Detecting a relative motion across the Japan Trench using precise acoustic ranging

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Researchers reported that the 2011 Tohoku-oki earthquake accompanied coseismic slip over 50 m (e.g. Iinuma et al., 2012, JGR). In the Tohoku-oki region, GPS/Acoustic (GPS/A) observation is now ongoing after the Tohoku-oki Eq. Tomita et al. (2015, GRL) revealed the observed acceleration of the Pacific plate can be explained by viscoelastic relaxation modeled by Sun et al. (2014, Nature). However precise nature of localized interplate motion is still unknown only using GPS/A observation. Therefore, we conducted direct path acoustic ranging across the Japan Trench from September 2014 to May 2015. Direct path acoustic ranging can continuously and precisely detect relative motion between a pair of instruments across plate boundary or a fault. In our preliminary examination, precision in 1 cm/yr was achieved (Osada et al., 2014, JpGU).
In the observation, three instruments were deployed across the trench axis at the Miyagi-oki region forming two baselines, 7 km and 10 km, respectively. Acoustic ranging was repeated every 4-hours. Relative ranges can be calculated by multiplying a round trip time of acoustic signal and sound velocity. Sound velocity depends on temperature, pressure and salinity. Then, we concurrently measured in-situ temperature. Pressure was taken from NAO.99Jb tide model (Matsumoto et al., 2000, J. Oceanogr.). Salinity was assumed to be constant because of its stability in deep ocean. Precisions of 2 baselines were less than 2 cm/yr, as same as the pre-observation.
In the observation, we obtained data for about 8 months, and found no relative motion, which indicates subducting rate about 8 cm/yr in global model is not compensated at the trench. Thus, near Miyagi-oki region, postseismic slip does not occur at this moment and is already in the interseismic locking state.
Since September 2015, five instruments were newly installed at the same region for two-years continuous observation. Furthermore, we plan to install additional instruments at Fukushima-oki region, where postseismic slip rate is reported strikingly large (Sun and Wang, 2015, JGR). Integrating these data, it is expected in the near future that deformation pattern along the trench axis would be revealed.

Keywords: direct path acoustic ranging, the 2011 Tohoku-oki earthquake, the Japan Trench, postseismic slip, seafloor geodesy

