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## The probability of large earthquakes cannot be calculated from seismicity rates

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The hypothesis that extrapolation of the Gutenberg-Richter (GR) relationship allows estimates of the probability of large earthquakes is incorrect. For nearly 200 faults for which the recurrence time,  $T_r$  (1/probability of occurrence), is known from trenching and geodetically measured deformation rates, it has been shown that  $T_r$  based on seismicity is overestimated typically by one order of magnitude or more. The reason for this is that there are not enough earthquakes along major faults. In some cases there are too few earthquakes for the fault to be mapped based on seismicity. Some examples are the following rupture segments of great faults: the 1717 Alpine Fault, the 1856 San Andreas, the 1906 San Andreas, the 2001 Denali earthquakes, for which geological  $T_r$  are 100 years to 300 years and seismicity  $T_r$  are 10,000 to 100,000 years. In addition, the hypothesis leads to impossible results when one considers the dependence of the b-value on stress. It has been shown that thrusts, strike-slip and normal faults have low, intermediate and high b-values, respectively. This implies that, regardless of local slip rates, the probability of large earthquakes predicted by the hypothesis is high, intermediate and low in thrust, strike-slip, and normal faulting, respectively. Measurements of recurrence probability show a different dependence: earthquake probability depends on slip rate. Finally, the hypothesis predicts different probabilities for large earthquakes, depending on the magnitude scale used. For the 1906 rupture segment, the difference in probability of an M8 earthquake is approximately a factor of 50, using the two available catalogs. Various countries measure earthquake magnitude on their own scale that is intended to agree with the  $M_L$  scale of California or the  $M_S$  scale of the USGS. However, it is not trivial to match a scale that is valid for a different region with different attenuation of seismic waves. As a result, some regional M-scales differ from the global  $M_S$  scale, which yields different  $T_r$  for the same  $M_{max}$  in the same region, depending on whether the global or local magnitude scale is used. Based on the aforementioned facts, the hypothesis that probabilities of large earthquakes can be estimated by extrapolating the GR relationship has to be abandoned.