Postseismic deformations following the 2004 SE off Kii peninsula earthquake sequence and its tectonic implications

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On September 5, 2004, two earthquakes of M6.5 and 7.4 hit the central and southwest Japan. Hypocenters of these events are located SE off Kii peninsula and right beneath the axis of the Nankai trough. The Tonankai earthquake of 1944 occurred between the hypocentral region of these events and Honshu Island. Aftershocks are aligned in two trends: one is parallel to the Nankai trough and the other is oblique to it. According to the observation with ocean bottom seismographs, the further is about 20km deep, and the later is much shallower (Shinohara et al., 2004). These events have almost pure thrust mechanism, but their P axes are in the NS direction that is different from the relative motion between the subducting Philippine Sea and overlying continental plates and nodal planes are very steep. However, some large aftershocks have nearly strike-slip fault mechanism. These strike-slip type aftershocks occurred along the oblique distribution to the Nankai trough.

GEONET, a nation-wide continuous GPS observation network operated by the Geographical Survey Institute, detected coseismic displacements. We also made an urgent continuous observation of denser network of GPS than GEONET in order to detect postseismic deformations following these events. Since we established this network in 2001 and repeated observations for a week or two every spring, we can compare the coordinates after the earthquakes with those in spring in 2004. We used dual frequency receivers such as Asthech Z-12, Javad Legacy-E, Trimble 5700. We adopted a standard scheme of continuous observation of 30sec sampling and elevation mask of 10 degrees. We continued observation for one and half month after the events and analyzed the data with GIPSY OASIS II. In this analysis the precise point positioning was adopted using precise ephemeredes by JPL. Since our network is limited in Kii peninsula, we also utilize daily solutions of GEONET sites outside of the Kii peninsula provided by GSI in the following discussion.

Coseismically most GPS stations moved south, but those on the west side of Kii peninsula moved west to southwestward. This pattern of horizontal displacements can explained by a thrust fault trending parallel to the Nankai trough. We cannot determine the dip direction on the basis of observed displacements. During the first three weeks at the postseismic stage, the E-W components increased slightly at all stations (eastward shift), then decreased. Southward movements up to 1cm are dominant even at the stations on the west side of Kii peninsula. This result suggests that the coseismic and aftrslip are different from each other. One possible explanation of postseismic deformation is afterslip on the fault plane that ruptured in the main shock or its extension. Right lateral strike-slip along the oblique distribution of aftershocks may not contribute to the postseismic deformations so much, since it will produce NW-ward movements in southern Kii peninsula.