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The shear strength of the reverse fault type of plate boundary

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In the northeastern Honshu region, the displacements caused by earthquakes at plate boundary beneath off-Sanriku, which have the large E-W component, become small with an increase in the epicentral distance. The theory of continuum mechanics and the model of earthquake source process explain such displacement fields observed by GPS almost completely. This might make us to accept that the forces applied at the plate boundary determine the stress field in the region.

The horizontal stain accumulated during about 85 years shows dilatation of surface area almost everywhere in the northern part of the northeastern Honshu except for the central part. In Kitakami highland area, the extension in the NNE-SSW direction is predominant. The stresses measurement by DRA has revealed that the stress is tensional in the NNE-SSW direction in this area. Here, the tensional field means that the average horizontal stress is smaller than the vertical stress. This consistency of the stress field with the strain field may permit us to assume that the long-term strain reflects the in-situ stress. On this assumption, the stress field in the northeastern Honshu conflicts with that inferred from the deformation due to earthquakes of the plate boundary. Although this conflict does not necessarily mean the small frictional coefficient of the plate boundary, this implies the small contribution of the force applied at plate boundary to the stress field in the land area. It is the basic problem to know the static frictional coefficient of the plate boundary in order to understand the stress field in the northeastern Honshu correctly.

It has been inferred that the frictional strength is small for the San Andreas Fault that is located at the plate boundary. However, it is impossible without any condition to argue that the frictional coefficient of plate boundary faults is small, because the structural materials of the blocks across the fault plane are similar for strike slip fault and different for the reverse fault at the plate boundary. Further, there seems to be no restriction on the confining pressure for the strike slip fault, while the confining pressure increases with an increase in depth for the reverse fault.

The Nojima fault appears to be weak, even if it is not located at the plate boundary. The fault has the damaged zone where the shear stress is small. It can be interpreted that this small shear stress is caused by the small fracture strength of damaged rocks in the zone. From these result and interpretation, it has been shown that damaged zone has the elastic property of the large Young's modulus to the stress normal to the fault plane and the small rigidity to the shear stress, and further that this elastic property of damaged zone can be one of the causes of weak fault. The elastic property of damaged zone is characterized by the anisotropy. The anisotropy is caused from the orientation of the tensile cracks induced by the applied stress. The laboratory experiments show that the tensile cracks are kept open even under high confining pressure. The reason may be that the tensile cracks are induced by the stress concentrations around the tips of shear microfracture.

Damaged zone is considered to be the remains of process zone. The zone is expected thus to be a part of fault zone structure, which is common to any types of faults. The stress in and around fault zone is the most important information to clarify the strength of faults. Even if we have no data of the stress, the followings may be useful to know the stress state and the strength of faults; 1) to clarify the existence of the damaged zone, 2) to clarify the elastic property of damaged zone especially its anisotropy, 3) to clarify the fracture density in damaged zone, and 4) to know the distribution of damaged zones along faults or plate boundary.