

The 2008 Wenchuan earthquake and advances in earthquake science

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Objectives: The 2008 Wenchuan earthquake occurred in the time interval from 2004 to 2016 during which there was a surge of very large earthquakes around the world and mature deployments of large seismological, geodetic and tsunami monitoring networks. The resulting unprecedented data and new modeling methods have advanced our quantification of large earthquakes significantly.

Methods: The 2008 Wenchuan earthquake involved complex faulting that has been resolved using a combination of seismological, geodetic and geological observations in many research efforts. There is consistency in primary features of many models and the basic rupture characteristics are now quite well resolved. This event is one of a large number of global earthquakes that occurred over the past 15 years for which such analyses, sometimes also including tsunami observations for offshore events, have resulted in time-varying finite-fault rupture models. Given this rigorous characterization of rupture process of multiple large events, it is possible to determine scaling behavior and to assess influences of regional variations. The results for the 2008 Wenchuan event are compared with those for other large events, primarily in subduction zones, focusing on differences in tectonic setting.

Results: The Wenchuan rupture involved multiple thrust fault mechanisms in the southwest transitioning to dextral strike-slip to the northeast with significant rupture distributed along ~250 km. Composite measures such as moment-scaled radiated energy and the radiated energy enhancement factor (REEF) are compared with comparable moment events involving thrusting and strike-slip faulting in other environments. There is distinct behavior for intraplate and interplate events and for varying mechanism type.

Conclusion: The 2008 Wenchuan earthquake struck at a time of greatly expanding geophysical observations, enabling detailed determination of the rupture geometry and slip complexity. Many contemporaneous events have occurred, primarily off-shore, and the 2008 event intraplate location has enabled exceptional analysis of the source process. Comparisons with source properties for similar size events elsewhere are advancing our fundamental understanding of very large earthquake ruptures, but the short time window of detailed observations still limits our ability to anticipate future occurrence of such events.