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Recurrence of Large Earthquakes on the San Andreas Fault, California

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Over two decades of trenching studies at the Wrightwood, California paleoseismic site provide a unique opportunity for testing earthquake recurrence patterns and uncertainties intrinsic to paleoseismic data. The site is located on a small debris fan that covers the San Andreas fault, where the depositional record alternates between black organic-rich marsh-like deposits and tan debris flow deposits. Clear stratigraphic contacts allow identification of great evidence of earthquakes based on faulting, fissuring, and growth strata relationships produced during progressive folding. The published record includes a total of 29 earthquakes and is complete for two periods, 5000 to 3500 BP and 500 BP to present. Although every effort was made to correctly identify all ground-rupturing earthquakes, including multiple exposures of complicated structures, detailed examination of stratigraphic evidence of past ruptures, and objective measures of the quality of earthquake evidence, the structural setting and depositional history of a site can still contribute uncertainty in a paleoseismic record. We used non-parametric tests to differentiate random behavior from periodic or clustered behavior on 23 alternate records to explore the consequences two aspects of geologic uncertainty. To explore possible over-interpretation of the record, we removed up to three earthquakes which were categorized as possible due to lower quality evidence. To explore the possibility of missed earthquakes, we added five hypothetical earthquakes to periods in which low sedimentation rates could attenuate earthquake evidence. All variations to the master record were more periodic than would be expected from a random (Poisson) distribution at the 80% confidence level, and showed no evidence of clustering. These results are consistent with estimates of the coefficient of variation for Wrightwood and new radiocarbon dates from the nearby Pallett Creek paleoseismic site (~0.68). Taken together, these results indicate that earthquake recurrence on the Mojave section of the San Andreas fault is quasi-periodic, and should be modeled with a time-dependent renewal model.