

## Detecting critical point behavior of seismicity prior to large earthquakes

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The spatio-temporal distribution of worldwide large earthquakes since 1900 exhibits a long-term recurrent activity along the Eurasian/Indian-Australian plate boundary zone since around 1990. The extensive activity has culminated in the 2004 great Sumatra earthquake Mw9.3, a unique Mw 9 class event in low-latitude region in the Indian Ocean in recent years. Further in and around the Indo-Himalayan collision zone and Tibet plateau, after 40 years of remarkable quiescence of large intraplate events, a recursive active period begun from about later half of 1990s which includes the latest 2008 Sichuan earthquake Mw 7.9. From the viewpoint of the critical point behavior prior to large earthquakes, we focus on precursory seismicity in broad area before the 2004 Sumatra earthquake and currently increasing seismicity in the Indo-Himalaya collision zone based on the Harvard/Global CMT and USGS/NEIC catalogs since 1976.

We apply models of time-to-failure analysis (Bufe and Varnes, 1993) to the cumulative seismic moment release of presumably precursory earthquakes. Calculating the curvature parameter of the acceleration of the cumulative Benioff strain (Bowman et al., 1998) in circular areas around the 2004 Sumatra earthquake and using iterated grid search method, we estimate an optimum critical region radius 3200 km centered at point near Nicobar Islands. Because of the periodic fluctuation of the cumulative curve, we use both the power law function and the log-periodic function added to the power law relation (Sornette & Sammis, 1995) to determine parameters by the nonlinear least-square method. The better fitting of the log-periodic function with final failure time  $t_f=2005.3$  may indicate an intrinsic oscillatory behavior of the seismic strain release before the 2004 event in the hierarchical fault network approaching to the critical point. This is consistent with general trend of decrease of time intervals of successive events and increase of corner magnitude  $M_c$  of the Gutenberg-Richter relation as approaching to the time of the 2004 final rupture. Although we do not observe systematic change of spatial correlation length, we notice the emergence of spatially rare events from around 2000, which include large events near the epicenter of the coming 2004 event; June 4, 2000 Sumatra Mw 7.8 and the succeeded June 18, 2000 Indian Ocean Mw 7.9.

Applying the same method to the seismicity in the Indian-Himalayan collision zone, we obtain an optimum area radius 2600 km centered at 28N and 90E as one possible critical area for the accelerating cumulative Benioff strain. Though the suspected critical area includes the latest and largest Sichuan earthquake of May 12, 2008 Mw 7.9 since 1976, the two time-to-failure functions predict further large event with final fracture time 4-5 years from now. The centered position corresponds to one of potential areas of great earthquakes along the Himalaya arc with potential slip accumulated since 1800 (Bilham et al., 2001). To look more closely at the fault network system and to clarify the ongoing crustal activity, detailed analysis of earthquake data observed by regional and local network is necessary.