

## **2012 SCEC Progress Report**

**Award #12198:** Building a Holocene slip history for the Mojave section of the San Andreas Fault: Dating offsets near Oakdale and Shoemaker Canyons.

**Principal Investigator:** Dr. Eric Cowgill: UC Davis Geology

**Collaborators:** Dr. Kate Scharer: U.S. Geological Survey, Pasadena, CA; Dr. Ryan Gold: U.S. Geological Survey, Golden, CO

### **Summary:**

To test for possible temporal variation in slip rate and reconcile possible geodetic-geologic rate discrepancies, this project aims to help build a Holocene fault-slip history for the Mojave section of the San Andreas Fault by dating offset streams near Oakdale and Shoemaker Canyons. In detail we are using surficial geologic mapping, topographic data, excavations, and  $^{14}\text{C}$  geochronology to bracket measurements of both channel age and total offset at each site. Although our field studies have been delayed due to changes in personnel, in the last year we 1) obtained NSF funding to date landforms at 8 other sites, 2) constructed a preliminary slip history for the MSAF using Monte Carlo analysis of existing slip-rate data, 3) graduated MS student Tracy Compton, and 4) recruited a new PhD student, Mary Barr, to continue the project. We will conduct reconnaissance fieldwork along the MSAF at the end of March 2013 in preparation for a full season of work in summer 2013. We are currently converting a chapter of Tracy Compton's MS thesis into a manuscript for submission in 2013.

### **Technical Report:**

Measuring histories of fault slip spanning multiple ruptures (e.g., 10-100) has the potential to advance understanding of fault and fault-system behavior, including temporal variations in the rate of strain release. A kinematic model of interacting fault systems in southern California (Dolan et al., 2007) and long paleoseismic records along the Mojave section of the San Andreas Fault (MSAF, Weldon et al., 2004) suggest temporal variations in strain release. However, reported offset data along the MSAF are too sparse to determine of such variations characterize the Holocene record of slip along the MSAF.

For 2012 we proposed to obtain slip rates at 2 sites along the MSAF to support an NSF proposal to investigate the full Holocene slip history by determining slip rates at 8 additional sites. Our proposed field studies have been delayed due to the graduation of MS student Tracy Compton. However, we have made the following progress:

1. In January 2012 we submitted a successful NSF proposal to investigate 8 other potential slip-rate sites previously identified with support from 2011 SCEC award #11061. The NSF award started in September 2012 and does not duplicate funding for our work at the Oakdale and Shoemaker

Canyons, which is supported by SCEC award 12198. We anticipate conducting fieldwork at these 2 sites with support from the current SCEC award in 2013.

2. In winter 2012, Tracy Compton worked with USGS collaborator Kate Scharer to compile and review existing slip-rate data from along the MSAF (Table 1). Tracy then traveled to Colorado to work with USGS collaborator Ryan Gold to analyze these data using his Monte Carlo method for slip-history analysis (Gold and Cowgill, 2011). The analysis yielded both a long-term average rate for the MSAF and a preliminary slip history (Figure 1).
3. In August 2012, Tracy Compton completed her MS thesis at UC Davis prior to starting work at consulting firm AMEC Geomatrix. For her thesis Tracy used virtual-reality based analysis of B4 lidar data to identify 60 potential slip rate sites along a 100-km-long section of the MSAF, generated preliminary surficial geologic maps and reconstructions at 10 of these sites, and then used Monte Carlo methods to analyze published slip-rate data and determine a preliminary slip history for the MSAF.
4. In September 2012, 1<sup>st</sup>-year PhD student Mary Barr, started work with Eric Cowgill to continue the project after the departure of Tracy Compton. During fall quarter, Tracy worked 1 day a week to help transition the project to Mary. To date Mary has focused on conducting her own remote mapping and site reconstruction in advance of fieldwork at Oakdale and Shoemaker Canyons in spring/summer 2013. Mary and Eric will conduct reconnaissance fieldwork along the MSAF at the end of March, to help prepare for a full season of work this summer.

