The 2008 earthquake off Ibaraki prefecture

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Abstract

The GPS network has revealed coseismic and postseismic deformation associated with the Mw6.8 earthquake that occurred off the coast of Ibaraki prefecture, central Japan, on May 8, 2008. The estimated coseismic slip is large near the epicenter. Postseismic deformation does not follow an exponential or logarismic decay. Time-dependent analysis clearly shows after-slip west and southwest of the coseismic slip area. Westward propagation of the after-slip area is consistent with the aftershock distribution, suggesting that a similar aseismic slip is the cause of the westward propagation of aftershocks in a 1982 earthquake. The estimated afterslip changes the stress state favorable for the occurrence of a Mw6 class earthquake beneath Ibaraki prefecture on the Pacific plate. This may be one more possible mechanism in the paired earthquake hypothesis that predicts the occurrence of a Mw6-class earthquake beneath Ibaraki prefecture several months before or after a Mw6.7-7-class earthquake off the coast of Ibaraki. Since post seismic deformation still continues, we are paying attention to the expected earthquake beneath southern Ibaraki prefecture.

2. Data and analytical procedure

We used east-west (EW), north-south (NS), and up-down (UD) components of ground deformation at continuous GPS sites in Japan relative to 950252 GPS site. The annual changes and earthquake offsets are estimated for the period between January 1, 2006, and August 26, 2008, using the method described by Ozawa et al. (2004). After estimating annual changes and earthquake offsets, we estimated a linear trend for the period between January 1, 2007, and May 4, 2008. This linear trend is subtracted from the raw position time series together with the estimated annual changes and coseismic offsets. The results show that, large displacements up to around 1 cm are observed in the coastal area of Ibaraki prefecture, while displacements at GPS sites in inland areas decrease rapidly in the case of the coseismic deformation. Compared with the coseismic deformation, the detected postseismic displacements in the area inland from Hitachi and Iwaki are relatively large compared with those in the coastal area, which suggests that after-slip occurs in the area closer to the coastal area than the coseismic slip area.

We estimated the slip distribution employing the method of Yabuki and Matsu'ura (1992) to the coseismic deformation and the time dependent inversion to the post seismic deformation.

3. Results and Discussion

Our analysis revealed that the main coseismic slip occurred near the epicenter between the Okhotsk plate and the Pacific plate. The estimated coseismic slip model well reproduces the observations. The estimated moment magnitude is Mw6.8. with a rigidity of 30 GPa. Compared with the coseismic slip area, the estimated after-slip area expands to the coastal area from Hitachi to Iwaki and also closer to an area offshore of Choshi from the main shock slip area or asperity. The estimated aseismic slips are well beyond one standard deviation in the area of large slippage. In this point, we judge the estimated area of large aseismic slippage to be reliable on the basis of GPS data signals.

Ohtake and Kasahara (1983) and Ohtake (1986) proposed the hypothesis that a Mw6 class earthquake will occur between the subducting Pacific plate and the Philippine Sea plate several months before or after a Mw6.7-7 class earthquake between the subducting Pacific plate and the Okhotsk plate offshore of Ibaraki prefecture, on the basis of a statistical study. In terms of this paired earthquake hypothesis, our postseismic model which expanded to west and southwest of the main shock in 2008 changed the stress state in favor of the occurrence of an anticipated Mw6 class interplate earthquake beneath the southern part of Ibaraki prefecture.