Crustal deformation associated with the 2000 Western Tottori Earthquake and a fault model

Takeshi Sagiya[1], Eiichi Fukuyama[2], William L. Ellsworth[3]

[1] Research Center, GSI, [2] NIED, [3] USGS

Coseismic and postseismic crustal deformation of the 2000 Western Tottori Earthquake (Mw=6.6) was observed with continuous GPS and leveling. The deformation data were inverted to estimate coseismic as well as postseismic slip distribution of the event assuming configuration of fault segments based on the precisely determined aftershock hypocenter locations. Main part of the estimated slip occurred shallower than 8km on the fault plane. Postseismic deformation was caused by a fault slip on the northern extension of the main rupture, and has a close relationship to aftershocks mainly distributed in the northern area.

We studied crustal deformation associated with the Western Tottori Earthquake on October 6, 2000. Continuous GPS stations recorded significant coseismic displacements up to 16 cm, and the observed deformation pattern was concordant with the seismological source mechanism, a left-lateral slip on a NNW-SSE trending fault. We found northeastward postseismic displacements up to 2cm at GPS stations northeast of the focal region. The largest postseismic displacement was observed at Saihaku station which was installed just after the main shock. According to the leveling survey conducted after the main shock, significant vertical displacements (11cm uplift, 13cm subsidence) occurred in the southern focal region.

We estimated a detailed static fault model of the Western Tottori Earthquake inverting these deformation data. Since deformation data themselves cannot control the fault configuration well, we used prescribed fault segments based on a precise aftershock relocation with the double difference method (Fukuyama et al., 2001). We divided 10 fault segments into 96 subfaults with dimensions of 2-3 km, and estimated both dip- and strike-slip components for each subfault with a smoothness constraint.

We inverted GPS displacement vectors and leveling data. Since the leveling survey was conducted from late October to December, we set November 10 as the reference date after the main shock. GPS displacement vectors are calculated comparing averaged GPS coordinates for 10/1-5 and 11/8-12. Thus our fault model contains both coseismic slip and postseismic slip for 35 days.

Estimated seismic moment of the Western Tottori Earthquake is 9.5*10^18Nm (Mw=6.6). The main rupture occurred on the three southern segments. Estimated slip is larger than 2m at the shallower part (depth < 8km) above the main shock hypocenter. At the southernmost segment, shallow fault slip is necessary to fit the leveling data though the aftershocks were not located there. The estimated slip distribution is basically consistent with waveform inversion results such as Ide (2000).

We also calculated contribution of each segment to the surface displacements in order to discuss afterslip distribution. Slip on the three main shock segments does not fit the observed postseismic deformation pattern. Slip on the fourth segment located next to the main shock segments can quantitatively reproduce the observed postseismic deformation. We deduce main part of the afterslip occurred on this segment. However, it is also possible that other northern segments were activated at the same time. We consider that the spread aftershock activity in the northern extension of the main focal region was caused by afterslip on the northern fault segments.