### **Intellectual Merit**

Together with the NSF study, this work will provide the first Holocene slip history for a section of the San Andreas fault and allow us to test for secular variation in slip that should be observed if slip switches between major fault systems in southern California. Documenting short-term changes in slip rate would lead to a re-evaluation of the timescales at which deformational processes operate in the crust and mantle across this 1000 km wide system. Through this project we will continue to develop alternative methods for obtaining and analyzing records of seismic strain release along faults, thereby expanding the repertoire of tools available for neotectonic analysis. For example, this work should allow us to further develop our understanding of the type of topographic settings that make for particularly good (or bad) slip-rate sites.

### **Broader Impacts**

This SCEC project, along with project #11061, supported the MS thesis research for graduate student Tracy Compton. It will also support thesis research at Oakdale and Shoemaker Canyons by new PhD student Mary Barr. In addition, it

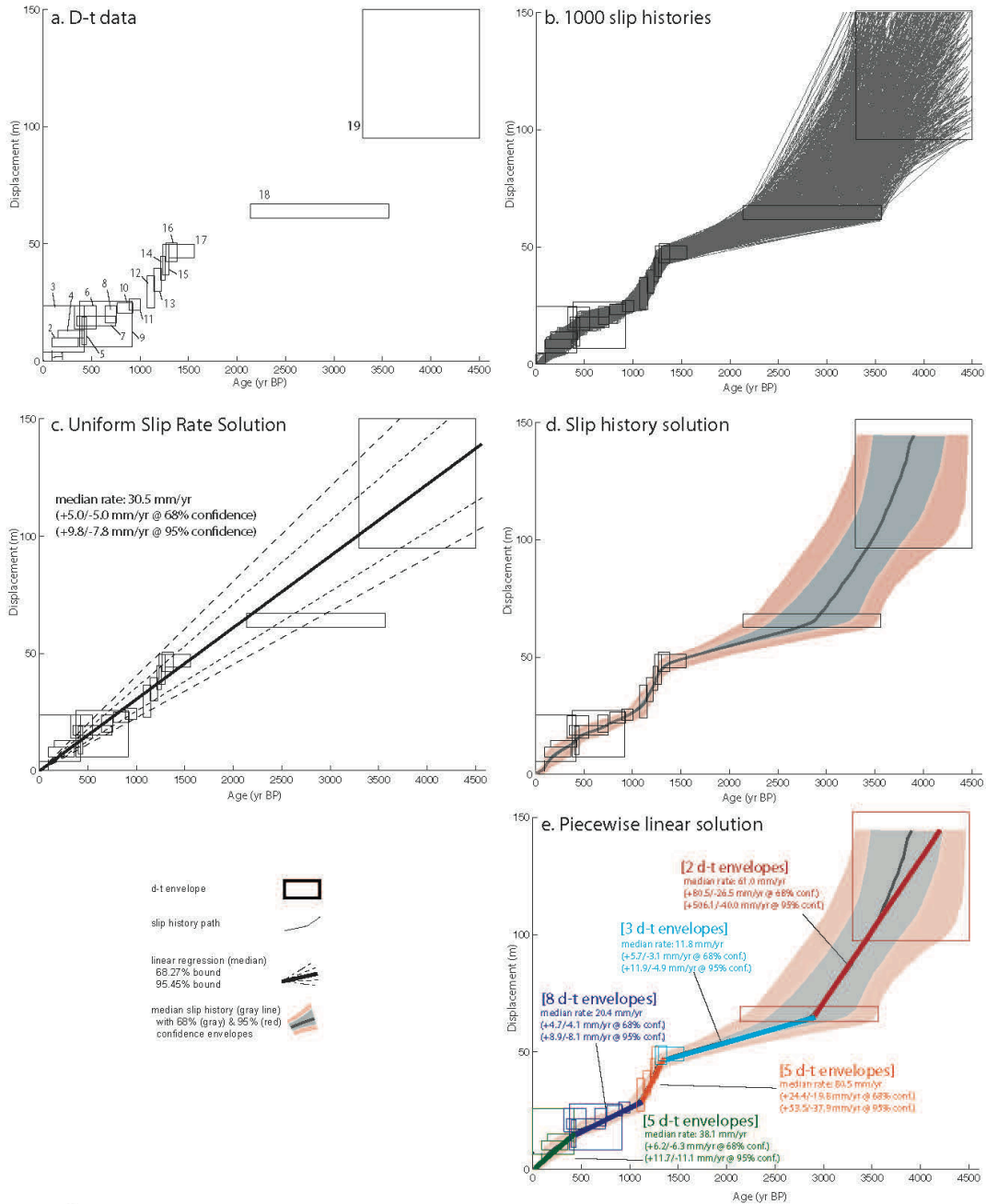
continues to strengthen collaborative partnerships between researchers at UC Davis (PI Cowgill and student Mary Barr) and those at the USGS (Kate Scharer and Ryan Gold).

