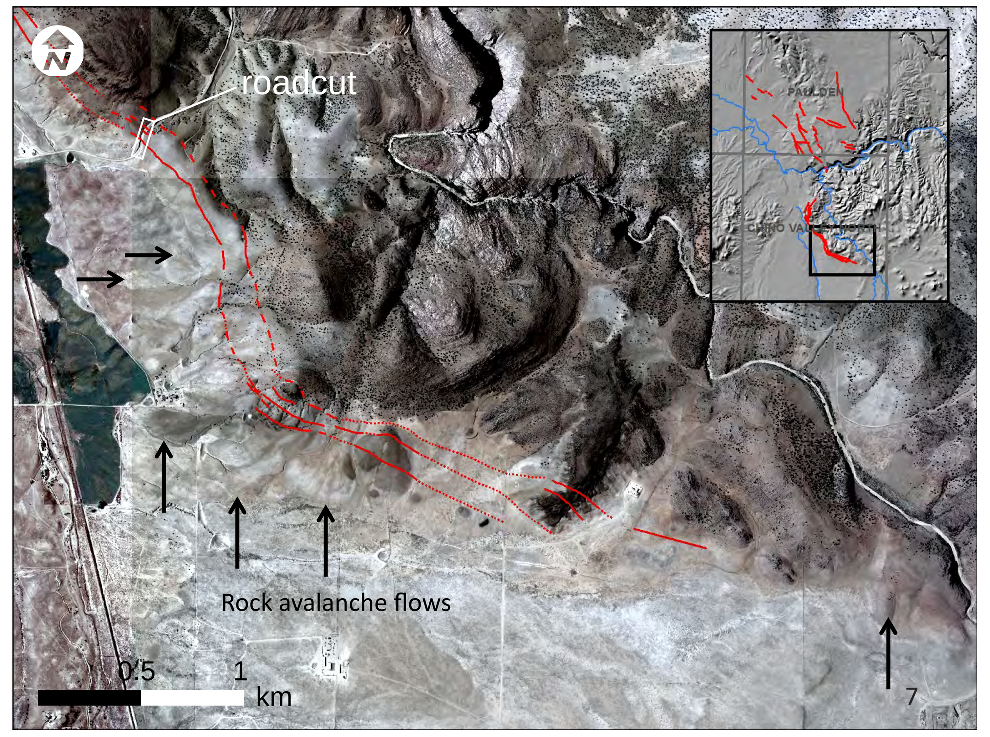
Gigapan photo of the 80-meter roadcut wall, by David Haadad (Arizona State University).

White boarder shows the extent of detailed mapping shown above.

