Southern California Earthquake Center

Final Technical Report

Dekameter-scale geologic structure validation of shallow seismic properties along the San Jacinto fault

November 2018

This project was completed as the MS thesis of Mr. Adam Wade: Adam M. Wade, M.S., Geologic and structural characterization of shallow seismic properties along the San Jacinto Fault at Sage Brush Flat, Southern California. Arizona State University, August 2018.

It is available publicly at: https://repository.asu.edu/items/50609

Abstract:

Theoretical models of earthquake ruptures along a bi-material interface predict asymmetrical damage and preferred rupture propagation direction. The San Jacinto fault zone (SJFZ) in southern California provides an excellent forge for conducting geologic experiments on a young plate boundary, providing invaluable information on fault zone evolution and constraints on earthquake physics. Recent studies using a dense array of dense geophones deployed in a 10 m grid spacing along the Clark strand of the SJFZ at Sage Brush Flat (SGB), produced a high resolution seismic model of shallow fault zone structure and developed new techniques for seismic wave imaging and earthquake detection. We characterized the geology and structure imaged in the SGB dense array based on surface observations to help validate those from the dense array at a similar, dekameter, scale. Dissimilarities in geomorphology on opposite sides of the SJFZ are attributed to structural growth and fault zone damage. Spatial distributions of rock damage within SGB are primarily asymmetric with pulverization dominantly between fault strands or in the NE fault block. Observations from fault perpendicular transects depict an exhumed fault zone with complex structure and secondary high intensity rock damage roughly 70m from the main fault trace. Finally, a synthetic three-dimensional fault zone model illustrates the complexity of the structure at SGB for comparison with dense array seismology products.

Intellectual Merit:

This project contributed to our understanding of the relationship between the geologic structure as observed at the surface and the 3D seismic structure as characterized at depth. It showed that some of the simplified concepts of asymmetric damage may hold but the cumulative geologic history of deformation must be accounted for. Importantly, the work demonstrated a number of geological analyses and approaches which may have broad application for other similar geology-seismology characterizations of high resolution fault zone structure.

Broader Impacts:

This project represented a substantial labor by Mr. Adam Wade and comprised his M.S. thesis. It was part of a broader collaboration with Frank Vernon of Scripps, Yehuda Ben Zion of USC, and Andrea Donnellan of JPL. It provided an important benchmark and framework dataset for the SGB seismological dataset. Numerous papers will come from this work indirectly.

