

# STRUCTURAL MATURITY OF FAULTS AND HOW IT MAGNITUDE-FREQUENCY DISTRIBUTION AND THE PREDICTABILITY OF EARTHQUAKES

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It is well known that structural barriers impede earthquake rupture propagation and by that affect maximum earthquake size as well as overall seismic behavior of the respective fault. Sustained accumulation of slip along a fault on the other hand progressively degrades those barriers, promoting changes in maximum earthquake size and seismic behavior as the fault structurally matures. The prevailing difficulties in formulating general models that constrain earthquake recurrence time and size distribution are at least partially linked to structural maturity which varies practically from fault to fault.

Using quasi-static numerical earthquake simulations, we investigated the effect of fault roughness --as proxy for structural maturity-- on earthquake recurrence characteristics, magnitude-frequency distribution and along-fault slip accumulation patterns for strike-slip faults. Based on a large set of synthetic seismic records, we find that bimodality in magnitude frequency distribution --the largest earthquakes occurring more frequent than anticipated from the Gutenberg-Richter relation-- is tightly linked to the structural maturity of a fault: Bimodality, the size of the largest earthquakes, and their contribution to seismic moment release increases as fault roughness decreases. We further find that slip at a point along the fault is generally variable. Simulations suggest that this variability becomes increasingly systematic as the fault matures. Based on these observations and supported by paleoseismic data we propose that previously presented earthquake recurrence models describe the seismic behavior of faults with different structural age and fault-system complexity. The predictability of the largest earthquakes evolves with structural maturation--major earthquakes along spatially isolated faults exhibit inherent periodicity. These findings may help to improve assessments of potential size and recurrence statistics of future earthquakes.

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