Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SCG63-03 Room:303 Time:May 20 09:30-09:45

Triggered non-volcanic tremor in SW Japan by the Love waves from the 2011 M9.0 Tohoku earthquake and its aftershocks

ENESCU, Bogdan[1*], Kevin Chao[2], Zhigang Peng[2], OBARA, Kazushige[3], MATSUZAWA, Takanori[1], TANAKA, Sachiko[1], TAKEDA, Tetsuya[1]

[1]National Research Institute for Earth Science and Disaster Prevention, [2]Georgia Institute of Technology, [3]Earthquake Research Institute, The University of Tokyo

The March 11, 2011 M9.0 Tohoku earthquake was followed by large aftershocks and broad seismic activation both inland and offshore Japan (e.g., Hirose et al., 2011; Ogata, 2011; Toda et al., 2011). Previous studies (Enescu et al., 2011; Miyazawa, 2011; Obara and Matsuzawa, 2011) reported remotely triggered seismicity at distances up to about 1350 km from the mainshock. Deep non-volcanic tremor in south-west Japan (Obara, 2002) was also clearly activated following the Tohoku earthquake. We focus here on the detailed analysis of the triggered tremor.

We detect tremor that correlates with the passage of the mainshock surface waves at several Hi-net seismic stations in Shikoku region, at distances of about 1000 km from the Tohoku earthquake epicenter. We use an envelope cross-correlation technique to locate the tremor sources. The best tremor location is determined using a 3D grid-search that minimizes the residuals between observed and calculated travel time differences at pairs of recording stations. While the depth of the tremor source is not well constrained by our grid search, the signal originates from a deep source in the lower crust. Our location results show that the mainshock triggered tremor in two distinct areas, in western and central Shikoku, in regions where ambient (i.e., not triggered) tremor occurs (e.g., Obara et al., 2010). The triggered tremor in western Shikoku also occurs close to the tremor triggered by previous large, remote earthquakes (e.g., Miyazawa and Mori, 2006).

We have also detected triggered tremor during the passage of the incoming surface waves from the earliest aftershock (M7.4) of magnitude above 7.0, which occurred about 23 min. after the mainshock, as well as from the largest aftershock (M7.7) that occurred about 30 min from the mainshock. However, we did not find any evidence of triggered tremor by the M7.3 foreshock, occurred on March 9th, 2011.

We have estimated the peak dynamic stresses during the passage of surface waves from the mainshock and the two aftershocks, using the observed peak ground velocity at nearby F-net and KiK-net stations. The obtained values are roughly between 10 KPa and 180 KPa (the upper value corresponds to the mainshock), higher than the apparent triggering threshold found in this and other regions (Chao et al., 2011).

We have checked whether the detected tremor was triggered by the passage of the Love or Rayleigh waves from the Tohoku mainshock and its aftershocks. Our results indicate that the Love waves were the main triggering factor. The tremor triggered by the mainshock and the M7.4 aftershock, in particular, correlate well with the Love waves cycle. Our results are consistent with theoretical modeling that shows that Love wave displacement to the south-east (sea-ward) would promote up-dip shear on the plate interface in the Shikoku region (Hill, 2010). In a related study, Chao et al. (2011) report Love wave triggering in Shikoku by other remote earthquakes. While the triggering by Rayleigh waves in south-west Japan has been well documented (e.g., Miyazawa and Mori, 2008), our recent work shows for the first time clear evidence of Love wave triggering in the region.

Keywords: Non-volcanic tremor, SW Japan, triggering, Love waves, 2011 M9.0 Tohoku earthquake