Current frontiers in spatio-temporal b-value analysis

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The frequency-size-distribution of earthquakes, characterized by the b-value in the Gutenberg-Richter law, has been documented for its variation in space and time. In many examples it could successfully be related to physical parameters such as stress concentration in asperities or high pore pressures in geothermal regimes. A generically observed depth gradient supports the laboratory-based hypothesis of b-values being inversely dependent on differential stress, which is equally reflected in significant variation between observed b-values for different faulting styles. Temporal variation is more difficult to detect robustly since it is easily biased by spatial activation heterogeneity. However, retrospectively detected b-value decreases before large events have been documented on scales ranging from few days to decades, while post-mainshock significant increases of b-values especially in the highest slip patches have been observed.
Here, we present an overview of some of the latest advances in studying patterns in the size distribution. In these examples from different regions of the world, including the subduction zones around Japan, we bridge various scales: from the smallest detected events to the giant megathrust earthquakes, from large-scale tectonic imprints to local heterogeneity along active faults, from temporally stable to time-varying patterns, from individual sequences to generic aftershock characteristics, from linear frequency magnitude distributions to those not following Gutenberg-Richter scaling, from low-b-focus to implications of observing very high b-values, from interpreting patterns in terms of physical processes to estimating future rupture potential.
Reliable b-value analysis is critically dependent on monitoring capabilities and homogeneous reporting of events. We demonstrate that improvements in this field are worthwhile: spatio-temporal b-value analysis has the potential to improve real time seismic hazard assessment and additionally provides many insights to advance the qualitative understanding of physical conditions and mechanisms.

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