Behavior of the San Andreas fault over the last 5000 years: Wrightwood's clues and questions

Kate Scharer
Assistant Professor, Department of Geology
Appalachian State University

In a recent editorial, Seth Stein wrote: "[W]e still don't know the most basic question about earthquake recurrence: whether it's time-dependent or time-independent." (Seismological Research Letters v. 77, no. 3, 2006) Recent paleoseismic studies of the southern San Andreas fault are improving our ability to answer this basic question. At the Wrightwood paleoseismic site on the southern San Andreas fault, we* have excavated over 40 trenches into a small (200 x 400 m) marsh that is periodically covered by debris flow deposits. The depositional and structural setting of the site preserved a high-resolution record of ground-deforming earthquakes on the San Andreas fault for the last 5,000 years. Within this period, we have documented approximately 40 paleoearthquakes, but most of our effort has focused on two periods: the "young section" from present to 500 CE and the "old section" from 1500 to 3000 BCE. Additional work is required to unravel the stratigraphy and date the sediments of the intervening "middle section" before an earthquake series can be evaluated. However, concerning the two well-studied sections, we have shown that both sections contain about the same number of earthquakes (14) in the same amount of time (1500 years), indicating there is no material change in the average recurrence rate over a time span that is significantly longer (>25 times) the average recurrence interval.

Using nonparametric statistical tests, we have begun to evaluate rate changes in the earthquake series that explore the time-dependence or independence of the fault. We examined the chronologies separately and in combination and explored the robustness of the results by including or excluding earthquakes that have less compelling expression in the trenches. Importantly, we found that due to the length of the series, stable estimates of recurrence parameters can be obtained even when the exact membership of the earthquake series is unknown. One test compares the periodicity of the earthquake series to the null pattern, a random (Poisson) series. This test showed that the old record is more regular than the younger. When the two periods are combined, 88 to 99% of the tests are too regular to result from a random distribution at the 80% confidence limit.

The results imply an underlying regularity to the recurrence pattern that is consistent with the calculated lognormal variance of ~0.62 (0.49-0.92). This work directly answers the "basic question" - at least for one location on one long fault. Paleoseismic slip-per-event data and additional long series – on the San Andreas and elsewhere – are necessary to explore wider questions about fault behavior.

*Ray Weldon, Tom Fumal, Glenn Biasi, and the author are principal authors of various published papers about the site.