The 2011 M6.4 Shizuoka earthquake sequence: triggering process investigation

*Anca Opris¹, Bogdan Enescu², Yuji Yagi², Sachiko Tanaka³, Katsuhiko Shiomi³

1. Earth Evolution Sciences, Graduate School of Life and Environmental Sciences, University of Tsukuba, 2. Faculty of Life and Environmental Sciences, University of Tsukuba, 3. National Research Institute for Earth Science and Disaster Prevention

Many inland areas in Japan were seismically activated following the 2011 M9.0 Tohoku-oki earthquake. The activation mechanism includes triggering by dynamic, static or fluid-induced stress changes (e.g., Toda et al., 2011; Miyazawa et al., 2011; Shimojo et al., 2014). In this study we aim to understand the triggering processes associated with the 2011 M6.4 Shizuoka earthquake sequence; the mainshock of the sequence occurred on March 15, close to Mt. Fuji.

To improve the detection of smaller earthquakes, we have applied the Matched Filter Technique (MFT; Peng and Zhao, 2009) for the time interval from the Tohoku-oki earthquake until seven hours after the Shizuoka earthquake. We used Hi-net (NIED) continuous waveform data and seismograms of 1126 template events with M >= 1.0, which occurred in the study area between 2001 and 2014. The total number of Hi-net stations used was 25, selected within a 40 km radius from the main shock.

No foreshock activity was detected prior to the March 15 Shizuoka earthquake, which contrasts with other similar inland seismicity activations following the Tohoku-oki earthquake (e.g., Kato et al., 2013; Shimojo et al., 2014). Since the co-seismic static stress change due to the Tohoku-oki earthquake on the Shizuoka fault plane was significant (~0.5 bar), we argue that this is likely the most significant triggering mechanism and the delay of this sequence could be explained by the rate-and-state friction law (Dieterich, 1994).

The aftershock detection for the first 7 hours following the M6.4 event was significantly improved. When looking at the space-time distribution of the MFT detections, we observe that the earliest aftershocks (first minutes after the Shizuoka earthquake) occur to the north, close to Mt. Fuji, likely due to a stress increase from the Shizuoka mainshock. Indeed, by comparing the locations of these events with the slip model of Shizuoka earthquake derived from strong-motion data (JMA, 2011), we observe that they occur at the tip of the mainshock rupture.

The largest earlier aftershocks (M >= 4.0) occur as well in the north region. Aftershock distribution and focal mechanism data suggest that the northernmost earthquakes may have occurred on a different fault segment.

We also detect a rather gradual expansion of the aftershock distribution to shallower depths; the delay of activation in the shallow part remains to be further explored.

Keywords: seismicity, 2011 Shizuoka earthquake, triggering