

A detection of afterslip of inland earthquake using similar earthquakes

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Frictional properties control the slip behavior on a fault surface such as seismic slip and aseismic slip. Asperity, as a seismic slip area, is characterized by a strong coupling in the interseismic period and large coseismic slip. On the other hand, steady slip or afterslip occurs in an aseismic slip area around the asperity. Afterslip is observed geodetically after a large earthquake. If the afterslip area includes small asperities, a repeating rupture of single asperity can generate similar earthquakes due to the stress accumulation caused by afterslip. We can, thus, expect a monitoring of afterslip using similar earthquakes. We here investigate a detail distribution of similar earthquakes in the aftershocks of the 2007 Noto Hanto earthquake (Mjma 6.9) using the data obtained by the group for the aftershock observations of the 2007 Noto Hanto Earthquake and try to monitor the afterslip through similar earthquakes.

We select aftershocks whose cross correlation coefficients of band-pass filtered waveforms of 1-4 Hz are greater than 0.95 at more than 5 stations. We reexamine the arrival times of P and S waves and the maximum amplitude of those earthquakes and apply the double-difference method (Waldhouser and Ellsworth, 2000) to relocate them. We estimate the source radius of the earthquakes from the scaling relationship between the scalar moment and the magnitude and the circular fault model reported by Brune (1970; 1971). Finally, considering the overlap of the source area and the difference of the magnitude, we select 50 groups of similar earthquakes. 24 of those groups lie on the source fault and most of them are distributed around the deeper edge of the asperity estimated by Horikawa (2008). This indicates that small asperities are distributed around the asperity, showing consistency with the distribution of asperities on the plate interface.

We estimate the amount of slip of the similar earthquakes using an empirical relationship between the scalar moment and the slip (Somervill et al., 1999). The cumulative slip of a group ranges 0.6 to 2.7 cm and tends to be large at the deeper edge of the asperity where many similar earthquakes occur. Comparing the result of this study to the slip distribution of the afterslip estimated from the postseismic crustal movement observed by GPS (Hashimoto et al., 2008), we find that the similar earthquake occur not at the shallow part where large afterslip is estimated but the deeper part where the amount of the after slip ranges 1 to 2 cm. The amount of slip estimated from the similar earthquakes is consistent with that from the postseismic crustal movement. We also estimate the slip velocity from the average slip and the duration of each group and find that the slip velocity is large at the edge of the asperity. Not a few aftershocks of the 2007 Noto Hanto earthquake occur in the asperity, showing that the afterslip area estimated from the similar earthquakes is spatially complementary to the asperity on the fault surface.

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