Exemplary figure

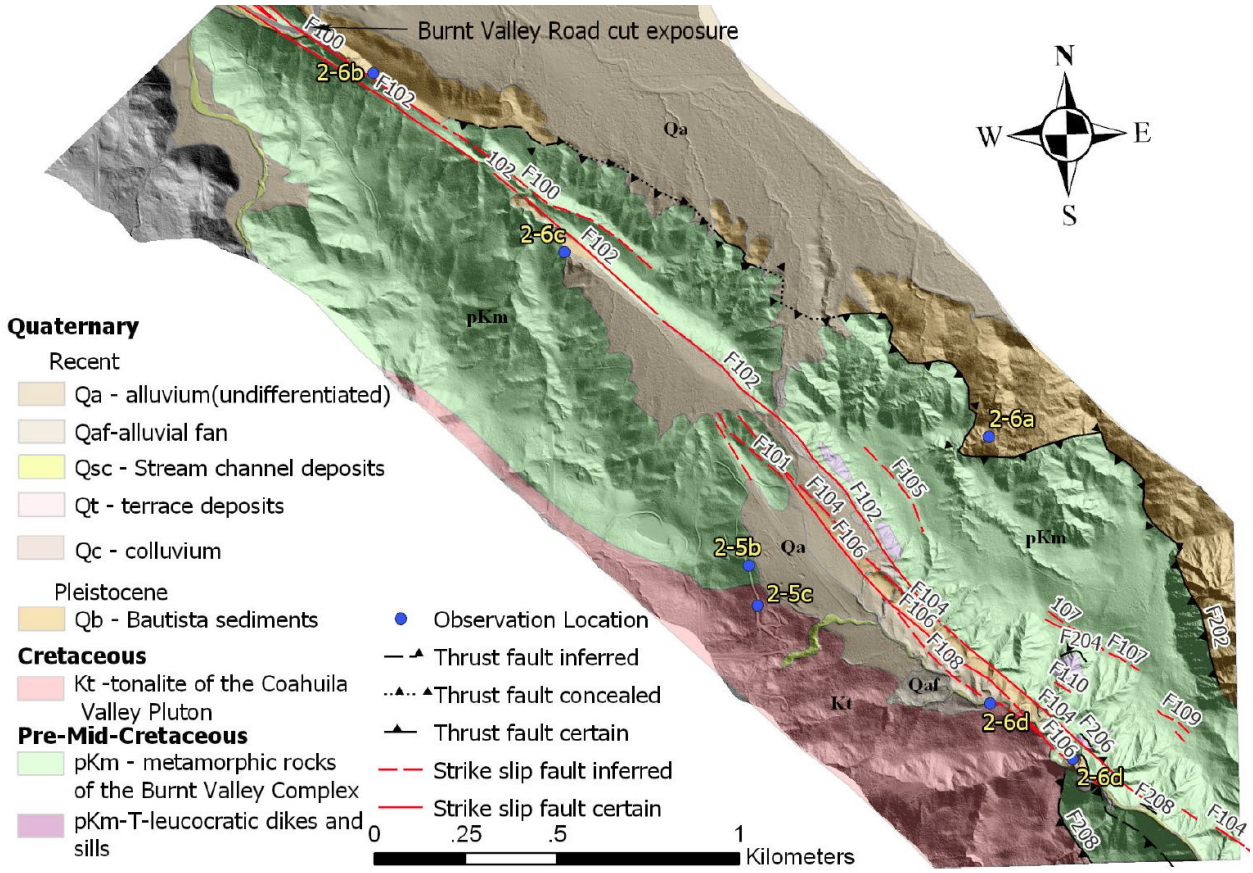

Figure 2-4: Geologic Map of SGB and surrounding areas. B4 hillshade basemap (Bevis et al., 2005) from Burnt Valley Road (NW) to Alkali Wash (SE). Fault trace mapping and nomenclature based on efforts from this study. Blue dots with yellow numbers indicate locations described in text and observed in figures 2-5 and 2-6 of the Wade thesis.

Geologic and Structural Characterization of Shallow Seismic Properties Along The San Jacinto Fault at Sage Brush Flat, Southern California

Abstract	The study of fault zones is a critical component to understanding earthquake mechanics and seismic hazard evaluations. Models or simulations of potential earthquakes, based on fault zone properties, are a first step in mitigating the hazard. Theoretical models of earthquake ruptures along a bi-material interface result in asymmetrical damage and preferred rupture propagation direction. Results include greater damage intensity within stiffer material and preferred slip in the direction of the more compliant side of the fault. Data from a dense seismic array along the Clark strand of the SJFZ at Sage Brush Flat (SGB) near Anza, CA, allows for analysis and characterization of shallow (<1km depth) seismic structure and fault zone properties.... (more)
Created Date	2018
Contributor	Wade, Adam Micahel (Author) / Arrowsmith, Ramon (Advisor) / Reynolds, Stephen (Committee member) / Devecchio, Duane (Committee member) / Arizona State University (Publisher)
Subject	Geology / Geophysics / Geomorphology / Clark Faut / Dense Array / Fault Zone Structure / Rock Damage / Sage Brush Flat / San Jacinto Fault Zone
Type	Masters Thesis
Extent	132 pages
Language	English
Copyright	
Note	Masters Thesis Geological Sciences 2018

Collaborating Institutions	Graduate College / ASU Library
Additional Formats	MODS / OAI Dublin Core / RIS

Full Text

85.0 MB application/pdf

Preview Download Permanent Link

Download Count: 7

Description	Dissertation/Thesis

SGB_Geologic_Map_oversized.pdf

258.3 MB application/pdf

Preview Download Permanent Link

Download Count: 4

Description	Geologic Map of Sage Brush Flat

SGB_SJFZ_3D_Model.pdf

177.9 MB application/pdf

Preview Download Permanent Link

Download Count: 4

Description	3D fault zone model of the SJFZ at Sage Brush Flat