Intracontinental Earthquakes: Complex Spatio-temporal Patterns and Implications for Hazards

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Large intracontinental earthquakes show complex spatio-temporal patterns that do not fit existing earthquake models. Individual faults or fault zones tend to fall into long term (thousands of years or longer) dormancy after a burst of ruptures, whereas large earthquakes seem to roam between widespread faults. These behaviors are characteristic of complex dynamic systems of interacting faults. In such systems, widespread faults collectively accommodate slow tectonic loading; a major fault rupture both transfers stress to neighboring faults and perturbs loading conditions on distant faults. Because of the slow tectonic loading, local stress variations from fault interaction or nontectonic processes, or changes of fault strength could trigger intracontinental earthquakes. The resulting seismicity renders some commonly used concepts such as seismic cycles, recurrence intervals, characteristic earthquakes, and seismic gaps inadequate or irrelevant in intracontinental settings and calls for rethinking of the probability estimates based on these concepts. It requires a paradigm shift in approaches of studying intraplate earthquakes. Instead of focusing solely on the balance of tectonic loading and yield strength of individual faults or fault segments, we need to understand mechanical interactions between different fault segments and among all faults in a seismic zone or a tectonic region over multiple temporal scales. Although this approach does not promise short-term earthquake prediction on individual fault, it could allow for better forecasting of long-term seismicity of fault systems and therefore improve hazard assessment.