Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS31-P11 Room:Convention Hall Time:May 25 18:15-19:30

Revisiting Interplate Coupling Beneath the Tohoku District Based on Geodetic Observations

IINUMA, Takeshi[1*] ; IMANO, Misae[2]

[1]International Research Institute of Disaster Science, Tohoku University, [2]Graduate School of Science, Tohoku University

Many studies have been carried out into the distribution of interplate coupling between the subducting Pacific and overriding continental plates based on observations of the surface displacement rate field using satellite geodesy. In such studies, the degree of coupling has generally been expressed in terms of the back-slip (or slip deficit) at the plate interface. In some cases, seismological rather than geodetic data have been used to investigate the spatiotemporal variation of the back-slip distribution. Although it is difficult to resolve the back-slip distribution at the plate interface off the coast of the Tohoku District along the direction normal to the trench based only on terrestrial observations, it can be constrained to some extent in the direction parallel to the trench.

Iinuma et al. (2010, 114th Meeting of the Geodetic Society of Japan) proposed a method for monitoring the spatiotemporal variation of interplate coupling based on calculating the spatial gradient of the surface displacement rate field within belt-like zones along the direction perpendicular to the trench axis. They suggested that the gradient of the horizontal component of the displacement rate depends mainly on the strength of the interplate coupling in shallow ($<$40 km) regions of the offshore plate interface, and that the sign of the vertical displacement rate gradient indicates the presence or absence of interplate coupling at deeper ($>$50 km) regions of the plate interface beneath the land. Thus, the spatiotemporal variation of interplate coupling can be monitored based on the temporal change in the trench-parallel distribution of the displacement rate gradient. Based on an analysis of small repeating earthquakes, Uchida et al. (2013, Fall Meeting of the Seismological Society of Japan) reported that there is a strong correlation between the temporal change in the displacement rate gradient and the slip rate.

Application of this monitoring method to geodetic data before the availability of satellite geodesy data may enable us to estimate the state of interplate coupling by calculating the displacement rate gradient along the direction perpendicular to the trench axis based on leveling and triangulation surveys. Therefore, in this study, leveling survey data were used to estimate the degree of interplate coupling beneath the Tohoku District for approximately the past 100 years.

The spatial gradient of the vertical displacement rate along an observation line from Ayukawa to Sendai via Rifu was calculated from leveling survey data recorded by the Geospatial Information Authority of Japan since 1900. Fifteen sets of vertical displacement rate field data were used to calculate the spatial gradient along the direction perpendicular to the Japan Trench. The results for recent decades were compared with the vertical displacement rate gradient estimated from GPS observations, and were found to be in reasonably good agreement. It can therefore be concluded that the degree of interplate coupling at deeper regions of the plate interface can be assessed even for periods before the introduction of global navigation satellite systems, based on leveling survey data alone. The results indicated that there were clear cycles in the strength of this coupling, interspersed with large interplate events such as the 1936 and 1978 Miyagi-oki earthquakes. Before these events, strong coupling existed in deeper regions, but disappeared after the main shock occurred. The results of similar investigations for observation lines from Kamaishi to Yokote via Kitakami, and Iwaki to Aizu-Wakamatsu via Koriyama will be presented at the meeting.

Keywords: Iinterplate coupling, The 2011 Tohoku-oki Earthquake, Leveling Survey, GPS