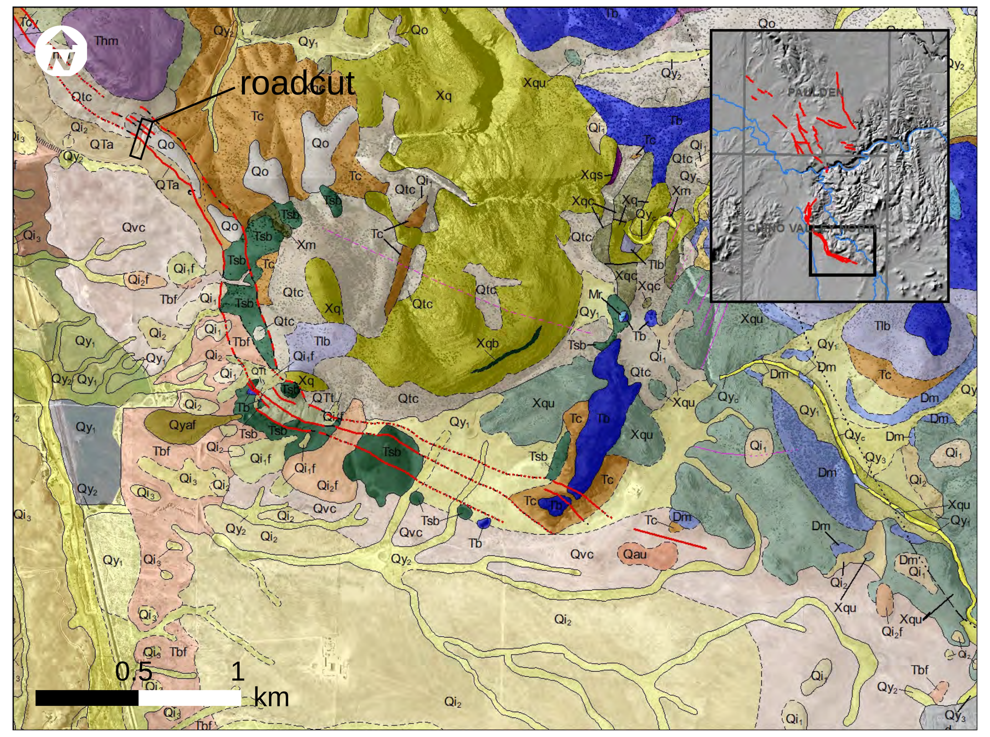
Mapping scale 1:50
View to Southeast

Predominantly massive silt
Predominantly sand
Predominantly sand and gravel
42 Trench 1-meter grid (meters)
OSL-6 Radiocarbon Sample Locations and age in thousand years
OSL Sample Locations and age in thousand years
Fault or fracture, dashed where inferred with vertical displacement in centimeters from adjacent marker horizon
blue/white
Holocene to latest Pleistocene soil development
Paleosol with capping argillic horizon and underlying silt and sand. Color label refers to color flags used on roadcut wall.

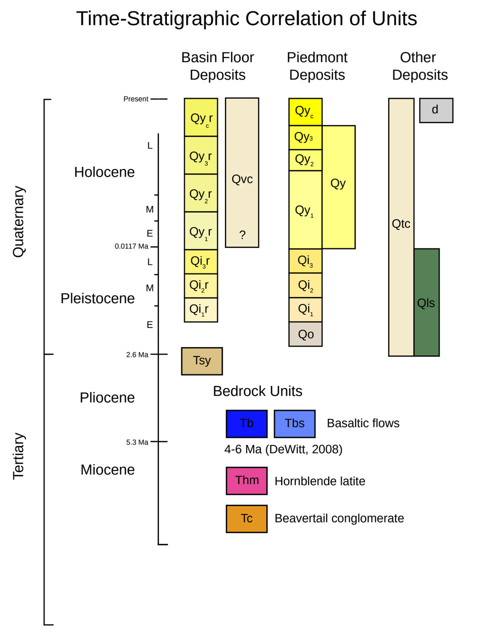
GEOLOGIC MAPPING



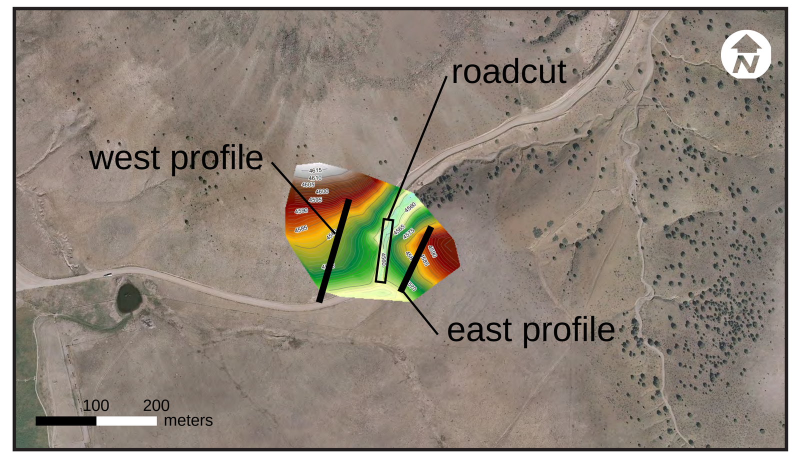
Aerial view of the southern porition of the Little Chino Fault. Fault strands are red, dashed where inquired. Black arrows show rock-avalanche debris flows at the base of Granite Creek hills. See inset for regional location.



