Early recurrence of M~6 intraplate earthquake (5.8 years) observed in northern Kanto region, Japan

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On 28 December 2016, an M~6 normal fault earthquake occurred in the northern part of Ibaraki prefecture in Kanto region, Japan (hereafter called event B). This event was observed by the Japanese ALOS-2 satellite equipped with PALSAR-2, an L-band synthetic aperture radar (SAR). Interferometric SAR (InSAR) processing indicates clear displacement discontinuity line, directing approximately NW-SE. The amount of discontinuity is ~30cm in the line-of-sight (LOS) direction (approximately from East with incidence angle of 36 degrees). A preliminary inversion found a dip angle of 42 degrees with fault slip confined in the upper-most 5km in the crust.

The region has experienced swarm-like normal faulting activities after the occurrence of the 11 March 2011 Mw9.0 Tohoku-oki earthquake including an Mw6.6 event composed of complex ruptures on multiple faults (e.g., Fukushima et al., 2013, BSSA). One of such events was an M~6 event on 19 March 2011 (hereafter called event A).

We performed InSAR analysis also for the event A using the data acquired by the ALOS satellite equipped with PALSAR radar. After removing the displacements caused by the Tohoku-oki earthquake, we obtained a remarkably similar displacement pattern for the event A as compared with the event B. Specifically, the locations of displacement discontinuity lines were almost identical, and the amount of displacement discontinuity was up to ~45cm for the event A and ~30cm for the event B. The displacement patters were similar, both indicating southwestward normal faulting on a NW-SE striking fault, suggesting that the same fault ruptured. The slight larger displacement for event A indicates that this event was associated with slightly larger slip on the fault at least close to the ground. The InSAR data for the event A presumably includes the displacements associated with an Mj 5.7 event, which should be taken into account for further comparison.

Our result indicates that the same M~6 fault can re-rupture in a very short time interval of 5.8 years. Two interpretations are possible as to the mechanism of the extremely early recurrence: 1) rapid loading of the fault occurred after the event A, possibly associated with the postseismic deformation due to the 2011 Tohoku-oki earthquake, and 2) stress level on the fault remained high after the event A, enabling further slip on the fault, without significant loading.

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