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The existence of a thrust-type tectonic line in the foreac sliver off Sumatra, and its potential to generate tsunami

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After the 2004 Sumatra-Andaman earthquake, the seismic activity off Sumatra have been high. The 2004 Sumatra-Andaman (Mw=9.3) and 2005 Nias earthquakes (Mw=8.6) ruptured northern part of the Sunda trench (e.g. McClosky et al., 2005; Nalbant et al., 2005). On September 12, 200 7, another great earthquake with Mw=8.3 occurred off Bengkulu, south of the Sumatra island. This event was followed within a day by two large earthquakes with Mw=7.9 and 6.8, which occurred in the northwest of the first Mw=8.3 earthquake. The centroid depths of these events were between 25 and 30 km. The studies of the historical seismic activity revealed that great earthquakes have occurred every 200-250 years off Sumatra (e.g. Sieh et al., 2008). The previous great events off southern Sumatra occurred on 1797 and 1833, which ruptured the Sunda trench and the estimated magnitudes Mw were 8.7-8.9 and 8.9-9.1, respectively (Natawidjaja et al., 200 6). In addition to these great earthquakes, a number of events occurred around Sumatra in the past 300 years, causing damages to the Sumatra island due to the strong motion and/or tsunamis (Newcomb and McCann, 1987). Therefore, to reveal the seismic activity around Sumatra is crucial for the disaster mitigation in this region.

After the devastating tsunami damage from 2004 Sumatra-Andaman earthquake, the early tsunami warning system in Indonesia (InaTEWS) has been developed to monitor the seismic activity in and around Indonesia. We have developed a catalogue of the centroid moment tensor (CMT) of earthquakes around Indonesia (InaCMT).

We focus here on the seismic activity of the source region of the 2007 off Sumatra seismic sequence. We call here the three largest earthquakes in the seismic sequence as ``mainshocks''. We found three burst sequences of aftershocks. The first and second burst activity occurred in February 2008 and April 2009 (160 and 580 days after the mainshocks, respectively). These burst sequences, consisting of about 10 events with maximum magnitude of Mw 6, occurred around the source faults of the mainshocks. Therefore, these activities can be considered as aftershocks in a general sense.

The third burst sequence occurred about two years after the mainshocks in August 2009, along the eastern coast of the Siberut island. This region was seismically less active until this burst. Source parameters of about 10 events were determined, with maximum magnitude of 6.7. The source centroid depths were 5-10 km, which were shallower than the depth of the plate boundary in this region. Accordingly, we consider these earthquakes did not occurred along the blate boundary, but occurred on a fault located in the shallower part of the crust. The focal mechanisms of the events were dominated in reverse fault component, similar to that of the other aftershocks. The linear alignment of the earthquakes parallel to the Sunda trench and the strike of the nodal planes of these events infers the existence of a tectonic line representing a thrust fault deformation.

The Mentawai fault is mapped around this region, which runs parallel to the Sunda trench and was described as a strike-slip fault (Diament et al., 1992). If this fault, or other unknown fault in this region, has an evident dip-slip component, tsunamis may be generated when large earthquakes occur along the fault. Indeed, the arc-normal compressional deformation can be recognized in the deformations around the Siberut island obtained by GPS observations (e.g. Prawirodirdjo et al., 2000), which suggests the existence of thrust faults around this region. Earthquakes along such faults might cause seismic damages above the source region and/or large tsunamis because of the shallow source depths. Therefore, we should prepare earthquakes and tsunamis caused by such faults in this region, as well as the events anticipated to occur along the Sunda trench.

Keywords: InaCMT catalogue, Mentawai fault, Sunda trench, JISNET