

Direct measurement of postseismic motion of incoming Pacific plate after the 2011 Tohoku Earthquake using acoustic ranging system

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Postseismic deformation after the 2011 Tohoku Earthquake by the both of onshore (e.g. GNSS) and offshore (e.g. GNSS-Acoustic: GNSS-A) geodetic observations is strongly affected by viscoelastic relaxation. This significant intraplate deformation makes it difficult to identify the postseismic slip (afterslip) from the postseismic deformation data.

In this study, Direct Path acoustic Ranging (DPR) system was used to reveal motion of the shallowest portion of the megathrust. DPR periodically measures two-way travel time between a pair of acoustic transducers on the seafloor. By measuring baseline lengths between the instruments placed on the incoming Pacific plate and the overriding Okhotsk plate, across the Japan Trench, the rate of plate convergence at the trench can be obtained directly.

Baseline lengths are calculated by estimating sound velocity in the seawater, dependent on temperature, pressure, and salinity. Temperature and pressure were precisely measured by collocated sensors, and salinity, much more stable than those, was assumed to be constant. We further monitored the attitude of instruments so that we know the relative motion of acoustic transducers on the benchmarks deployed on the seafloor. After knowing these parameters, two-way travel times were converted to baseline lengths with precision of several millimeter for 1 km baseline length. Ranging data was recovered with the instruments by pop-up collection or acoustic data link.

Observations were executed three times (2013, 2014-2015, and 2015-2016) at the off-Miyagi region, where massive coseismic slip happened. In this region, no significant shortenings of the baselines were observed. Our result suggested that postseismic slip did not occurred along the shallowest subduction plate boundary at least in the period of our observations in the off-Miyagi region. The results are consistent with the postseismic slip model based on the regional postseismic deformation data corrected for the viscoelastic relaxation, in which no substantial postseismic slip is expected around our observation site.

In this presentation, we will also show the preliminary result of a new observation, executed in the off-Fukushima region in 2017 and still ongoing. In the region, no large shallow coseismic slip was estimated but significant shallow postseismic slip is expected to be on going.

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