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The next great earthquake and tsunami in western Sumatra based on analysis of the 7th centuries paleogeodetic history, 5 year cGPS data and recent strain releases during the September 2007 event.

D.H. Natawidjaja (1) and K. Sieh (2)

(1) RC Geotechnology, Indonesian Institute of Sciences (LIPI), Bandung, Indonesia (danny.hilman@gmail.com), (2) Earth Observatory of Singapore, Nanjang Technological University, Singapore (sieh@ntu.edu.sg)

The Mw8.4 and Mw7.9 Sumatran earthquakes of 2007 resulted from partial rupture of the 700-km-long Mentawai section of the Sunda megathrust. Paleoseismic and paleogeodetic patterns of the past 700 years show that these were the largest ruptures within the Sumatran megathrust section, south of the Equator, since the early 19th century and imply that 2007 was the beginning of a new episode of strain release. The previous episode occurred in 1797 (∼Mw8.5) and 1833 (∼Mw8.9). We have used growth patterns and U-Th dating of coral microatolls to map in detail the vertical deformation associated with these two earthquakes. The northern and southern limits of the 1797 rupture are well constrained. They lie beneath Siberut, Sipora, North Pagai, and South Pagai islands. The uplift in 1797 ranges up to 80 cm and shows a pronounced tilt away from the trench. Modeling of the 1797 uplift implies that megathrust slip ranged as high as 8 m on an ∼300-km rupture, with a moment magnitude (Mw) between 8.5 and 8.7. During the 1833 event the same chains of islands, except Siberut, rose again, but uplift ranged up to 280 cm. The 1833 uplift corresponds to the slip models with slip ranging as high as 7 to 18 m on an ∼300-km rupture (Mw 8.6 – 8.9). This giant earthquake couplet implies that slip magnitudes can vary by a factor of four on the same fault patch and that not all accumulated strain need be relieved in a giant earthquake. Paleogeodetic records from coral microatolls reveal earlier episodes of uplift about every two centuries. Thus, the big earthquakes of 2007 had been anticipated. At least three of the episodes of the past 700 years appear to have been couplets, separated by just decades. Modeling of paleogeodetic and cGPS data from the Sumatran GPS Array (SuGAr) implies that the megathrust patches under the Mentawais are currently fully-to-partially locked, thus confirming that this section has been accumulating strain since the last couplet. The total uplift associated with the events of 2007 is similar to that of the 1797 event, but is farther south, nearly coincident with the 1833 uplift. The recent earthquake sequence released only a portion of the strains that have accumulated since 1833. The most plausible future scenario is that a larger event is yet to come. In this paper, we present several plausible scenarios for future events, which we will use to assess earthquake and tsunami hazards along the west coast of Sumatra.