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Stress field in and around active faults inferred from stress tensor inversion

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Stress state in and around active faults is indispensable information to understand how earthquakes occur. If we have a population of focal mechanism solutions, it is possible to obtain information on stress field (the orientation of the three principal stress axes and the relative magnitude of the principal stresses) by a stress tensor inversion method. For better understanding the stress accumulation process of large earthquakes, we need accurate focal mechanisms of many small-sized earthquakes as data. We have demonstrated that it is possible to determine reliable focal mechanism solutions of small earthquakes down to magnitude 0 by using amplitude data together with P-wave polarity data. As a result, it has become possible to obtain stress information whose resolution is higher than previous studies. In this talk, we review our studies and demonstrate the applicability of the approach. Here we use the inversion method of Michael (1984, 1987).

(1) Atotsugawa fault

We performed a dense temporary seismic observation in and around the Atotsugawa fault during the period from July 2002 to October 2004. A stress tensor inversion shows that the stress field is thrust faulting regime in regions shallower than a brittle-ductile transition zone, while the strike-slip faulting regime dominates around the brittle-ductile transition zone. This observation might suggest that there exists localized aseismic slip along the deep extension of the fault.

(2) 2004 Mid Niigata earthquake

In order to improve our ability to forecast earthquake hazards, we performed a dense temporary seismic observation in the seismic gap adjacent to the source region of the 2004 Mid Niigata earthquake. A stress tensor inversion method indicates that, at the southern ends of the Muikamachi fault, the stress field changes from the thrust faulting to the strike-slip faulting regime. Although the present data alone cannot reveal why the stress field changes, it is interesting that such a change suddenly occurs at the end of the fault.

(3) 2005 west off Fukuoka prefecture earthquake

After the occurrence of the 20 March 2005 west off Fukuoka prefecture earthquake (Mj 7.0), off-fault aftershocks occurred in and around Hakata bay adjacent to the main fault of the earthquake. The locations of the activity seem to coincide with the Ishido-Uminonakamichi fault, which is a structural boundary and not considered as an active fault. We determined focal mechanism solutions of events occurring in and around the Hakata bay. A stress tensor inversion method shows that the fault plane inferred from the surface trace of the Ishido-Uminonakamichi fault is unfavorably oriented. It is likely that the permanent stress field makes it difficult to reactivate the fault plane inferred from the surface trace of the Ishido-Uminonakamichi fault within Byerlee's (1978) range of rock friction coefficients.

Through the above-mentioned studies, we found that it is possible to extract inhomogeneous stress field of at least 5-10 km scale. In the next step, we should estimate a temporal change of stress field to elucidate the stress accumulation process of large earthquakes.