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Modeling deviatoric stress field around the hypocentral area of the 2005 Fukuoka earthquake (M7.0) using focal mechanisms

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Recent numerous studies about stress field estimated from focal mechanism of microearthquakes succeeded to estimate stress field in seismogenic zone. They showed heterogeneous feature around the fault, which suggests that non-uniform stress field could control potential of large earthquake occurrence. In order to model the stress field around a fault zone, we have developed an inversion method from focal mechanism data of microearthquakes. Stress variation resulting from inelastic deformation in a medium (e.x. aseismic slip on a fault and inelastic deformation) can be expressed as equivalent body forces in the medium. Thus we attempted to model stress field through estimation of parameters of regional stress and spatially distributed moment sources. We supposed that stress at a point consists of regional stress and stress due to moment tensors located at grid points. The method estimated the direction of principal regional stress and stress ratio, and moment tensor at grid points. The method was applied to the focal mechanism data of the aftershocks of the West Off Fukuoka Prefecture Earthquake (M7.0) occurred on 20 March 2005 at off-shore of Fukuoka city, the northern part of Kyushu, Japan (Fukuoka earthquake). On the basis of the aftershock distribution and focal mechanism, the earthquake fault was determined to be a left-lateral strike-slip-type fault with a strike in the WNW-ESE direction. The tension and compression axes inferred from the focal mechanisms of the microearthquakes generally have the same direction as principal stress of tectonic stress in this region. However, the direction of stress from the focal mechanisms at the edge of the earthquake fault did not always coincide with the direction of the regional stress. We performed the method to the data with assumptions that are 1) slip of the microearthquake occurred on the pre-existing small fault in the direction of maximum share stress on the fault, 2) regional deviatoric stress tensor and moment tensors at grid points along the fault only had three horizontal components and 3) regional deviatoric stress was uniform over the target region. In the analysis, we divided the target region into shallow and deep part, and separately solve the nonlinear inversion. The minimum direction of the obtained regional principal stress at a layer almost agrees with another one, being in NNW-SSE as expected from the general tendency of focal mechanisms. The estimated moment tensors became larger at the segmentation boundary between the earthquake fault and adjacent faults. That was also relative large and indicated double-coupled force acting on the middle part of the earthquake fault. The results of the moment tensors revealed interesting information about the stress field in the target region, which suggested that inelastic deformation at the both edge of earthquake fault could existed and aseismic slip might occurred at the base of the earthquake fault.