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Plate junctions and great earthquakes: the recent Sumatran puzzle

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The great devastating tsunamigenic earthquake of 26 December 2004 (M9.0) in Sumatra was quickly followed by another great one on 28 March 2005 (M8.7) in the same region. This is for the first time in the known history of Seismology that 2 great earthquakes have occurred in close spatial proximity in such a quick succession. In the present study we highlight the role of the multiple plate junction comprising the India, Burma, Australia and Sunda plates, in generation of such great earthquakes. These earthquakes have occurred on distinct India-Burma and Australia-Sunda plate boundary segments, possibly separated by a stress barrier or a lithospheric break at the junction that prevented stress transfer along the arc during both earthquakes. This is evidenced by the confinement of aftershock activity on either sides of the barrier during each of the earthquakes. It appears that the large impulsive coseismic deformation during the first earthquake of 26 December 2004 triggered the already saturated adjoining segment of the Australia-Sunda plate boundary within a short period of 3 months, generating the second one on 28 March 2005. An examination of the locations of the world's 12 largest earthquakes during the last century indicates a strong correlation ($>$80%) with multiple plate junctions. Apart from the 2 great Sumatran earthquakes observed at the quadruple plate junction of India, Burma, Australia and Sunda, even the 2 greatest earthquakes in the Himalayas – the 1897 Shillong and the 1950 Assam earthquakes – each of magnitude 8.7, occurred at a quadruple junction comprising the India, Eurasia, Burma and Sunda plate junction. Finite element modeling of stress field at plate junctions indicates the mechanism of great stress build-up due to the plate geometry and variable plate velocities. In general, it is inferred that triple and quadruple plate junctions are potential targets for future great earthquakes.