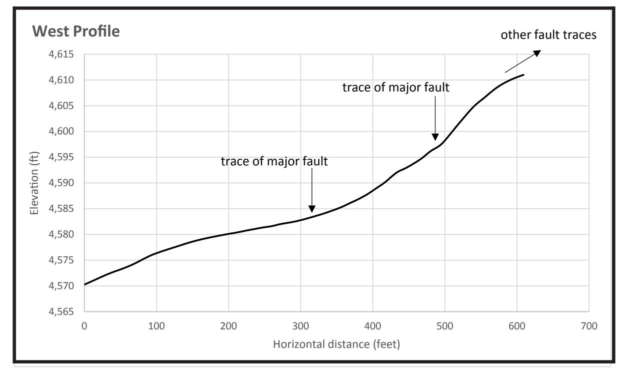
Geologic map superimposed over the same area shown to left, emphasizing Quaternary units in relation to faulting. Legend of mapping units and relative ages to right.



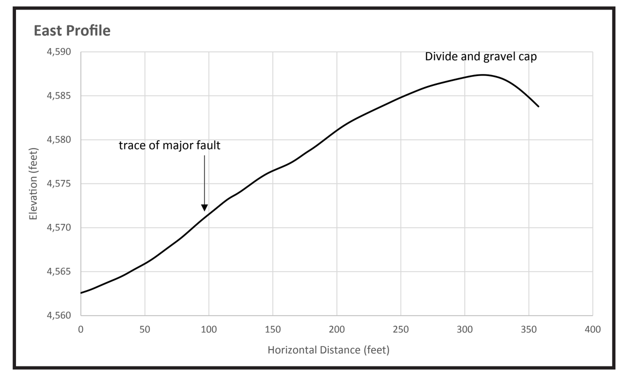
LAND SURVEYING



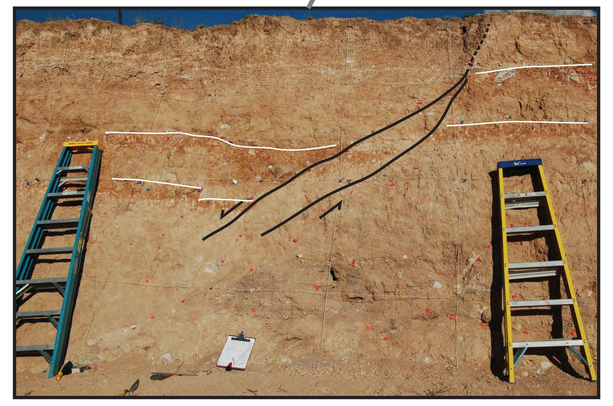
Roadcut across Road 5-North. Topographic survey with 1- and 5-foot (labeled) contours and hillshade base-map. North to top.



Topographic profile west of the roadcut. Data derived from detailed land survey. Profile is mantled with coarse talus derived from Tertiary units upslope.



Topographic profile east of the roadcut showing convex upwards topography. Slope is mantled with colluvium derived from Quaternary early-Pleistocene capping gravels.


Close-up of the southern roadcut wall, with two prominent buried paleosols (white lines). Fault displacement (black line) is ~1.5 meters during one event.

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Additional Resources

1. AZGS Interactive Hazard Viewer (data.azgs.az.gov/hazard-viewer)
2. AZGS Arizona Earthquake Monitoring and Risk Assessment in Arizona: http://www.azgs.az.gov/eq_monitor.shtml
3. YouTube videos of Big and Little Chino Faults, keywords "AZGS, Chino Faults"

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