Do geology and seismology tell consistent stories about earthquake rates?

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Evidence for quasi-periodic recurrence in California comes largely from paleo-seismic data. A team of experts compiled the most reliable data for use in the third Uniform California Earthquake Rupture Forecast (UCERF3). They reported dates of observed displacements at 32 sites on 13 named faults in California. There is a problem: recorded paleo-seismic events ceased at about the beginning of the instrumental seismic era, inconsistent with inferred paleo-event rates.

Corrected for multiple-site ruptures, the total reported paleo-event rate is about 0.04/year. Yet the most recent paleo-event date is 1916. Such a long hiatus is extremely unlikely for a Poisson process and even less probable for an ensemble of quasi-period processes.

Possible explanations for the discrepancy include (1) extreme luck, (2) unexplained regional fault interaction, or (3) mistaken identification of near-surface displacements as evidence of large earthquakes. The first can be rejected with 99% confidence. There is no evidence for the second in the pre-1916 paleo-seismic history nor in any theoretical models yet reported. The third could explain the observed quiescence because mistaken identity would be prevented by instrumental seismic data. In any case the paleo-event recurrence rates can’t be trusted for the next century because they fail the last one.

A separate problem is the assumption that seismic moment rate can be inferred from surface deformation data. Seismic moment rate depends on earthquake rate at the completeness magnitude, the b-value, and the upper magnitude limit. The earthquake rate may vary with time, and the upper magnitude limit is poorly known. The tectonic moment rate inferred from surface deformation depends on slip- or strain rate, rupture contact area, effective rigidity, and coupling, most of which are poorly known. The equality of seismic and tectonic moment rates has never been verified anywhere.

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