Reconstruction of stress fields before earthquake using aftershock focal mechanisms together with the mainshock fault model

Kazutoshi Imanishi[1]; Yasuto Kuwahara[1]

[1] GSJ, AIST

There are many observations that the stress release associated with large and moderate earthquakes perturbed the stress field in the source region. Because the stress field following the mainshock equals the pre-mainshock stress field plus the stress change due to the mainshock, it is possible to infer the pre-mainshock stress field from aftershock focal mechanisms and a mainshock slip model. By comparing the stress field estimated by the stress tensor inversion with the theoretically calculated post-shock one, for example, Imanishi and Kuwahara (2008) inferred that the uniaxial reverse-faulting regime with a differential stress of several 10 MPa or greater reflects the stress field before the 2007 Niigataken Chuetsu-oki earthquake.

In this study, we develop an inversion method to determine a pre-mainshock absolute stress field. The change in the stress associated with the mainshock **S** is expressed as

S=**A**-**B** (1)

where **A** and **B** represent the post- and pre-mainshock stress tensor, respectively. The absolute amplitude of the stress tensor cannot be determined from the stress tensor inversion, since only kinematic data (focal mechanism) are used. We rewrite equation 1 as

S=c_1**a**-c_2**b** (2)

where **a** and **b** represent stress tensors determined by the stress tensor inversion, c_1 and c_2 are scale factors. Wesson and Boyd (2007) developed an inversion method to determine c_1 and c_2 from estimates of stress tensor before and after the mainshock and the stress change associated with the mainshock. They applied it to the 2002 Denali fault earthquake and showed that the shear stress resolved onto the faults before the earthquake is about several MPa. In general, most of background seismicity does not overlap with aftershock distributions, so that the region where this method can be applied is limited.

Therefore, we try to estimate c_1 and c_2 while grid-searching for **b**. In the inversion, we constrain c_1 and c_2 to be positive and introduce a smoothing constraint that minimize the difference in c_1 and c_2 at adjoining regions. We confirmed the applicability of this method based on numerical tests.

Imanishi, K. and Y. Kuwahara, Stress field in the source region after the 2007 Mw 6.6 Niigataken Chuetsu-Oki earthquake deduced from aftershock focal mechanisms, submitted to Earth Planets Space, 2008.

Wesson, R. L. and O. S. Boyd, Stress before and after the 2002 Denali fault earthquake, Geophys. Res. Lett., 34, L07303, doi:10.1029/2007GL029189, 2007.