

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

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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 $M \geq 1.0$, 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 ($M \geq 4.0$) 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