**Bibliography:**

PI Cowgill is currently converting a chapter of Tracy Compton's MS thesis into a manuscript for submission in 2013. In addition Tracy Compton presented her work at the 2012 SCEC annual meeting and the Fall 2012 AGU meeting:

Compton, T., E. Cowgill, K. Scharer, R.D. Gold, R. Westerteiger, T. S. Bernardin, and L.H. Kellogg, 2012, Preliminary Holocene history of fault slip for the Mojave section of the San Andreas fault: Abstract T13D-2640 presented at the 2012 Fall Meeting, AGU, San Francisco, CA.

## 0 - 4.5 kyr, 2-sigma



**Figure 1:** Preliminary fault-slip history for the Mojave section of the San Andreas Fault (MSAF) from present day to 4.5 ka derived from Monte Carlo analysis of existing slip-rate data. **A)** Plot showing previously reported slip-rate data; each box shows the extent of uncertainties in both displacement and age for an individual faulted marker. Numbers correspond to studies listed in Table 1. **B)** Model paths showing 1000 slip-rate histories generated by the Monte Carlo analysis. **C)** Uniform slip rate solution fit to the 1000 model paths, with a median

rate of  $\sim 32 \text{ mm yr}^{-1}$  (solid center line). The shorter dashed lines represent the  $\sim 68\%$  confidence bounds, the longer dashed lines represent the  $\sim 95\%$  confidence bounds. **D)** Slip-rate history derived by contouring the 1000 model paths using a geometric mean linear least square regression showing  $\sim 68\%$  (blue) and  $\sim 95\%$  (red) confidence bounds from the median (black line). **E)** Interpreted piecewise linear solution results in five defined changes in slip rate with three fast periods (4.5 to 2.9 ka, 1.5 to 1.1 ka, and 0.4 ka to 1857) and two slow periods (2.9 to 1.5 ka and 1.1 to 0.4 ka). Figure from Compton (2012).

**Table 1: Slip-rate data used in the Monte Carlo analysis**

Site name	Box # <sup>1</sup>	Source
Frazier Mtn	3	Scharer pers com; Scharer et al., 2008
Frazier Mtn	9	Scharer et al., 2011a
Oak Flat <sup>2</sup>	Outlier	Rust, 2005
Ritter Ranch	18	Weldon et al., 2009
Littlerock	19	Weldon et al., 2008; Weldon et al., 2009
Littlerock	4	Pruitt et al., 2009; Weldon et al., 2009
Littlerock <sup>2</sup>	Outlier	Pruitt et al., 2009; Weldon et al., 2009
Pallett Creek	6	Salyards et al., 1992; Scharer et al. 2011b
Pallett Creek/ Wrightwood	1	Sieh, 1978; Weldon et. al., 2004
Wrightwood	5	Weldon et al., 2004
Wrightwood	7	Weldon et al., 2004
Wrightwood	10	Weldon et al., 2004
Wrightwood	11	Weldon et al., 2004
Wrightwood	12	Weldon et al., 2004
Wrightwood	13	Weldon et al., 2004
Wrightwood	14	Weldon et al., 2004
Wrightwood	15	Weldon et al., 2004
Wrightwood	16	Weldon et al., 2004
Wrightwood	17	Weldon et al., 2004
Wrightwood	2	Weldon et al., 2004
Wrightwood	8	Weldon et al., 2004; Scharer et al., 2011b; Weldon et al., 2002

<sup>1</sup> Numbers correspond to envelope labels on Figure 1.

<sup>2</sup> Indicates outlier slip-rate observations that were excluded from the Monte Carlo analysis

## References:

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