

Aseismic slip along plate boundary off Miyagi Prefecture after the 2002 (M6.3) and 2005 (M7.2) earthquakes estimated by GPS data

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Northeastern Japan, where the Pacific plate is subducting at a rate of about 80 mm/yr beneath the overriding continental plate, is one of the most active areas in seismicity in the world. Various studies on major interplate earthquakes around this area have revealed that some of those events can be regarded as recurrent ruptures of asperities, which are defined by distributed patches showing large coseismic slips (Nagai et al., 2001; Matsuzawa et al., 2002; Okada et al., 2003; Yamanaka and Kikuchi, 2003, 2004; Hasegawa et al., 2005).

Earthquakes with magnitudes of about 7.5 or larger have repeatedly occurred on the plate boundary east off Miyagi Prefecture (Miyagi-Oki) with an interval of about 37 years. The most recent one took place in 1978, i.e., the M7.4 Miyagi-oki earthquake (e.g., Seno et al., 1980). Based on historical records of these recurrent earthquakes, the Headquarters of Earthquake Research Promotion of Japan (HERP) stated that the next Miyagi-Oki earthquake will occur with a probability of about 50 % in the next 10 years (HERP, 2003). In response to this seismic hazard assessment, Tohoku University established 13 new continuous GPS stations around the source area of the 1978 event to complement the nationwide GPS network operated by the Geographical Survey Institute of Japan (GSI), GEONET (e.g., Miyazaki et al., 1997).

On August 16, 2005, there occurred an interplate earthquake with magnitude 7.2, hereafter referred to as the 2005 Miyagi-Oki earthquake. Okada et al. (2005) carried out the relocation of aftershocks of the 1978 and 2005 events to reveal that the aftershock area of the 2005 event is overlapped only with the southeastern part of that of the 1978 event. In addition, they performed the seismic waveform inversion for the 2005 event to estimate the coseismic slip distribution and found that it also overlapped with the southeastern part of the 1978 rupture area.

The surface displacement data derived by the dense GPS network demonstrate clear coseismic deformation together with minor postseismic one. In the present study, we use GPS data to estimate both co- and post-seismic slip distributions on the plate boundary by means of a geodetic inversion technique (Yabuki and Matsu'ura, 1992).

Co- and post-seismic deformations associated with the 2005 Miyagi-Oki earthquake were investigated to resolve the causal interplate slips, using continuous GPS data and the geodetic inversion. The coseismic slip distribution estimated by the present study shows good agreement with that estimated by waveform inversions. The major slip area corresponds to the southeastern part of the rupture area of the 1978 event. This suggests that there still remains the locked plate interface, which may cause major interplate earthquakes in the near future.

The afterslip seems to have extended uni-laterally to the south of the coseismic slippage. This distinctive feature also might be caused by the presence of asperities, where seismogenic stress has not released yet, in the northern neighborhood. Monitoring of space-time evolution in aseismic slip occurring on the plate interface is a clue to predict occurrences of interplate earthquakes and to understand the process of plate subduction.