Study an estimation of stress field using shallow borehole

Tsutomu Kiguchi[1]; Namiko Sato[1]; Yasuto Kuwahara[2]

[1] AIST; [2] GSJ,AIST

It is especially important for improving the long-term prediction of inland earthquake occurrence to estimate the present stress field around earthquake faults. Kuwahara (2004) has proposed to evaluate the ratio of stress drop at a fault plane to far field stress by using the dense measurements of stress directions at 2-D area around earthquake faults. Although it is possible to measure a stress direction using a borehole drilled near the fault, the ratio of the stress drop is not able to be estimated because of very sparse data. We have a new plan to measure stress directions densely at 2-D area around earthquake faults using shallow boreholes.

For estimating shallow stress field, we must consider the noise factors of stress which are caused by near-surface effect. Shallow stress field is composed of the following factors (Sato et al., 2004).

Shallow stress = far field stress + gravity (lithostatic pressure, topographic effect) + heterogeneous stress (fault, crack, residual stress) + stress relief + thermal stress.

We need to measure the stress direction which is caused by both far field stress and the stress by fault among those. Thus, the other factors which compose of stress field should be removed from the observed data, if the factors are not enough small. In this study, we try to estimate the topographic effect quantitatively.

When the measuring points are located in or nearby mountainous regions and/or valley, we need to evaluate the topographic effect due to gravity. The topographic effects have been estimated by using a finite element method (e.g. Mizuta et al., 1998). However, the previous studies evaluated the effects of the specific topography, and general topographic models were not applied. Therefore, we try to obtain the index of the general topographic effects. The estimation of any topographic effects is considered to be presented by the superposition of the gravity effect and far field stress calculated independently at some simple models.

The stress field at 10 m depth was calculated for a mountain range model of width 10 km and height 500 m. In case of far field stress with 1.0 MPa, the topographic effect causing at flat section of the model can be neglected by compared with far field stress. And in case of 0.5 MPa, topographic effect remains at the flat section from the foot of the mountain to about 5 km away. For a conical mountain model of height 500 m, far field stress with 0.5 MPa makes the topographic effects at the flat section enough small to be neglected.