Accelerated Subduction Following Megathrust Earthquakes in Japan, Sumatra, and Chile

*Mohammad Yuzariyadi[1], Kosuke Heki[1]

1. Hokkaido University

From GNSS station coordinates data, Heki and Mitsui (2013 EPSL) found postseismic enhancements of inter-plate coupling in the adjacent segment of the 2003 Tokachi-oki and the 2011 Tohoku-oki earthquake. They hypothesized that these earthquakes caused accelerated subduction of the Pacific Plate slab in addition to already-known postseismic processes such as afterslip and viscous relaxation. Uchida et al. (2016 GRL) confirmed this in terms of increased frequency of small repeating earthquakes beneath the Kanto Region. Melnick et al. (2017 GRL) found a similar enhancement of coupling to the north of the 2010 Maule earthquake rupture zone, and Loveless (2017 GRL) considered this a common phenomenon after megathrust earthquakes and named it as the super-interseismic phase.

GNSS station coordinates data available before and after large earthquakes could help us understand the general pattern and the implication in the seismic cycle of this phenomenon. We compiled the GNSS data recording postseismic enhancement of coupling in adjacent segments, especially in Japan, Sumatra, and Chile. As already reported, we found the enhanced coupling following the 2003 Tokachi-oki earthquake (Mw8.0), the 2011 Tohoku-oki earthquake (Mw9.0), the 2010 Maule, Central Chile, earthquake, (Mw8.8). We also newly found that similar enhanced coupling occurred after the 2014 Iquique, Northern Chile, earthquake (Mw8.2) and the 2006 Bengkulu, Southern Sumatra, earthquake (Mw8.5).

In order to find a general law in this phenomenon, we plotted the increase of the landward velocities of GNSS stations as a function of the distances from the centers of the fault ruptures. Stations very close to the rupture area show trenchward postseismic movements coming from afterslip. However, acceleration of the landward velocities (enhanced coupling) emerge as we go away from the rupture zone. This enhanced coupling decays as we go farther away from the fault. We also found that the acceleration in Chile is much greater than those in Japan. For instance, the relative acceleration in the adjacent region of the 2010 Maule earthquake could reach 70 percent of the original velocity. On the other hand, the acceleration remains ~25 percent after the 2011 Tohoku-oki earthquake. This is somewhat paradoxical considering that the moment magnitude of the Tohoku-oki earthquake was greater than the Maule earthquake.

We discuss possible factors responsible for these differences, e.g. the discrepancies between the subduction directions and the trench strikes. In Japan, the Kuril and the Japan Trenches have slightly different strikes, while the whole subduction zone is straight in Chile. Difference between the stress-drops by these megathrust earthquakes may also be an important factor.

Keywords: Megathrust earthquake, subduction acceleration, GNSS, interplate coupling

